Archifiles

Journal of Architecture and Building Environment
Vol.1 No.1, March 2025

APPLICATION OF SUSTAINABLE ARCHITECTURE ON AGRO-TOURISM OF PALM OIL PLANTATIONS IN SIAK

Zikra Hafizah[1], Tri Yuni Iswati[2]

[1,2] Department of Architecture, Faculty of Engineering, Universitas Sebelas Maret, Surakarta
Email: zikra.hafizah2119@gmail.com

Received: 3/01/2025 | Accepted: 15/02/2025 | Published: 17/03/2025

Abstract

Siak Regency, located in Riau Province, is a region with a strong Malay culture and an economy based on the oil palm plantation sector. With a plantation area of 346,897 hectares, Siak is one of the main producers of oil palm in Indonesia. However, the potential of educational tourism in Siak is still not optimal due to the lack of infrastructure and promotion. Based on the potential and existing problems, an agritourism area is needed that can integrate environmental education, energy efficiency, and preservation of local culture through a sustainable architecture approach. The methods used include site analysis, literature review, precedent study, and the application of passive design principles such as natural ventilation, passive lighting, rainwater harvesting systems, and solar panels. The results show that the agritourism area can support environmental preservation, increase tourist attractiveness, and contribute to the development of adaptive and sustainable agriculture-based tourism.

Keywords: *Agritourism, Sustainable Architecture, Oil Palm Plantation, Siak.*

INTRODUCTION

Siak Regency is located in Riau Province, Indonesia, which is known as a region with a long history, rich Malay culture, and great economic potential. As the former center of the Sultanate of Siak Sri Indrapura, the region has a strong cultural and historical appeal through historical sites such as Siak Palace, Sultan Syarif Hasyim Mosque, and Balai Kerapatan Tinggi. In addition, the geographical condition of Siak, which is dominated by flat land and swamps with an area of 8,556 km², provides great opportunities for the development of the plantation sector, especially oil palm. Until 2023, the area of oil palm plantations in Siak reached 346,897 hectares, making it one of the largest palm oil producing regions in Indonesia (BPS Siak, 2023). This sector is a major source of livelihood for local communities, especially smallholders.

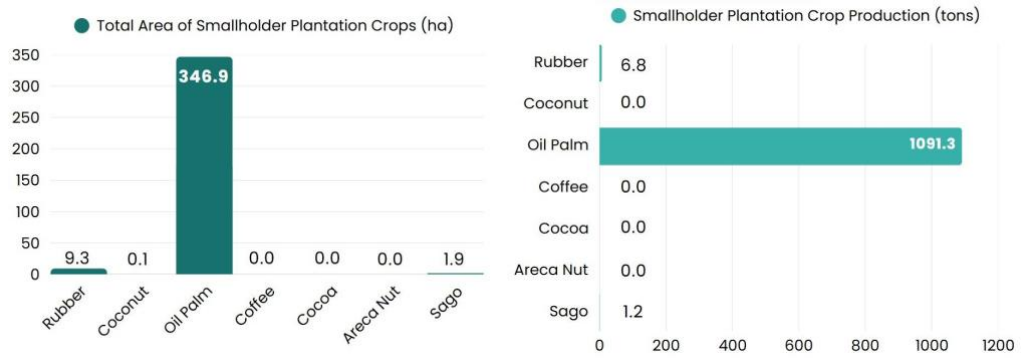

Figure 1. Diagram of Plantation Area and Production of Smallholder Plantation Crops in Siak Regency, 2023
Source: *BPS Kabupaten Siak, 2024*

However, economic dependence on the oil palm plantation sector creates a number of challenges, including environmental damage due to land conversion, carbon emissions from conventional practices, and global commodity price fluctuations. To reduce the risk of this dependency, economic diversification through the development of agritourism is one strategic solution. Agritourism, which integrates agriculture with tourism, has great potential to provide added economic value, education, and environmental preservation. According to Utama and Junaedi (2019), agritourism can increase farmers' income and provide educational experiences for tourists about sustainable agricultural practices. In addition, agritourism can enrich local tourism destinations by providing a unique experience that combines natural beauty, local culture, and educational activities.

The development of agro-tourism based on oil palm plantations in Siak has great opportunities to support educational tourism and ecotourism. However, this potential has not been optimized due to limited infrastructure, lack of promotion, and lack of policy support. In addition, unsustainable environmental management is also a challenge, especially in terms of palm oil waste management and land conservation.

In this context, sustainable architecture is a relevant approach to address these issues. Sustainable architecture, according to Kibert (2016), is a design approach that reduces negative impacts on the environment by ensuring energy efficiency, wise resource management, and the creation of healthy spaces for people. Furthermore, Yeang (2006) emphasizes that sustainable architecture is not just about environmentally friendly buildings, but also about designs that are integrated with local ecosystems, support biodiversity, and meet the social and economic needs of the community.

Paola Sassi (2006) outlines six main principles of sustainable architecture, namely land, energy, water, materials, health and community. These principles are applied to the agritourism of oil palm plantations in Siak. Energy efficiency is applied by utilizing cross ventilation, passive lighting, and solar panels to reduce fossil energy dependence. Water management is done with rainwater harvesting technology for irrigation, sanitation, and landscape maintenance. Local materials such as bamboo and recycled materials are used to reduce the carbon footprint and support the local economy. The building design also supports biodiversity through the use of native vegetation and ponds as habitats for local fauna. Spaces are designed to provide

health and comfort through natural ventilation, adequate lighting, and low-VOC materials. Space and circulation efficiency are prioritized to ensure the comfort of tourists and farmers in education, recreation, and management activities.

This research aims to design an agro-tourism area based on oil palm plantations in Siak Regency by applying the principles of sustainable architecture. The scope of the research includes site analysis, spatial planning, building design, and integration of environmentally friendly technology. Related issues include environmental conservation, local community empowerment, and preservation of the distinctive Malay culture in Siak. Thus, this research is expected to contribute to the diversification of the local economy through the development of sustainable agritourism, increase environmental awareness, and preserve local culture.

METHODS

The research method used in planning and designing this design object is qualitative descriptive with four main stages, namely problem identification, data collection, data analysis, and concept formulation. The problem identification stage is carried out to identify the main issues in the development of agritourism based on oil palm plantations in Siak, such as the lack of educational tourism, the environmental impact of plantations, and the need for the application of sustainable architecture. This process involved a literature review on agritourism, sustainable architecture, oil palm plantations, and initial observations.

The data collection stage involved collecting primary data through field observations, interviews, and site studies related to geographical, climatic, and infrastructure conditions. Secondary data was obtained from literature on sustainable architecture, agritourism, and precedent studies from similar projects, as well as statistical data from BPS Siak Regency.

The data analysis stage was conducted to evaluate the potential and constraints of the location, space requirements, and the relevance of sustainable architecture principles. The analysis included site studies for solar orientation, wind direction, and environmental risks, as well as precedent studies to understand the application of green technology and eco-design.

The final stage is to formulate a concept, which is the result of a response to the design criteria and analysis that has been carried out. This formulation includes various aspects, such as site concept, form concept and visualization, spatial concept, structural concept, and building utility concept.

RESULT AND DISCUSSION

The oil palm plantation-based agro-tourism area in Siak Regency is designed as an educational and recreational tourist destination that integrates the principles of sustainable architecture. This area has the main function to provide experience to visitors about oil palm cultivation, processing of its derivative products, and environmental preservation. This object is designed with attention to visitor comfort,

energy efficiency, environmental sustainability, and empowerment of local communities through tourism and creative economic activities.
The site is located on Jl. Simpang Buatan, Kampung Rempak, Siak District, with an area of 26,000 m². This location is strategic because it is near the center of Siak City and has good accessibility via the main road. The site is also surrounded by residential areas to the west, green plantation areas to the north and east, and other public facilities. Based on the Regional Spatial Plan of Siak Regency for 2021-2041, this area can be developed as a tourism zone with the provisions of a maximum Basic Building Coefficient (KDB) of 50%, a minimum Green Basic Coefficient (KDH) of 20%, and a Building Setback Line (GSB) of 8 meters from the main road.

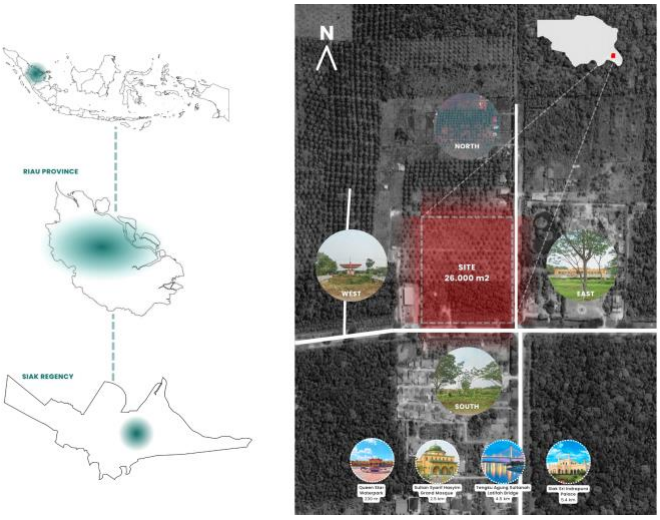

Figure 2. Location and Existing Building Site

One of the first steps in analyzing the site is to understand the local climatic conditions, as climate affects building performance in terms of lighting, ventilation and energy savings. The site is located in the tropics, specifically in Siak, which is known for its high rainfall and relatively hot temperatures. Therefore, the orientation of the building is designed with climate factors in mind, such as daylighting and air circulation, to reduce reliance on external energy. The main building is oriented with respect to the position of the sun, by facing in a direction that can maximize daylighting and reduce direct exposure to sunlight on walls that heat up easily.

To maximize the use of natural light, the site is designed with large openings on the north and south sides, leading to natural lighting throughout the day. Meanwhile, the east and west walls, which are exposed to direct sunlight in the morning and evening, are fitted with natural sunshades such as vines and secondary skins made of bamboo or wood. Thus, energy use for lighting and cooling can be reduced, providing indoor thermal comfort and reducing the building's carbon footprint.

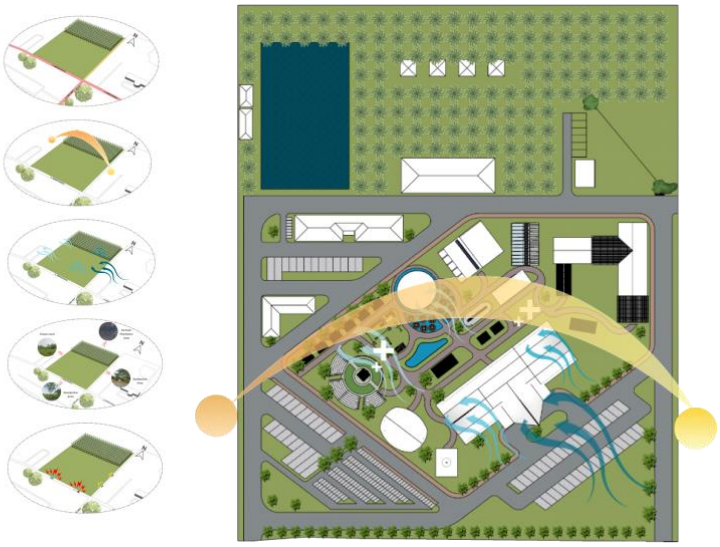

Figure 3. Site Analysis and Concept of Palm Oil Plantation Agrotourism Area

The space in the agritourism area is designed based on the main functions that support education, recreation, and area operations. Educational zones, such as the palm oil museum and laboratory, are designed to educate visitors about the process of cultivating and processing palm oil. The museum uses a layout that maximizes natural lighting through large windows and skylights, thereby reducing electricity consumption during the day. Laboratories and workshops support interactive activities such as the making of processed palm oil products and the utilization of waste as compost.

The recreation zone takes advantage of the natural scenery of the oil palm plantation, with facilities such as an educational park and pedestrian paths designed to provide a visual experience and direct interaction with nature. Green open spaces are integrated with the landscape to create a comfortable space for visitors while supporting environmental conservation.

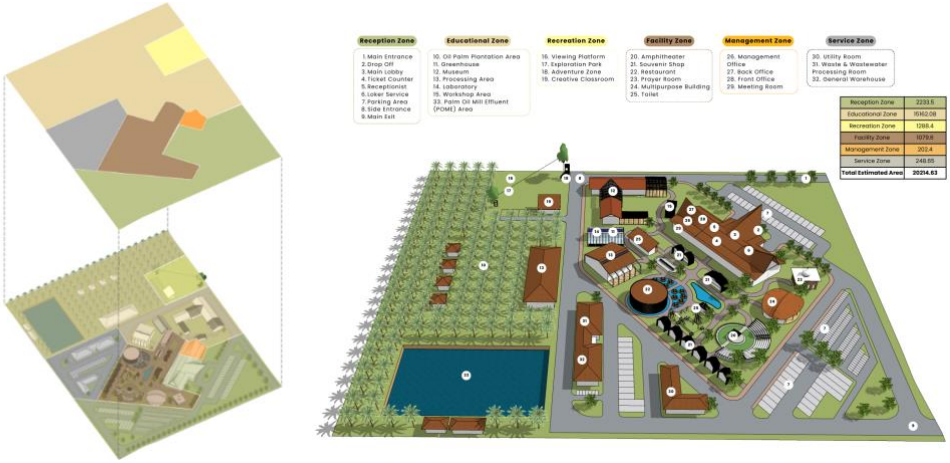

Figure 4. Zoning and Spatial Concept of Oil Palm Plantation Agrotourism Area

The form and appearance of the agro-tourism buildings are designed with sustainable architectural principles that focus on energy efficiency, the use of environmentally friendly materials, and integration with local culture. The main building adopts the kajang folding roof concept, with high and steep roofs that support natural air

circulation and drain rainwater into a rainwater harvesting system. This not only reduces the risk of inundation but also utilizes rainfall for irrigation and sanitation.

The façade of the building is equipped with a secondary skin made from local bamboo and wood, designed with modern techniques for tropical climate resistance. These materials act as sunshades, lowering indoor temperatures and reducing the need for air conditioning. The use of bamboo and wood also supports sustainability as these materials are easily renewable and come from local resources, reducing the carbon footprint of material transportation and supporting the local economy.

The building is designed with large openings in the walls and roof to maximize natural light, reducing electricity consumption during the day. In addition, the building also uses low-VOC materials in paints and coatings to maintain healthy indoor air quality. By combining traditional elements and modern technology, the building design creates a balance between environmental sustainability, aesthetics and user comfort.

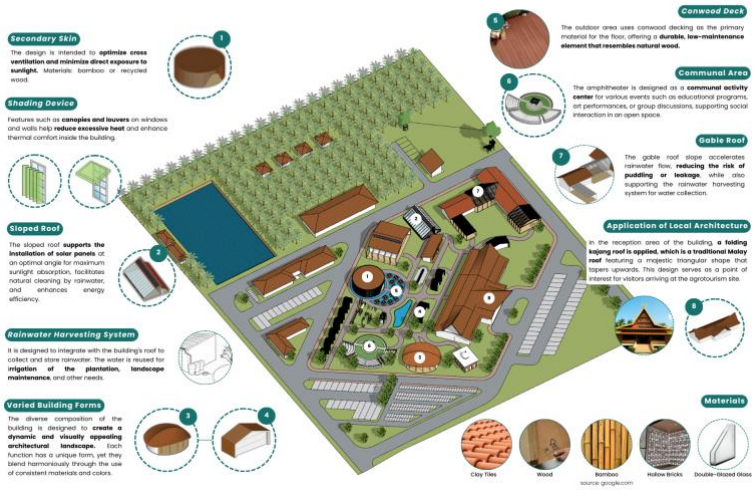

Figure 5. Concept of Shape and Appearance of Oil Palm Plantation Agrotourism Area

The building structure is designed with sustainable architecture principles in mind, prioritizing material efficiency and durability, as well as the ability to absorb and store energy optimally. The main frame of the building uses materials that have high resistance to tropical climates, such as wood derived from sustainably managed local resources. This wood was chosen not only for its strong mechanical properties, but also for its ability to absorb carbon from the atmosphere, helping to reduce the building's overall carbon footprint. In addition, the use of wood materials derived from renewable sources reduces the negative impact on the environment, especially in terms of deforestation.

The building's structural system is designed to maximize the use of natural materials by reducing reliance on concrete and steel-based building materials that require high energy in production. By adopting lightweight and modular construction techniques, the building can be built in less time and reduce construction waste. The structural strength of the building is also supported by the use of modern connection techniques

that reduce the use of metal nails or bolts, minimizing energy consumption in the construction process.

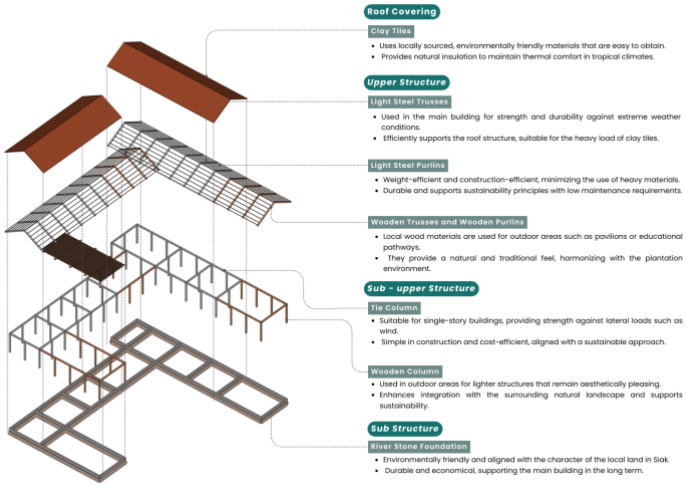

Figure 6. Agritourism Building Structure Concept

To ensure occupant comfort and long-term energy efficiency, the building's utility systems are designed with environmentally friendly technology. The main energy source used is renewable energy, such as solar panels installed on the roof of the building. These solar panels not only reduce dependence on electricity from the public grid, but also generate enough energy to meet most of the building's electrical needs, including lighting, ventilation systems and electronic equipment. As such, the building can operate autonomously in terms of energy consumption, reducing its operational costs and impact on the environment.

The water treatment system is designed with efficiency and sustainability in mind. Rainwater that falls on the roof of the building is collected through a rainwater harvesting system that is channeled to a storage tank. This water is used for irrigation of parks and gardens around the agritourism area, as well as for sanitation purposes, reducing dependence on groundwater sources or water from the city network. By optimizing the utilization of rainwater, this building can save water usage and reduce the risk of drought in the surrounding area.

In addition, wastewater treatment is also carried out with environmentally friendly technology. A biofiltration system is used to process wastewater before it is discharged into waterways. This system relies on plants and microorganisms to filter out impurities and chemicals in the water, so that the water discharged back into the environment remains safe and does not pollute the surrounding nature. This creates a more closed and environmentally friendly cycle, and reduces the burden on conventional wastewater treatment systems.

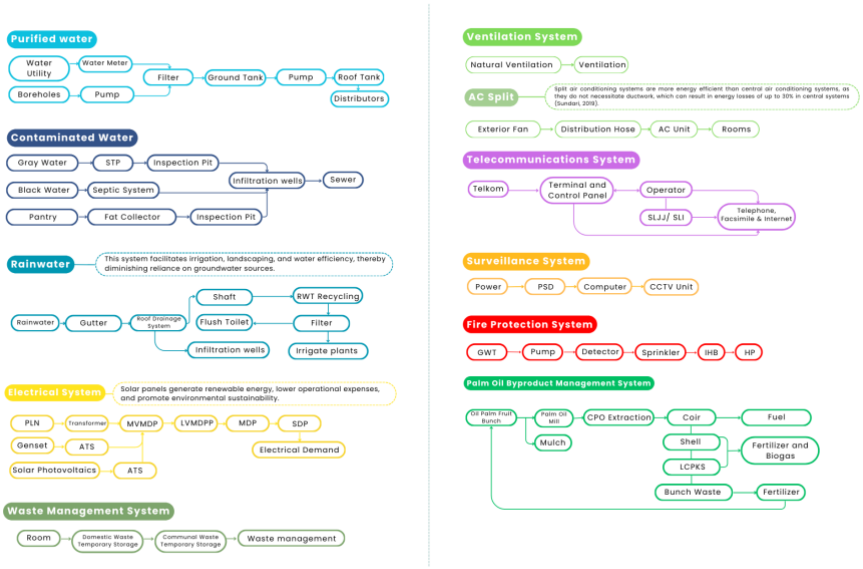

Figure 7. Utility Scheme of Agritourism Area

CONCLUSION

This research resulted in the design of an agro-tourism area based on oil palm plantations in Siak Regency by integrating the principles of sustainable architecture. These principles include efficient land use, energy optimization through natural ventilation systems and solar panels, water management through rainwater harvesting, use of environmentally friendly local materials, creation of healthy and comfortable spaces for visitors, and empowerment of local communities. The design results show that a sustainable architecture approach can create a tourist area that is not only environmentally friendly but also educative, which strengthens public awareness of the importance of sustainability.

The area is designed as a space that combines educational, recreational and economic functions while taking into account biodiversity and local culture. Visitors can learn sustainable agricultural practices and ecological management of oil palm plantations. In addition, the design supports the economic diversification of local communities through creative economic activities and community-based tourism. The main advantage of this design is the application of a holistic approach that not only pays attention to environmental aspects, but also provides thermal, visual comfort, and quality spatial experiences for visitors.

This oil palm plantation-based agro-tourism area is designed with the concept of sustainable architecture to meet the needs of educational tourism space, while supporting the preservation of the environment and local culture of Siak Regency. This approach is expected to have a positive social, economic, and ecological impact, through the integration of sustainability principles such as energy efficiency, water management, local material utilization, and community empowerment.

Suggestions for further development include more in-depth research and field studies, particularly on aspects of Malay culture to be better integrated in the design of the area. Further research into visitor characteristics and needs is also needed to ensure an optimal and satisfying tourism experience. In addition, evaluation of the site's environmental conditions, such as soil quality and water availability, is essential to support decisions on the selection of appropriate structures and materials. These steps will ensure that the agritourism area reflects the principles of sustainability in a holistic manner and provides long-term benefits to the environment, local communities and visitors.

REFERENCES

Siak District Statistics Center Agency. Plantation Area and Production of Smallholder Plantation Crops in Siak Regency. 2024. Accessed April 30, 2025. https://siakkab.bps.go.id.

Hawkins, P. Inclusive Design: Principles and Practice. London: Routledge, 2008.

Kibert, Charles J. Sustainable Construction: Green Building Design and Delivery. New Jersey: John Wiley & Sons, 2016.

Paola, Stefano. Strategies for Sustainable Architecture. London: Taylor & Francis, 2006.

Utama, I. B. R., and H. Junaedi. “Agritourism as an Alternative to Economic Diversification.” Journal of Sustainable Tourism 17, no. 2 (2019): 145–156.

Yeang, Ken. Ecodesign: A Manual for Ecological Design. London: Wiley-Academy, 2006 Building