Application of Sustainable Architecture Principles in Simple House Design in Klambir Lima Village

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Abstract
The application of sustainable architecture principlesto simple houses is important in maintaininga balance between the housing needs of the community and environmental sustainability.This study aims to analyze the application of sustainable architecture principlesin the design of simple houses in Klambir Lima Village, Deli Serdang Regency.The research method used is a qualitative approach with field observations, community interviews, and visual documentation of simple housesthat have been built. The results of the study show that most of the community has indirectly applied sustainability principles, such as the use of local materials, natural cross ventilation, and simple rainwater management systems. However, more targeted education and design guidance are still needed so that sustainable architecture principles can beoptimally applied in a rural context.

Keywords: Sustainable Architecture, Simple Houses, Green Buildings, Local Materials, Klambir Lima Village

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Introduction

The concept of sustainable architecture is a design approach that focuses on the balance between human needs and environmental sustainability (Yeang, 1999) in [1]. In the context of housing development, this principle seeks to minimize the negative impact of buildings on the environment through energy efficiency, resource management, and the use of local materials.

The village of Klambir Lima in Deli Serdang Regency has experienced significant development due to an increase in population and housing needs. However, the construction of simple houses in this area tends to still ignore the aspect of sustainability. In fact, the application of sustainable architecture principles not only protects the environment but can also reduce building operating costs in the long term [2].

This study aims to identify the extent to which sustainable architecture principles are applied in the design of simple houses in Klambir Lima Village and to provide design recommendations that are in line with the social and economic conditions of the local community.

Research Methodology

This study uses a qualitative-descriptive approach with a case study method, which aims to understand the existing conditions of simple houses in Klambir Lima Village and to design a model that is in accordance with the principles of sustainable architecture. This approach was chosen because it is able to explore in depth the relationship between environmental conditions, user behavior, and building characteristics [3].

The research location is in Klambir Lima Village, Hamparan Perak Subdistrict, Deli Serdang Regency, North Sumatra. This area was chosen because it has the potential for rural settlement development with a tropical environment and a community that still maintains some of its local cultural values in the form of its house architecture.

The data used in this study consists of:

1. Primary Data, obtained through:
    a. Field observations of the physical condition of buildings, sites, and the surrounding environment
    b. nterviews with residents regarding space requirements, comfort, and local cultural values
    c. Visual documentation in the form of floor plans and sketches of existing simple houses at the research site.
2. Secondary data, obtained from:
    a. Literature on sustainable architecture, green architecture concepts, and simple houses
    b. Regional spatial planning (RTRW) documents for Deli Serdang Regency
    c. Climate and solar direction data from BMKG.

The analysis was conducted by combining descriptive qualitative analysis and architectural design analysis, including:

1. Site and environmental analysis
   Identifying climatic conditions, sun direction, wind patterns, and vegetation around the site.
2. Existing architectural analysis
   Analyzing the form, orientation, ventilation system, materials, and structure of simple houses in Klambir Lima Village.

Results

1. Existing Conditions of the Site in Klambir Lima Village

Source: Author's data processing

Figure 1. Location plan for the construction of simple houses

Klambir Lima Village is an area with a humid tropical climate, with an average temperature of 27–33°C and high humidity. Most of the houses in this village are simple permanent houses with a building area ranging from 36–60 m², using main materials such as red brick and zinc roofing.

Observations show that most houses have suboptimal air circulation and natural lighting. These conditions cause the indoor temperature to be relatively hot during the day and uncomfortable for residents.

In addition, the pattern of house construction, which tends to follow functional needs without considering the orientation of the building to the sun and wind direction, results in inefficient energy use. However, a positive finding is the continued application of local cultural elements, such as the use of the front terrace as a social space, simple gable roofs that are suitable for the tropical climate, and green open spaces that support the balance of the microecosystem in the residential environment.

Source: Author's Documentation

Figure 2. Several houses in Klambir Lima Village

2. Analysis of the Application of Sustainable Architecture Principles

The application of sustainable architecture principles in the context of simple houses in Klambir Lima Village was carried out with reference to the three main pillars of sustainability, namely the environment, society, and economy, as well as taking into account the principles of green architecture.

According to Karyono (2010) in Green Architecture: An Introduction to Understanding Green Architecture in Indonesia, green architecture is a consequence of the concept of sustainable architecture. By designing green architecture, it is hoped that humans can live and carry out activities on this earth in a sustainable manner. Green architecture minimizes the use of natural resources by humans to ensure that future generations can utilize them for their livelihoods. Green architecture also emphasizes the need to minimize the negative impact of buildings on the environment in which humans live.

In theory, Vale & Vale (1996) in Green Architecture: Design for a Sustainable Future reveal that green architecture, including green buildings, must have the following criteria:

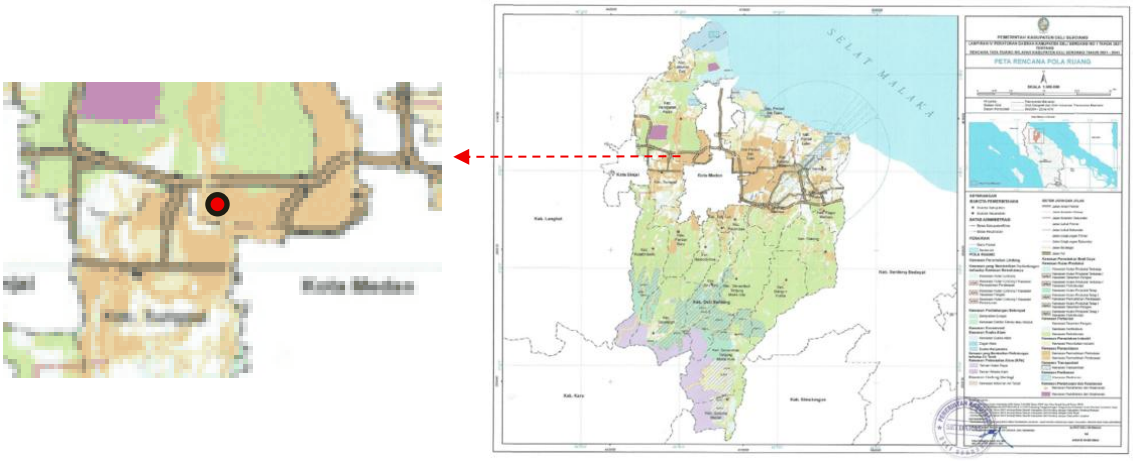
a. Conserving energy
b. Working with climate
c. Respect for site
d. Respect for user.
e. Limitting new resource
f. Holistic, comprehensive application of the five principles above.

The green architecture concept applied to this design is the green building standard used in Indonesia, namely Greenship by the Green Building Council Indonesia (GBCI). There are seven aspects assessed in the Greenship standard, namely:

a. Appropriate Site Development
b. Energy Efficiency and Conservation
c. Water Conservation
d. Material Resource and Cycle
e. Indoor Health and Comfort
f. Building Environment and Management

Results of observations and analysis of several houses in Klambir Lima Village

a. Appropriate Site Development



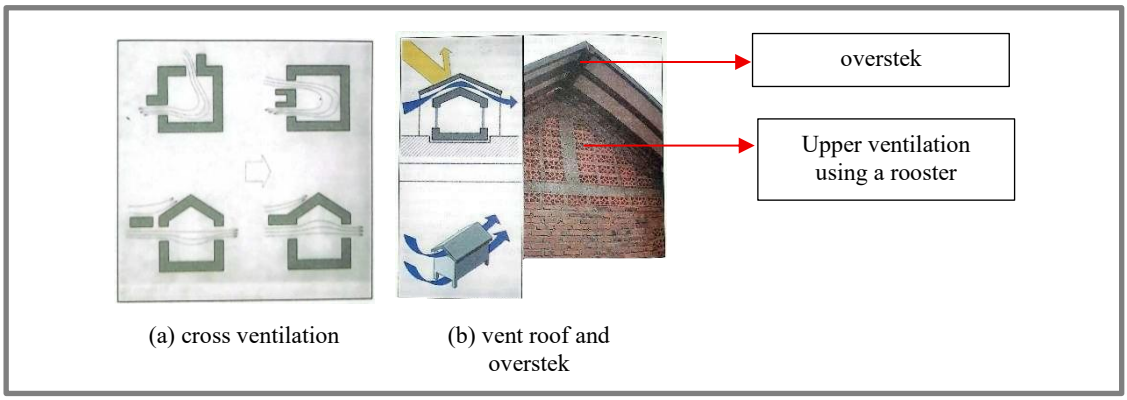
Source: Regional spatial planning map of Deli Serdang Regency

Figure 3. Appropriate Site Development Analysis

Based on the provisions of the Deli Serdang Regency Spatial Plan, the research site is located in a residential area that allows for the development of residential houses with a maximum floor area ratio (FAR) of 60% and a minimum green space ratio of

30%. The simple house design in Klambir Lima Village applies green architecture principles by maintaining a balance between built-up areas and green open spaces, preserving natural drainage, and adjusting the orientation of the building to the direction of the sun and prevailing winds. Thus, the site development is considered to be in accordance with the RTRW provisions while also meeting the criteria for sustainable buildings.

b. Energy Efficiency and Natural Lighting

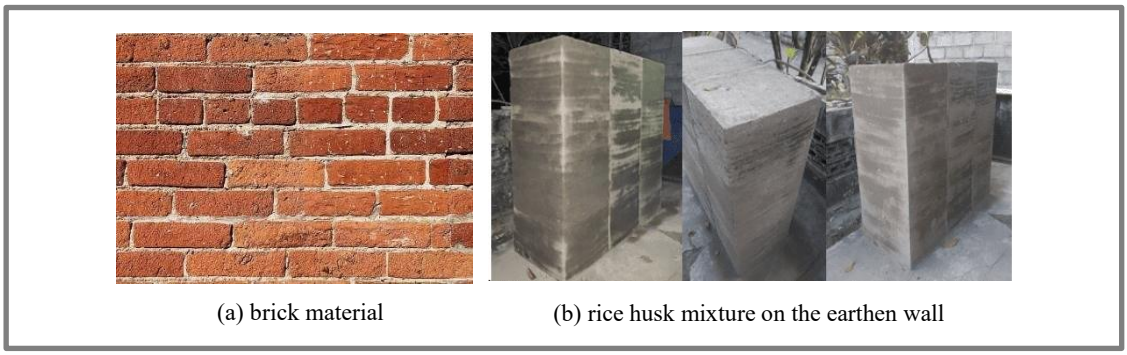


Source: Karyono (2010)

Figure 4. Energy efficiency and natural lighting analysis

The building is oriented north-south to minimize direct sunlight exposure on the east and west sides. Window openings are enlarged on the north and south sides to maximize natural cross ventilation. The roof is designed with roof vents to remove hot air from the interior, and the use of 70-100 cm overhangs to reduce the amount of solar heat entering through the walls and windows. The natural lighting system is enhanced by the use of overhead vents (louvers or roosters).

c. Use of Environmentally Friendly Materials

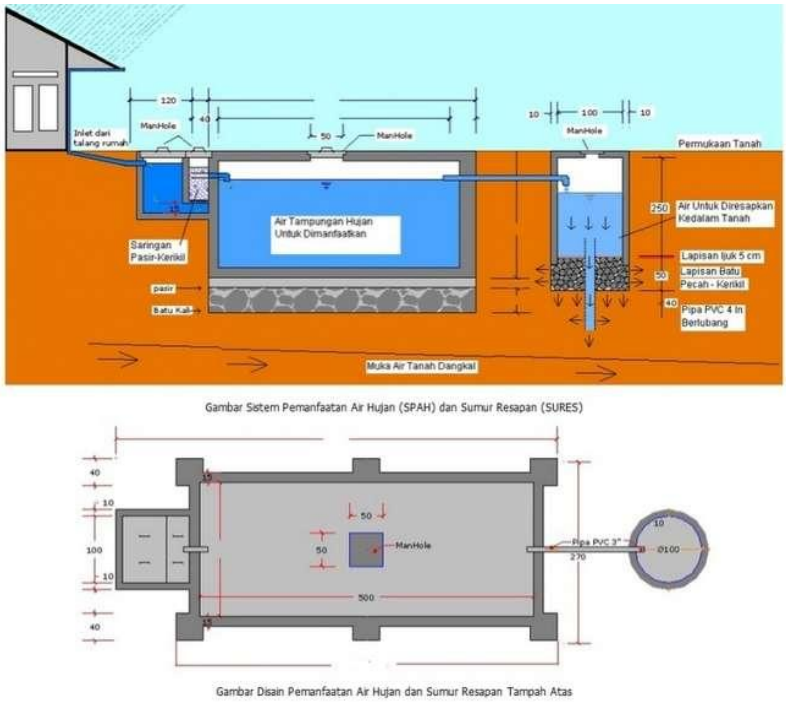


Source: Mulyadi (2020), Adhipramana et al., (2023)

Figure 5. Analysis of environmentally friendly material usage

The materials used were selected based on local availability and resistance to tropical climates, such as local red bricks for the main walls, which have good thermal capacity, coconut wood and bamboo for interior elements and lightweight structures, and clay tiles or shingle roofs as a substitute for zinc to reduce the effects of radiant heat. In addition, the use of organic waste as alternative materials (e.g., rice husk mixture in earth walls) was tested as a local innovation for cost efficiency and environmental sustainability.

d. Water Conservation and Environmental Management



Source: Wicaksono (2015)

Figure 6. Water conservation analysis

The house design includes a rainwater harvesting system with gutters and underground tanks with a capacity of 1000–1500 liters. This water is used for non-potable needs such as watering plants and washing. Domestic waste is drained through a simple infiltration well with layers of gravel and sand to aid natural absorption. Local vegetation such as shade trees and hedges are planted around the house to lower the microclimate temperature and add ecological aesthetic value.

e. Indoor Air Quality and Comfort

Source: Author's documentation

Figure 7. Analysis of openings in houses that affect indoor health

Green architecture design emphasizes the importance of indoor health through natural lighting, cross ventilation, and the use of non-toxic materials. Occupant comfort is measured in terms of thermal, visual, and acoustic aspects, which are passively

regulated according to tropical climatic conditions. Measurements taken in a simple house in Klambir Lima Village show that green architecture principles can improve thermal comfort and reduce energy consumption by up to 30%.

f. Local Social and Cultural Aspects

The simple house design is based on user activities and community social life, with a spacious terrace serving as a transitional space between public and private areas. The terrace functions as a space for social interaction, preserving the values of mutual cooperation and community spirit in the village. The interior space is designed to be flexible so that it can accommodate large family gatherings and traditional ceremonies that are still frequently held by the Klambir Lima community.

Conclusion

The findings of this study indicate that the application of sustainable architecture principles to simple house design in Klambir Lima Village contributes significantly to improving environmental quality, energy efficiency, and the well-being of residents. The research shows that most of the community has unconsciously adopted several green design principles such as utilizing locally available materials, incorporating natural ventilation, and managing rainwater for daily needs. However, these implementations are still partial and lack systematic design guidelines.

Based on the analysis using the *Greenship* assessment criteria by the Green Building Council Indonesia (GBCI), several aspects of sustainable architecture have been fulfilled. These include appropriate site development, energy and water conservation, use of eco-friendly materials, and enhancement of indoor health and comfort. The orientation of the building, optimized openings, and use of vegetative shading effectively reduce solar heat gain and improve indoor thermal comfort by up to 30%.

In addition, the design respects the local cultural and social context by maintaining spaces that encourage community interaction—such as terraces and semi-open areas—reflecting the village's traditional lifestyle. This integration demonstrates that sustainable architecture can be applied in rural housing without requiring complex or costly technologies.

Therefore, it can be concluded that the principles of sustainable architecture are highly relevant for rural housing development. Their implementation in Klambir Lima Village not only improves environmental performance but also enhances the socio-cultural sustainability of the community. The study recommends that future housing programs in similar rural areas adopt these principles through design guidelines, community education, and government support to achieve environmentally responsible and livable settlements.

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