

MANGROVE EDUCATIONAL TOURISM DESIGN WITH SUSTAINABLE ARCHITECTURE APPROACH IN PANTAI KAMPUNG NIPAH, SERDANG BEDAGAI**Rifa Lisly Santika ¹, Nurlisa Ginting ²**¹*Department of Architecture, Faculty of Engineering, Universitas Sumatera Utara, Medan, 20222, Indonesia*Email: rifaalislyy@gmail.com

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Abstract

Mangrove educational tourism offers an in-depth understanding of the ecologically, economically, and socially valuable mangrove ecosystem. Indonesia, with the largest mangrove ecosystem in the world, faces the challenge of mangrove destruction due to irresponsible land conversion. Conservation efforts through educational tourism can improve the local economy and reduce carbon emissions. A sustainable approach to planning and development, involving the principles of eco-friendly architecture, is essential to protect and restore coastal ecosystems. The implementation of energy strategies, water and waste management, and cultural preservation in the design of tourism villages will ensure environmental sustainability and community well-being. Intensive environmental studies and education can raise global awareness of the importance of mangroves, support sustainable tourism, and contribute to greenhouse gas emission reduction targets.

Article History*Submitted: 4 April 2025**Accepted: 7 April 2025**Published: 8 April 2025***Keywords***Educational Tourism,
Mangrove, Sustainable
Architecture***1. Introduction**

Educational tourism is a form of tourism that aims to provide understanding or knowledge about the tourism sector being visited. (Hermawan, et al., 2021) With the presence of educational facilities in a tourist area, it will increase tourists' knowledge about new understanding, in this case understanding about mangroves. Mangroves are an ecosystem that has very valuable value in terms of ecology, economy, and social. At the local level, mangroves provide various ecosystem services such as food sources and livelihoods for local communities. Globally, mangroves have great potential in reducing climate change because of their great ability to store carbon. By understanding that stopping carbon emissions stored in mangroves can make a significant contribution to achieving the target of reducing greenhouse gas emissions. (Nurhati & Murdiyarso, 2023) Based on this statement, mangrove educational tourism can improve the economy of people living around the coast.

According to the Ministry of Environment and Forestry's Public Relations Data in 2017, Indonesia has the largest mangrove ecosystem in the world and a high level of biodiversity. According to research by the North Sumatra Environmental Agency in 2013, around 90% of mangrove forests in North Sumatra are in a fairly severe state of damage. The main cause of this damage is the change in land use into oil palm plantations covering 12,000 hectares and ponds covering 10,000 hectares. Continuous and irresponsible use of mangrove forests can threaten the sustainability of the mangrove forest ecosystem. However, development can still be carried out without damaging the coastal ecosystem and mangrove forests by following appropriate planning guidelines, which involve attention to the functions of coastal and marine ecosystems. This includes designing green zones along the coast, preserving green mangrove forest belts to protect the coast, maintaining the life cycle of coastal aquatic biota such as fish, shrimp, shellfish, and turtles, as well as protecting coral reefs, seaweed, and preventing seawater intrusion. (Harefa, et al., 2020) With the right and sustainable approach, development

can be carried out without damaging mangrove ecosystems, which are not only important for biodiversity, but also for human well-being that depends on healthy coastal ecosystems.

Mangrove studies as educational and learning facilities are very important in the context of environmental education and sustainable tourism today. As the global community grapples with the urgent need for conservation and awareness in the face of climate change and biodiversity loss, mangrove ecosystems are important areas for exploration. (Verawati & Idrus, 2023) To create a mangrove forest that becomes an educational tourism attraction, a planned effort is needed that involves all parties to better understand and care about the important role of mangrove forests in human life. This can be achieved through educational steps for tourists and local residents around the area, with the aim of maintaining and preserving the existence of mangrove forests. (Rijal, et al., 2020) The statement about the importance of mangroves as educational facilities strengthens my reasons for building educational tourism in the mangrove area.

The sustainable architecture approach is a concept in building design that not only considers the comfort of its occupants, but also takes into account its impact on the environment. The principles of sustainable architecture are very important today, requiring a shared awareness to develop environmentally friendly and sustainable buildings, by reducing the drive to seek profit alone. Sustainable architecture has long-term benefits for all parties without sacrificing the beauty and aesthetics of the building. The main goal is to restore the earth and the environment in which we currently live. (Mu'min & Satwikasari, 2020) The principles of sustainable architecture, as explained by Ardiani (2016) and Sassi (2006), in the book *Sustainable Architecture: Sustainable Architecture*, include various important aspects in designing environmentally friendly buildings, namely Urban Ecology, Energy Strategy, Water, Waste, Materials, Environmental Community, Economic Strategy, Cultural Preservation, and Operational Management. These principles will later be applied to tourist villages that will be designed in order to create spaces that are not only comfortable but also environmentally friendly and have long-term benefits.

The design location will be carried out at the Mangrove Beach, Nipah Village, Serdang Bedagai Regency. The Mangrove forest ecosystem at Nipah Village Beach, Serdang Bedagai Regency has an area of ± 9 Ha. (Harefa, et al., 2020) The characteristics of mangrove tourism visitors in Nipah Village have an average age of around 21.82 years, with the majority having an educational background ranging from high school to college. The natural beauty of the Mangrove Tourism Object in Nipah Village is considered 'beautiful' by tourists. They can enjoy the beach atmosphere and feel the natural beauty of the Mangrove ecosystem around the beach. This is in accordance with the statement that natural beauty is one of the main natural attractions to attract visitors. (Purwoko, et al., 2023) The mangrove ecosystem is the main natural attraction on this beach, so it will be very effective if educational tourism with a sustainable architecture approach is applied to this location.

2. Literature Review

2.1. Mangrove Educational Tourism

Suwantoro (1997) classifies educational tourism into four types, namely:

a) Educational Tourism Science / Science;

Science Educational Tourism is educational tourism based on science. This tour prioritizes information about the science obtained by tourists after traveling.

b) Sport / Sports Educational Tourism;

Sport / Sports Educational Tourism is educational tourism based on physical education or sports.

c) Culture Educational Tourism;

Culture Educational Tourism is also called Cultural Educational Tourism. This tour presents cultural education in the fields of art, customs and others related to culture.

d) Agribusiness Educational Tourism;

This educational tour is based on agro-ownership or agriculture and animal husbandry which is also the business of a company or individual.

In this case, mangrove educational tourism is included in the type of science-based educational tourism. Because in its application, this tour will tend to prioritize education or knowledge about the surrounding nature, especially the mangrove ecosystem.

The type of activity in a group of activities is the basis for determining the space needed. Activity actors consist of the manager and the visitors. The manager is the person in charge of managing building operations including building maintenance. While the visitors are people who are visiting tourist attractions enjoying the facilities available while learning. In the Educational Tourism Area, space requirements can be divided into four main groups (Irawan et al., 2020):

1. Public Facilities: Space required for activities that are accessible to all visitors.
2. Supporting Facilities: Spaces that support activities in public facilities.
3. Management Activities: Space required for tourism management and management activities.
4. Services: Space required for service activities to visitors.

Table 1 Definition of Mangrove Educational Tourism

No.	Name (Source)	Definition
1.	(Akhil & Kurniawan, 2021)	Mangrove Educational Tourism is tourism that has various educational potentials such as a closer introduction to nature, the availability of unique and prominent flora and fauna, the existence of tour guides, and the existence of unique customs in tourist attractions.
2.	UN Tourism	Educational tourism encompasses a type of travel where the primary motivation is the traveler's involvement and experience in learning, self-improvement, intellectual growth and skill development. Educational tourism represents a wide range of products and services related to academic studies, skill-building vacations, school trips, sports training, career development courses and language courses, to name a few.
3.	(Prasetyo, Manik, & Riyanti, 2021)	Educational tourism is a tourism activity in which tourists spend their vacation time traveling for the purpose of education and learning, either as the main focus or as one of the objectives.
4.	(Purwanti, Utomo, Indrayani, & Fattah, 2020)	Mangrove educational tourism is tourism with activities that have the aim of raising awareness to the community, especially the younger generation in the mangrove forest area, of the importance of the benefits of mangrove vegetation for coastal ecosystems.

2.2. Sustainable Architecture

Table 2 Definition of Sustainable Architecture

No.	Name (Source)	Definition
1.	(Steele, 1997)	Architecture designed to meet the needs of the present without compromising the ability of future generations

to meet their own needs. These needs vary between communities and regions, and are best determined by local people.

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|----|---|--|
| 2. | (Mu'min & Satwikasari, 2020)
(Pandu & Anggana, 2020) | The concept of designing a building that not only considers the comfort of its occupants, but also takes into account its impact on the environment that has long-term benefits for all parties without sacrificing the beauty and aesthetics of the building. |
| 3. | (Kurniawan P. , 2020) | Sustainable architecture is the application of concepts in architecture that support the principle of sustainability, i.e. keeping natural resources available for longer. The concept relates to the lifetime of the vital potential of natural resources and the human ecological environment, including agricultural, industrial, forestry and architectural systems. |
| 4. | (Hidayatulloh & Anisa, 2021) | Sustainable architecture is an idea in architecture that emphasizes development that takes care of the environment. |

The principles of sustainable architecture, as explained by Ardiani (2016) and Sassi (2006), in the book *Sustainable Architecture: Sustainable Architecture*, cover various aspects that are important in designing environmentally friendly buildings. Ardiani (2015) outlines nine main principles in sustainable architecture, namely urban ecology, energy strategy, water management, waste management, material use, community participation, economic strategy, cultural preservation, and operational management. A brief explanation of each principle follows:

- a) Urban Ecology: This principle emphasizes the importance of maintaining the sustainability of urban ecosystems to ensure the survival of people, animals and plants and preserve nature for future generations.
- b) Energy Strategy: This principle aims to reduce energy consumption or reuse wasted energy and make efficient use of renewable energy sources, both through technology and nontechnological practices.
- c) Water Management: This principle emphasizes saving water and reusing water for sustainable use.
- d) Manajemen Limbah: Prinsip ini mengadvokasi pengurangan, pengelolaan, dan daur ulang limbah dalam berbagai bentuknya (cair, padat, dan gas).
- d) Waste Management: This principle advocates the reduction, management and recycling of waste in its various forms (liquid, solid and gas).
- e) Material Use: This principle underscores the importance of using materials that are safe, environmentally friendly, and recyclable without jeopardizing the health of residents and do not pollute the environment during the manufacturing process.
- f) Community Participation: This principle emphasizes the importance of community participation in sustainable development, creating environmental awareness and promoting the formation of sustainable communities.
- g) Economic Strategy: This principle involves opening up opportunities for small or medium enterprises to support the local economy and reduce dependence on large economies.
- h) Cultural Preservation: This principle emphasizes the importance of preserving a nation's cultural heritage, traditions and identity as part of sustainable development.

- i) **Operational Management:** This principle covers maintenance and user knowledge of the systems and technologies used in buildings to ensure that they function properly and efficiently.

2.3. *Mangrove Educational Tourism with Sustainable Architecture Approach*

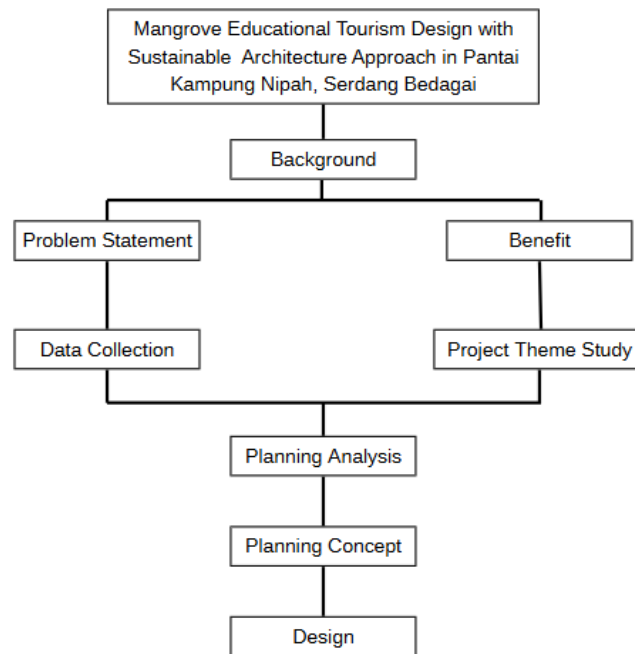
Mangrove educational tourism that applies a sustainable architecture approach is an initiative that integrates tourism infrastructure development by considering environmental, social, and economic aspects. In this case, the use of sustainable architecture principles guides the design and development of the space program for the mangrove tourism destination.

The Information and Education Center and Nature Laboratory form an important part of the infrastructure, providing opportunities for visitors to learn first-hand about the mangrove ecosystem and its important impact on the coastal environment. Tourist trails and exploration areas are designed to provide visitors with an interactive experience, while keeping in mind the preservation of the natural environment.

Support facilities, such as canteens and rest areas, are also taken into account by considering the principles of energy efficiency and waste management. In addition, interactive areas and workshops allow for a deeper understanding of mangroves through seminars and training activities, in line with the principle of community participation in sustainable development. The culture and tradition space is an important place to introduce cultural aspects and local values to visitors, in line with the principle of cultural preservation in sustainable architecture. As a result, mangrove educational tourism that applies a sustainable architecture approach not only provides a pleasant recreational experience, but also aims to raise environmental awareness and promote sustainability in mangrove ecosystem management.

3. Methodology

This study uses a qualitative method with a literature review approach, where the problem analysis is carried out through a literature study related to the design of mangrove educational tourism with a sustainable architecture approach. Various literature references are reviewed and interpreted to compile a summary of each study, with the aim of obtaining significant information to support this research. The purpose of this study is to design an educational tourism concept that focuses on preserving the mangrove ecosystem, as well as applying the principles of sustainable architecture to create an environmentally friendly and sustainable space. Thus, this study seeks to develop solutions that not only support ecological sustainability, but also provide economic and social benefits to the local community.

**Figure 1** Method/Approach

4. Findings

The application of sustainable architecture in buildings aims to create a comfortable atmosphere and pay attention to environmentally friendly development, by maximizing the use of available natural potential. Utilization of plants and water to regulate air temperature, energy efficient development, and the use of easily obtained building materials. (Kurniawan & Pamungkas, 2020) In the design of mangrove educational tourism, the application of sustainable architecture principles allows the use of mangrove plants and water to regulate air temperature and enhance the beauty of the environment. Energy-efficient development and the use of easily obtained building materials will reduce environmental impacts and speed up the construction process. This not only creates an attractive environment for visitors, but also contributes to the preservation of the mangrove ecosystem and the environment as a whole.

5. Discussion

5.1. Comparative Study of Similar Functions

5.1.1 Wisata Kebun Raya Mangrove Surabaya, Jawa Timur

Table 3 Activities and Service Facilities in Wisata Kebun Raya Mangrove

Activities	Services and Facilities
<ul style="list-style-type: none"> Viewing flora and fauna Enjoying the scenery Walking around the mangrove area Jogging Reading and increasing literacy lanting mangroves Worshipping Buying merchandise Picnic Eating Taking pictures 	<ul style="list-style-type: none"> Mangrove Forest 12m Monitoring Tower Jogging Track Suspension Bridge Library Science Center Musholla Restroom Auditorium Merchandise Culinary Tourism Center

<ul style="list-style-type: none"> • Riding rides 	<ul style="list-style-type: none"> • Boat Tour • Water Bike • Management Office • Photo Spot • Playground
Sumber: https://travel.kompas.com/ , https://dkpp.surabaya.go.id/	

5.1.2 Mangrove Centre Graha Indah, Balikpapan, Kalimantan Timur

Table 4 Activities and Service Facilities in Mangrove Centre Graha

Activities	Services and Facilities
<ul style="list-style-type: none"> • See flora and fauna • Tour the mangrove area • Eat and drink • Sanitation activities • Worship • Jogging • Plant mangroves • Take a boat 	<ul style="list-style-type: none"> • Mangrove Forest • Guest Area • Toilet and Prayer Room • 100 m Tracking Area • Surveillance House • Nursery Area • Five Boat Units
Sumber: https://repository.unmul.ac.id	

5.1.3 Bontang Mangrove Park TNK, Kalimantan Timur

Table 5 Activities and Service Facilities di Bontang Mangrove Park TNK

Activities	Services and Facilities
<ul style="list-style-type: none"> • See mangrove plants • Eat and drink • Worship • Sanitation activities • Rest • Jogging • Fishing • See fauna 	<ul style="list-style-type: none"> • Mangrove forest • Food court • Prayer room • Toilet • Gazebo • Tracking • Fishing pond • Mini Animal Zoo
Sumber: https://citytourism.bontangkota.go.id	

5.1.4 Comparison of Spatial Programs between Case Studies

Table 6 Comparison of Space Programs between Case Studies

Space Program		Wisata Kebun Raya Mangrove Surabaya	Mangrove Centre Graha Indah	Bontang Mangrove Park
Information and Education Center		✓	-	-
Library		✓	-	-
Natural Laboratory		✓	-	-
Tourist Trails and Exploration Areas		✓	✓	✓
Supporting Facilities	Canteen	✓	-	✓
	Rest area	✓	✓	✓
	Prayer Room	✓	✓	✓
	Toilet	✓	✓	✓

Interactive Area and Workshop		✓	✓	✓
Cultural and Tradition Space		-	-	-
Monitoring Tower or Surveillance Room		✓	✓	✓
Suspension bridge		✓	-	-
Auditorium		✓	-	-
Merchandise		✓	-	-
Management Office		✓	-	-
Living Area		-	✓	-
Nursery Area		-	✓	-
Gazebo		-	-	✓
Additional Facilities	Electric Car	✓	-	-
	Tour Boat	✓	✓	-
	Water Bike	✓	-	-
	Photo Spot	✓	-	-
	Playground	✓	-	-
	Fishing Pond	-	-	✓
	Mini Zoo	-	-	✓

5.1.5 Conclusion of the Comparative Study of Functions

Based on the comparison table of space programs that have been provided, it can be concluded that the Mangrove Educational Tour that will be built according to the potential of the location will meet the requirements of the space program in accordance with existing regulations for Mangrove Educational Tour. In addition, there will be additional space programs for outdoor activities for visitors. The overall space program of the resort that will be designed includes:

1. Information and Education Center
2. Natural Laboratory
3. Tourist Trails and Exploration Areas
4. Canteen
5. Rest Area
6. Prayer Room
7. Toilet
8. Interactive Area and Workshop
9. Watchtower
10. Merchandise
11. Management Office
12. Guest Area
13. Nursery Area
14. Gazebo
15. Library

Program Ruang Tambahan:

16. Tour Boat
17. Photo Spo

5.2. Comparative Study of Similar Themes

5.2.1 Comparative Study of Similar Themes

Table 7 Comparative Study of Similar Themes

Comparison Factors	Ágape Productive Housing	KAKR Bamboo Hall Buluh Awar	Sustainable Weekend Villa
Interaction with the Environment	 <p>Ágape Colectivo is an example of how a building can interact harmoniously with its surroundings. With a design that takes into account sustainability and user needs, the building is integrated with its natural landscape. The fence around the parking area creates a pedestrian-friendly space with a natural landscape within. The rainwater collection and wastewater treatment systems that are reused demonstrate a commitment to efficient resource management. In addition, the use of the façade structure as a sun shade and shade optimizes the use of natural energy and creates a comfortable environment for its occupants. Thus, Ágape Colectivo not only creates a functional therapeutic space, but also demonstrates awareness of environmental sustainability.</p>	 <p>KAKR Bamboo Hall interacts harmoniously with the surrounding environment by utilizing abundant local bamboo, reducing land burning, and supporting nature conservation. The building is designed with natural ventilation to minimize energy consumption and uses durable, flexible, and environmentally friendly bamboo. In addition to being a multifunctional place, the hall also functions as an education center, teaching the public the importance of bamboo conservation and sustainable construction, thus creating a positive impact on the local ecosystem and community.</p>	 <p>This tropical villa building interacts harmoniously with its surroundings. By considering the direction of the wind, rainfall and sunlight, the building creates a comfortable environment for its residents. Integration with the surrounding green garden and the use of local species in the landscape design strengthen the relationship with the local ecosystem. The building creates a harmonious and sustainable relationship with the environment, allowing residents to enjoy the peace of nature while paying attention to the principles of sustainability.</p>

Use of Types and Types of Materials



Ágape Colectivo uses wood and earth as the main materials in its construction. In addition, the building also utilizes metal for structural elements and ceramics for the sinks. They also collect and filter rainwater, showers, and sink waste for garden irrigation, and process black waste with a biodigester. Thus, the building shows awareness of environmental sustainability in the choice of materials and the use of natural resources.



KAKR Buluh Awar Hall uses bamboo as the main material in its construction. The abundant bamboo growth around this village is utilized for the development needs of Buluh Awar village. Bamboo material is very strong if processed properly and correctly.



Using a variety of carefully selected materials to achieve the desired goals of sustainability and aesthetics. Among these materials are wood, bamboo, concrete, and rice husks. Wood and bamboo are used to create a natural and warm atmosphere, while concrete provides the necessary structural strength. Rice husks are used as a roof for the "climate-controlled" part of the house, helping to keep the temperature down and protect the facade from rain. By using this combination of materials, the villa achieves a balance between natural beauty and sustainability.

Construction Technology




The building utilizes local materials and vernacular construction technologies. The bahareque construction process was modernized by using a mortar projecting gun with a



The KAKR Bamboo Hall building uses construction technology that combines traditional techniques and modern innovations to optimize the use of bamboo as an environmentally friendly material. Bamboo preservation technology is applied to increase



The construction technology used in this tropical villa in Ho Tram, South Vietnam, emphasizes the principles of bioclimatic architecture to create a comfortable environment both physically and spiritually. The house is designed with the main wind directions, rainfall and sunlight in mind, with two main sections

	<p>compressor, allowing the use of soil mixtures in less time and with better compression.</p>	<p>bamboo's resistance to termites and humidity. The building's foundation is adjusted to local conditions, using concrete or stone to support the lightweight bamboo structure. In addition, the building is designed with natural ventilation that utilizes free air flow through the gaps in the bamboo, keeping the room temperature cool without the need for additional energy.</p>	<p>forming a “T” shaped volume. The first section is the living space that opens onto the garden, while the second section is “climate controlled” and insulated with rice husks as a roof to keep the temperature low. Lighting designed by Kobi Lighting Studio connects the architecture with the landscape, creating an atmosphere that matches the mood of the occupants. The landscape design also takes into account local species to enhance biodiversity and minimize maintenance. With this approach, the villa creates a peaceful and sustainable place for its occupants.</p>
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5.2.2 Conclusion of the Comparative Study of Similar Themes

Based on comparative studies related to similar themes, it can be concluded that several concepts in the Mangrove Educational Tourism design with a sustainable architectural approach are:

- The concept of sustainability is very important for the stability of the surrounding environment. With a design that takes into account aspects of sustainability and user needs, the landscape of the Mangrove Educational Tour with the building will be well integrated.
- The use of sustainable materials in buildings such as wood, bamboo, or other materials that are easily obtained in the surrounding environment and do not damage nature.
- Open spaces or outdoor areas also use sustainable materials.
- The use of efficient construction technology and attention to user comfort.
- Careful selection of materials and thinking about easy material management.

6. Conclusion and Recommendations

This study highlights the importance of mangrove educational tourism in increasing understanding of the ecological, economic, and social values of mangrove ecosystems in Indonesia. A sustainable approach in planning and development, by integrating the principles of environmentally friendly architecture, is essential to protect and restore coastal ecosystems. Based on a comparative study of functions and themes, the design of Mangrove Educational Tourism is planned in accordance with existing regulations and location potential. Recommendations include the development of a comprehensive educational program, the application of sustainable architecture principles, diversification of facilities, effective management of natural resources, involvement of local communities, and the implementation

of a sustainable monitoring and evaluation system. By following these recommendations, it is hoped that Mangrove Educational Tourism can become a pilot model for sustainable mangrove ecosystem management and provide benefits to the surrounding community.

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