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Designing Smart Floating Village In Belawan With Ecological Architecture Approach

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Abstract. Rising sea levels are essential issues due to global warming increasing every year. This leads to the potential for the amount of land to be reduced. One of the areas in Medan that is directly adjacent to the water is Belawan Subdistrict. Based on the data observation of water level in the Belawan sub-district, there is a significant level change every year. Some areas in the coastal area of Belawan have the possibility of drowning. To overcome this, Smart Floating Village is designed as a floating settlement in the future. The method used to solve this design problem is through observation, literature studies, and precedent studies of similar projects that have been built. The analysis and study results obtained a large pontoon structure (VLFS) as the module's base used for floating settlements. Settlements based on large pontoon structure modules can have various activities such as housing and other community needs facilities. The Smart Village concept is also applied to this design to eliminate the perception of the slum environment in coastal residential areas. To connect the idea of a smart village and floating settlements, an ecological architecture approach is needed to maintain a balance between humans and the environment. This research is expected to be a further discussion study for further research on floating settlements that apply the innovative village concept and can be helpful in architectural science regarding case studies and similar approaches.

Keywords: ecological, floating village, smart village

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1 Introduction

The rising sea level is very influential for island nations such as Indonesia. Indonesia is the world's largest archipelago, with more than 17,000 islands meaning that many coastal areas will feel the impact of more significant seawater rise and threatened to lose land as their home. The threat of flooding will always wait until the worst can drown the homes of coastal communities. One of the areas threatened to feel the impact of rising sea levels is the coastal area of Belawan, Medan City [1].

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An architectural response is needed to address the problem of rising sea levels and the threat of reduced land for human habitation. Floating Architecture has become a new solution to respond to the issue of sea-level rise. This way to get in with this situation in the future is to get used to living with the water environment [2]. Floating islands will become new settlements by 2050, and other floating islands will use as food commodity producers and renewable energy sources as environmentally friendly independent energy producers [3]. Of course, future floating environmental solutions are inseparable from ecological architectural approaches. Ecological architecture principles should consider several aspects such as time, natural environment, socio-cultural, space, and construction technology (structure) [4].

2 Literature Review

2.1 Smart City

In the last ten years, the rapid development of smart cities has contributed to the uneven development between the city and the village. The condition occurs because community development efforts focus more on the city. So far, inequality between towns and cities has been a complex problem. The inequality has led to the extensive urbanization that is the cause of the increasing complexity of the city [5]. An increasingly densely populated city is undoubtedly experiencing a comparable economic surge [6]. To maintain financial balance, cities form housing clusters with various functions in one place. Such as The Johor Medan District, which divides specific points in the group of settlements as an economic generator [7]. *Smart cities* are components of cities that use advanced information technology to provide services, solve social problems, and combine intelligent people and intelligent governance to achieve an innovative economy, smart living, smart mobility, and intellectual environment [8].

2.2 Floating Architecture

The technology for creating floating settlements uses Very Large Floating Structures (VLFSs). VLFSs have two currently being developed types: the semi-submersible and pontoon types. The mega-floating system consists of a vast floating pontoon structure, a mooring Facility (tethering) to make the floating frame remain in place, access to bridges or floating lanes, and a breakwater as a breakwater system that affects the floating structure. In the design of the VLFS, various loads should be considered, especially tides, tsunamis, storms, and earthquakes. Materials used for floating surfaces are steel or composite materials of concrete or concrete steel and other materials that meet the specifications of floating buildings [9]. In some further research, efforts to find other materials that are cheaper and environmentally friendly, such as composite wood and fiberglass, foam, and recycled materials [10].

2.3 Ecological Architecture

The ecological approach in architecture is defined as "Ecological design is bioclimatic design, design with the locality's climate, and low energy design" [11]. Ecological design is a bioclimatic design that carries out the design by responding to the local climate and minimum energy consumption. Thus there is integration between local environmental conditions, micro and macro temperatures, tread conditions, building or regional programs, concepts, and systems responsive to the climate and minimize energy consumption.

Smart Floating Village is a new model city using Floating Urbanization. This concept has many advantages, such as: increasing the availability of land that is the solution to land limitations in the future; reducing flood risk: creating independent energy, food, water, and nutrients rather than consuming non-renewable energy sources and creating waste; and have positive consequences on the ecosystem and produce a safer and healthier area of life [12].

3 Methodology

This research uses quantitative methods and analyzes data descriptively. This method of solving design problems is done by analyzing information through the collected data and then will generate the right ideas or ideas to answer the design problem. The data collection methods used in this study are primary and Secondary Data—preliminary data in the form of observation and literature studies. Observations are made by making direct observations on the existing condition of the construction site's location, conducting direct comments on the area around the site, and conducting documentation as data supporting observation activities. Literature studies collect data through journals, books, and regulatory documents related to theory, design approach, similar projects, and local government regulations.

The data obtained is then analyzed, such as tread analysis located in the coastal area of Belawan Subdistrict, Medan. Determination of the site's location refers to the results of the analysis of the impact of the issue of sea-level rise on the site. Then analysis function is the function of intelligent village floats as a form of new settlements that overcome the impact of sea-level rise. Furthermore, user activity analysis is the population's daily activities, such as social, economic, and settled activities. And lastly, the analysis of the need for space in the village refers to facilities that support the village community's daily activities, such as the need for space for housing, economic activities, and social activities.

4 Result and Discussion

The location of this project is in the water area of Belawan I District near Kampung Nelayan, Medan City. The location is chosen based on the allocation of residential land in the water area of Medan City. This site is 3 hectares with a northern location bordered by mangroves and plantations. Belawan waters border the east, Kampung Nelayan connects the west, and the south is bordered by the settlements of residents of Belawan I Subdistrict (Figure 1).

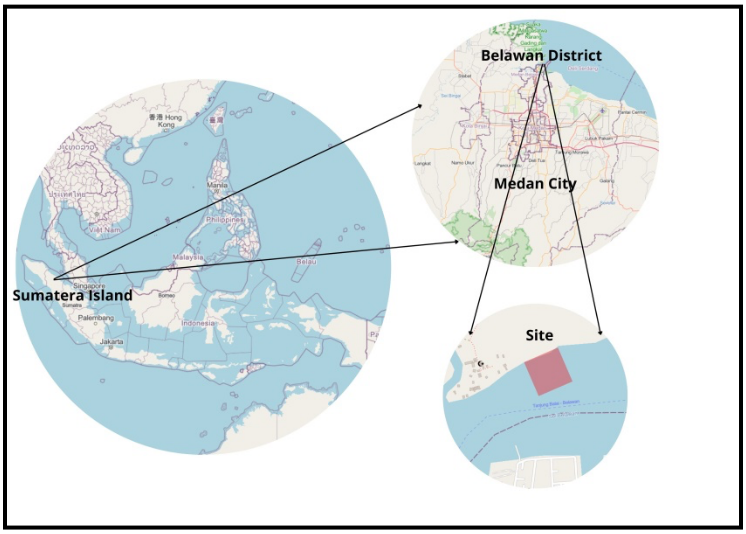


Figure 1 Project Location

The functions of land allocation around the planning site area are residential areas, defense and security areas, industrial areas, trade, and other particular areas. The conditions and potentials in the design land are located in the waters, a fishing area by local anglers. There is crossing access from Belawan I Subdistrict. It has access to electricity coming from PLN Stabat even though it is in the middle of the water. There are mangrove forests around the site as natural vegetation rob flood containment (Figure 2).

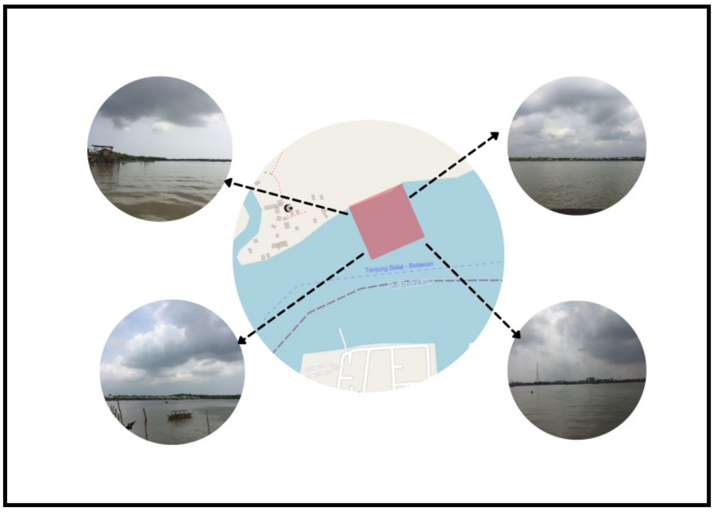


Figure 2 View from Site

4.1 Mass Concept

The concept of mass composition uses six wooden modules measuring 3x3 and arranged into a home layout. Each module becomes a room with its function, and the roof cover of the house uses a wooden frame and bitumen placed for the needs of hydroponic gardens on the house's roof. The concept of mass composition uses six rigid modules measuring 3x3 and arranged into a home layout. Each module becomes a room with its function, and the roof cover of the house uses a wooden frame and bitumen placed for the needs of hydroponic gardens on the house's roof (Figure 3).

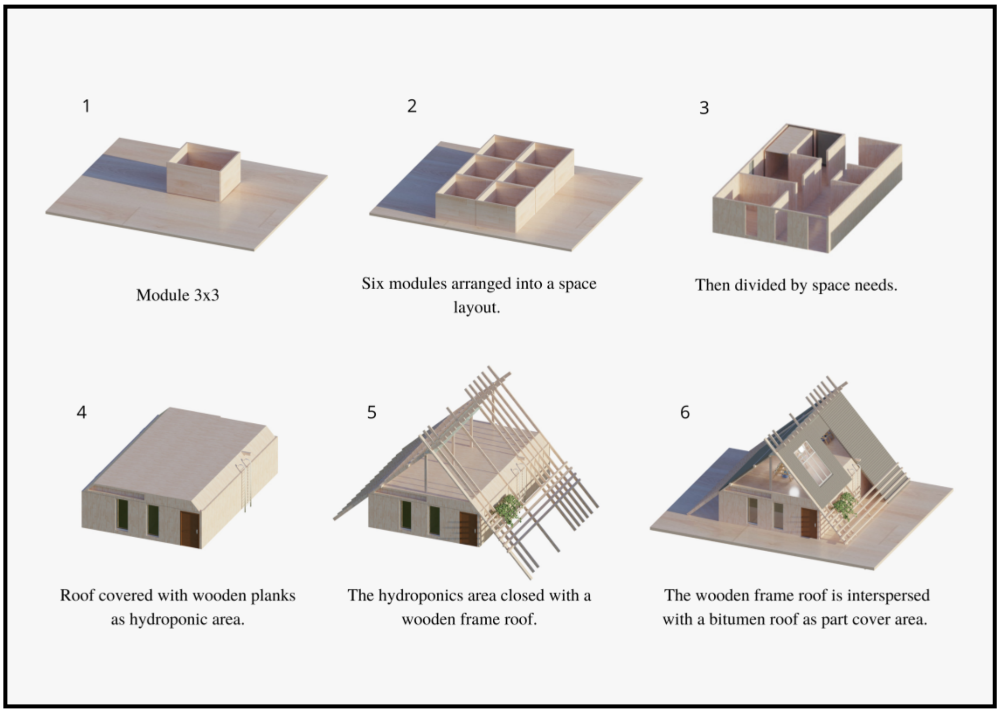


Figure 3 Mass Transformation

The concept of the destruction of the house mass is dominated by wood material as building construction. The roof of the building uses a wooden frame exposed as a result, and the unexposed part is closed using bitumen material. The roof area of the building is also used as a hydroponic garden area (Figure 4).

Figure 4 Housing Form

The mass of houses in each neighborhood module will be oriented to the center, thus creating interaction between residents. Then, each neighborhood module will form a circular pattern with a hydroponic garden at its center (Figure 5).

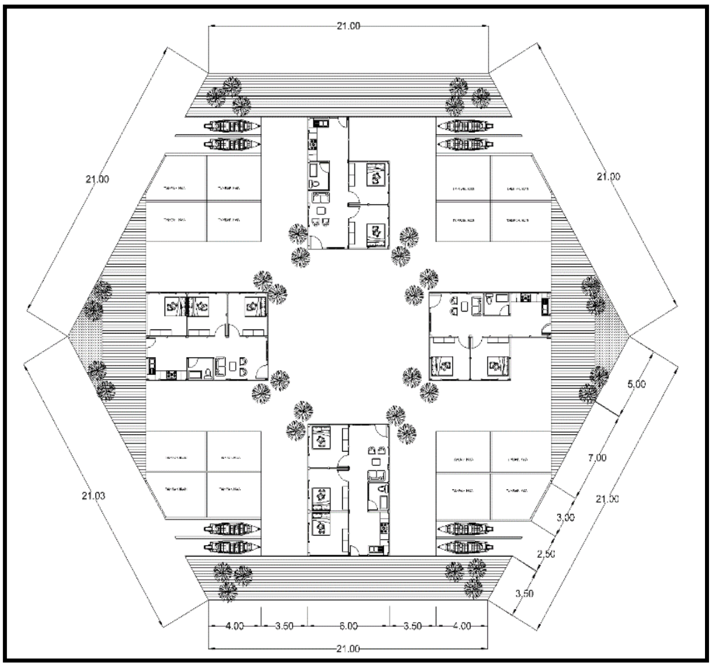
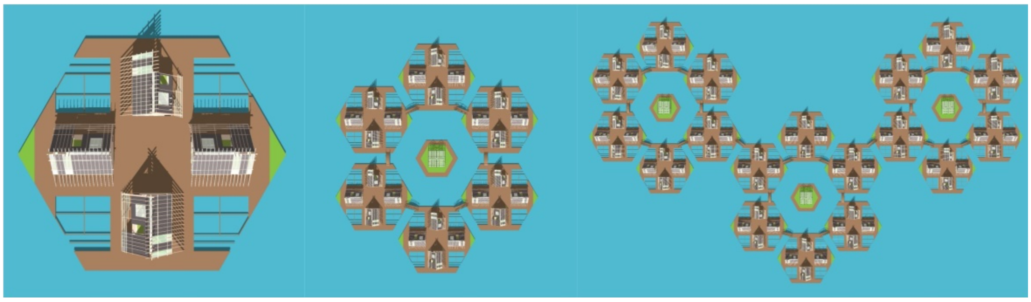


Figure 5 Residential Neighborhood Module

4.2 Outdoor

The concept of settlement development is modular. The initial module of the residential environment then develops into a settlement module and eventually grows into a village [13](Figure 6).



Initial module Neighborhood Village

Figure 6 Neighborhood Development

The concept of outdoor layout is to connect one environmental module and another environment. Some environmental modules have access to public facilities by boat. This public facility becomes an activity generator in the innovative floating village area. The achievement of the site area is focused on one central access point, a pier that becomes the entrance to the site. In addition, to access the site's achievement, this pier also serves boat crossing services that have become one of the sources of people's livelihoods. Circulation on the site is in the surrounding area of the environmental module oriented to the communal area. Circulation on the site can be reached using a connecting bridge between one environmental module and another environment. The concept of a green layout on the site is designed around each ecological module. It aims to reduce high heat in marine areas. In addition to reducing heat, this vegetation can be used as a food source such as fruits and other crops (Figure 7-8).

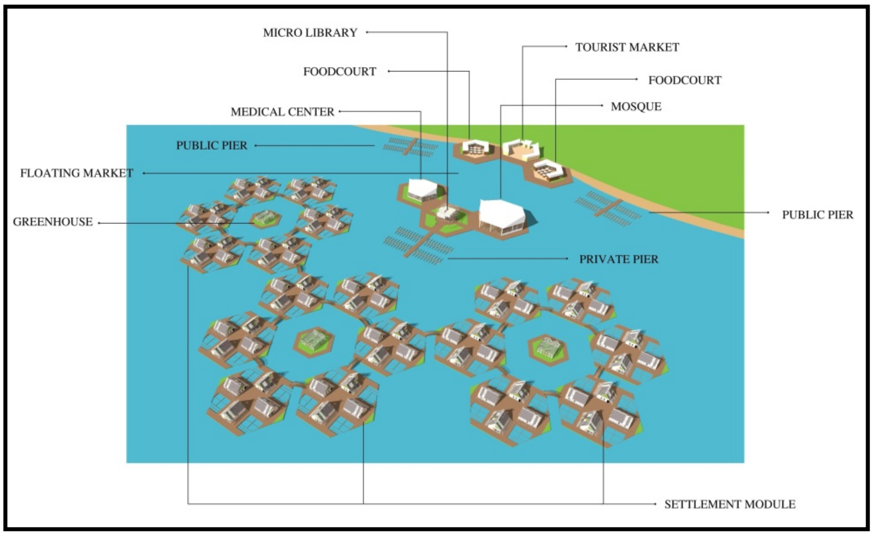


Figure 7 Concept of Settlement

Figure 8 Distribution of Settlements

4.3 Indoor

The modular home concept is formed from a 3x3 wooden module and arranged into six masses. The sleeping area is placed into a row zone, a private space, and the semi-public area is placed in one location, namely the kitchen and toilet, and the last is the public zone, which is the living room—planning the organization of space in residential dwellings using a grid-organized array of modules. Circulation follows the grid pattern of existing rooms (Figure 9-10).

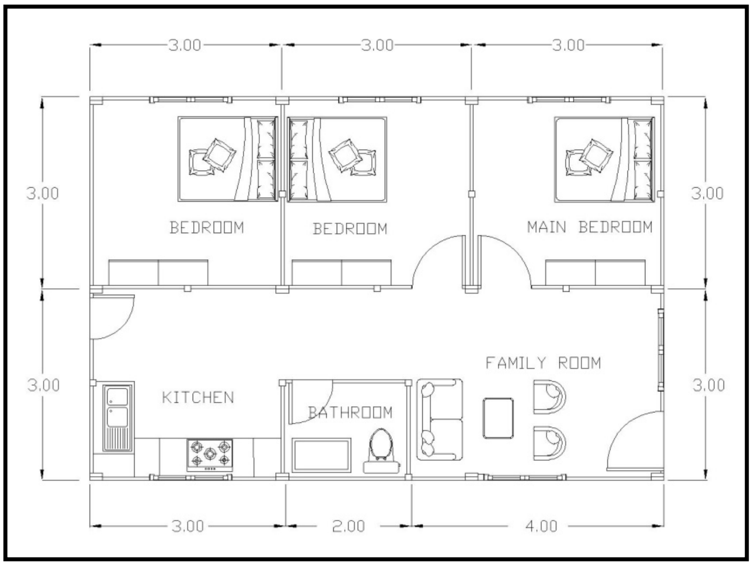


Figure 9 House Plan Type A

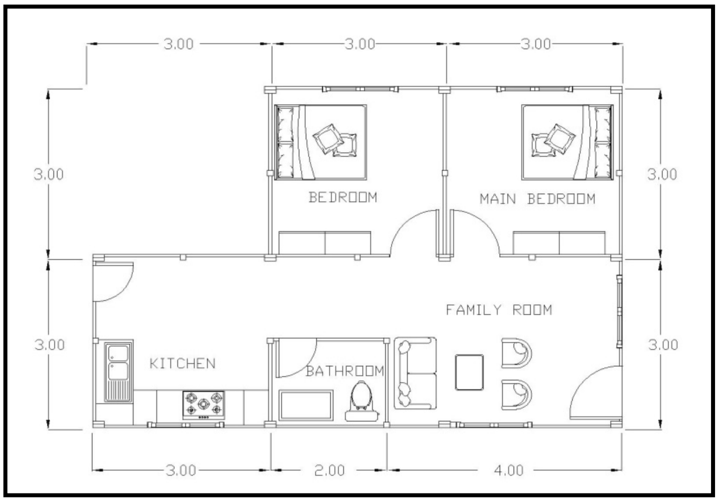


Figure 10 House Plan Type B

4.4 Smart Village Concept

Smart Floating Village in this design takes the main point on the variable concept of Smart City such as Smart Living. The method of this floating village aims to create a new perspective in the community that living in a town is very rundown, and the settlement is not organized. This design concept creates a healthy settlement pattern by putting forward a sound utility system, such as the procurement of proper sanitation. In addition, design modular settlements with sustainable concepts and arrange appropriate access and circulation points within site. Then Smart Economy, where the design of this floating village utilizes existing natural resources to create floating urban harvesting in the form of aeroponics and hydroponic plants that can be used as independent foodstuffs and can be sold as an economic commodity [14] (Figure 11).

Figure 11 Floating Market

Furthermore, Smart Society, namely, the design of residential areas, must undoubtedly have adequate public space as a shared facility. The innovative floating village design provides a versatile public space for fishing community activities, gardener community, citizen services, and children's educational facilities. Moreover, the last is Smart Environment. The concept of designing a floating village uses a floating structure equipped with a breakwater system to protect residential areas. In addition, this floating village processes waste independently with the concept of 3R being reused as material in buildings and natural energy management as an independent energy resource.

4.5 Structure

The structure used is VLFS (Very Large Floating Structure), a large pontoon, and anchor fasteners on the seabed to keep floating buildings in the position [15]. The type of structure used is a large pontoon structure commonly used in shipyard areas. The materials used in the design of the house are wood on the walls and roof frame. While in public places such as markets, food courts, mosques, medical centers use concrete and lightweight steel roof frames. The materials used for buildings are local wood materials and WPC (wood plastic composite) as connecting dock materials between functions. Hydroponic plantations use transparent materials on most facades, using a wooden frame as the mainframe of the building structure (Figure 12).

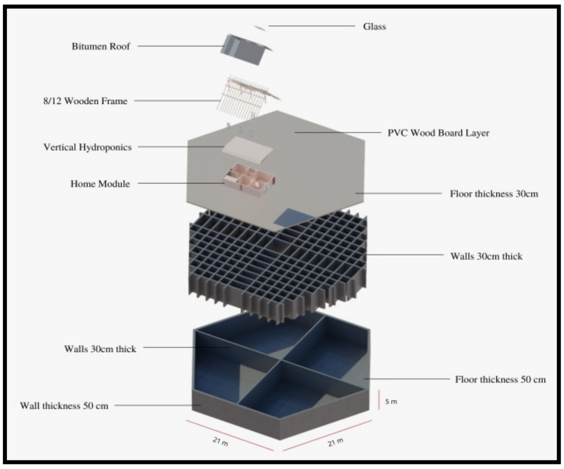


Figure 12 VLFS Structure

4.6 Ecological Architecture

The ecological architecture approach plays a vital role in working on the variables of the intelligent city concept outlined earlier. This design applies ecological themes such as conserving energy, which maximizes the use of renewable energy such as sunlight, water, and wind. Furthermore, working with climates where the shape and openings of buildings are made responsive to tropical climates. Then, minimizing resources is recycling or reusing materials that are still worth using. Furthermore, respect for the user, namely responding to the needs of surrounding community activities such as adequate public facilities. Then respect for site: make a building with floating structures in response to the issue of sea-level rise. And the last one is holism. The building is made based on the needs and comfort of the local community.

5 Conclusion

The design of the Smart Floating Village in Belawan is a future settlement planning to address the problem of human housing and settled needs in case of increasing sea-level rise caused by increasing global warming. The accommodation is modularly designed to be expanded as the population multiplies. This modular structure is not only a residential facility but can meet the needs of other public facilities. Making floating settlements needed massive construction of pontoons, commonly known as VLFS (Very Large Floating Structure), widely developed to make various floating facilities globally. Through Ecological Architecture, the design of floating settlements will always respond well to the surrounding aquatic environment and, at minimum, damage nature. From the above conclusion, based on designing the final task, further development of the design results is required through literature studies and precedent studies, which can influence the research and analysis of design results to find more appropriate design solutions. Hopefully, the Smart Floating Village design with Ecological Architecture Approach can be a further discussion study for future research. It can be helpful for architectural science on case studies and similar approaches.

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