Implementation of a floating system as a form of environmental adaptation in Kuala Bubon Village, West Aceh

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Abstract. One of the important factors in supporting the sustainability of an architectural design is the ability to adapt to the environment. This adaptation can be observed, among others, from the accommodative level obtained from a building design to the needs of the community that uses the design. One form of design that is considered to accommodate the needs of the user community is the design of a floating system used by fishing communities. This paper wants to explore the adaptability of the floating system design which is judged by its ability to accommodate the dynamics of the wet environment and the needs of the fishing community. The research method is descriptive and logically explains the causal relationship between the design of the floating system building and the environmental and socio-cultural aspects of the community. Observations show 2 things: a) the legged building system (pit foundation and 2 meter stilt building) is highly adaptive to wetland conditions with tidal characteristics of water at the mouth of the river; b) architectural design of residential units which are about 4 meters apart, allowing the development of residential units into 4 sides, to accommodate the increase in daily activities of fishing communities so that community productivity increases. The conclusion of the study shows that the floating system is very flexible and adaptive to the dynamics of the environment and people's lives (socio-cultural and economic aspects).

1. Introduction

The coastal area of West Aceh Regency is part of the West coast of Sumatra, very vulnerable to tsunamis and tidal waves from the Indian Ocean, which throughout the history of coastal civilization have eliminated several historical periods of coastal settlements [1]. The 2004 tsunami disaster again damaged the Southwest area of Aceh, eliminating most of its residential and urban environments [2]. One of the important areas damaged was the Kuala Bubon area, which was previously known as a fishing area, port area. When the post-tsunami rehabilitation and reconstruction program in Aceh and Nias was implemented, including the construction of housing for tsunami victims [3], one of the housing programs was the construction of a fishermen's relocation house in Kuala Bubon Village.

Kuala Bubon Village is located on the coast of the river mouth in Samatiga District, West Aceh Regency, Aceh Province, Indonesia, about 20 km north of Meulaboh City. After the 2004 tsunami disaster, the local government, assisted by NGOs, rebuilt a fishing village equipped with
infrastructure for a fish landing port on a tidal swamp land on a riverbank. All facilities are built on water without the need for stockpiling, with floating or floating systems. Floating system is the idea in using water space which is more dominant than land space. This system is a water-based residential design that has been used in many countries [4], which utilizes more parts of the sea than land, so that it is more helpful for environmental conservation efforts, because there is no need for reclamation or clearing of new land for housing needs, [5]. The idea of using this architectural form appears as a form of adaptation of artificial buildings to their natural environment.. At first people feel unfamiliar with the shape of this house, but then they can adapt slowly.

![Figure 1. Location of floating housing in Kuala Bubon, West Aceh Regency, Aceh Province, Indonesia.](image)

Based on this description, the purpose of writing this paper is to explain how residential buildings with a floating system, accommodate the natural challenges in the estuary swamp area, and the need to develop their dwellings as fishing communities. This is in accordance with Marpaung's opinion that the sustainability of a formally designed residential environment is closely related to the ability of the environment to accommodate the development needs of its citizens and the ability of community participation in developing their dwellings [6]. This research is considered important considering that until now there have not been many articles that have reviewed the implementation of the floating system as a form of adaptation to the environment from the perspective of the fishing community. Therefore,

2. Materials and methods
Residential space as a living space in a traditional society has a complex function, which will develop according to the character of its inhabitants [7]. The development of residential forms also adjusts to the conditions of the place and the accompanying technology. Humans will carry out a long process of adaptation after learning all the related things needed. Changes will appear in the architectural system, namely: space system, construction system and style system [8]. Space systems are related to floor plans and spatial dimensions. The construction system is related to how to build. The Style System is related to aesthetic aspects in developing their dwellings.
The tidal dynamics of sea water will affect the socio-economic life of fishing communities who are in direct contact with these natural conditions, therefore the adaptation pattern of the community will appear in the behavior of developing their residential environment [9]. Changes in socio-economic activities will affect the residential space system. Community participation can be seen from the extent to which people develop their residential spaces which have an impact on the architectural character of their environment.

A floating building is a construction system in a wet area, which if developed properly will become a specific force system for the built environment. According to Nillesen & Singelenberg, they divide this water-based building into 6 types of forms, namely: a) Residential Pillars (in the form of stilts) which are often found in Indonesia such as lanting houses in Kalimantan; b) Floating Dwelling, really floats; c) Amphibious shelter, can float and also be bound; c) Terps Residence (at an altitude/hill); d) Embankment House (in the form of embankment); e) Life on the water's edge.[10].

This research is an evaluative research on architectural design, using a qualitative method with a descriptive approach [11]. The data was obtained by means of rapid field observations in several places at the observation sites conducted on June 25-28 2021. Data collection was also carried out by interviewing residents of floating villages. There were 6 people interviewed. Each represents 6 social groups, namely youth organizations, local government, women, fishing associations, village officials, and religious leaders. The research data itself consists of 2 aspects: 1) initial design data for floating system buildings and adaptation patterns to the dynamics of the swamp environment; and 2) data on occupants’ socio-economic activities, which affect the development of their dwellings.

3. Results and discussion

3.1 Floating system in Kuala Bubon floating village
Environment The floating house housing is designed to consist of: a) residential units of 118 housing units; b) fishery facilities: docks and fish landing places, loading docks, storage of work tools; c) social/public facilities: schools, mosques, village halls; d) economic facilities: shops, markets selling processed fish products. Each house has two rooms, one bathroom, living/family room, front porch connected by a bridge to the neighborhood road (2.5 meters wide). Currently, several houses have developed houses both towards the back and side of the house, where the space is used for daily community activities such as terraces to clean fish to make salted fish.

Based on the observation that the design of the building foundation type includes a strongly bound type or also called fixed floating [6]. The foundation of the building is in the form of a concrete cylinder with a diameter of about 50 cm. The concrete cylinder is tied to a 1×1 meter concrete cube planted at the bottom of the estuary. From the outside, the shape of this village is similar to the traditional village in Bajo, South Sulawesi, namely houses on stilts on the water. It becomes interesting at high tide, as if the house is floating on water.

Each housing unit has an electrical installation, drinking water network, and a septic tank sanitation system. Each septic tank structure is connected by a sewage pipe that ends in a final storage tank. The houses are arranged in a pattern facing each other and divided into five alleys. Each aisle has a connecting path in the form of a road. In each alley, houses were built lined up facing each other on two sides of the road. There are 11 to 12 houses on each side of the street, and that means there are about 24 houses in one aisle.

3.2 Residential building floating system adaptation
3.2.1 Adaptation of the estuary swamp environment
The building design in the Kuala Bubon village environment is a 4 m high stilt house. This is related to the tidal character of the sea, where the highest tide point is about 50-70 cm below the building floor for 10 hours, while the lowest point is on the ground for 10-12 hours. At high tide, people take
advantage of this situation by catching fish using nets and fishing rods. Meanwhile, if conditions recede, the community uses the environmental area to catch shrimp and also dried processed fish for the home industry. However, communities do not land their boats near their homes, as in traditional natural villages. All community boats are centered on the pier, so that in the residential unit environment, the community can freely use their outdoor space.

3.2.2. Forms of fishermen's socio-cultural adaptation

Environmental adaptation resulting from the design of the floating system is in the form of the ability to accommodate the needs of the people who are residents of the floating village.

3.2.2.1. Residential development and home industry activities

The type of residence is 36 m2 which fulfills the basic needs of life and is able to accommodate the needs of fishery-based economic activities. People generally process fish catches by making salted fish, the process of which is carried out by women and carried out in their home environment as a home industry. In the early years of occupying the house, home activities were carried out in the terrace area of the house and the back room of the house. However, in line with the increase in the volume of processed materials, causing the community to develop initial houses both on the front and back and fish drying areas. The same thing happened to the housing assistance of the fishing community in Aceh Besar, where the residential environment developed in accordance with the activities that followed and was dominated by women [12]. This addition causes the residential environment to appear denser. See image below:

![Figure 2. Pattern of adaptation of additional space for salted fish home industry.](image)

From the picture, it can be seen that the additional building adjusts to the construction conditions of the existing floating house, so it appears that the tides of sea water still occur under the house. At high tide, residents take the water and collect it for washing fish. A place for drying fish by utilizing the
small space between houses and alleys, to get enough sunlight. The addition of a back room made by the community will bring together houses, so that the environment is more dense and prone to fires. But on the other hand, the relationship with the back house can be done by making a back door. This actually strengthens the relationship between residents of the community.

3.2.2.2. Adaptation of the sanitation system
One of the basic needs that must be met in a dwelling is access to sanitation. Both in the form of the availability of clean water and septic tank facilities. In the floating village, these two sanitation needs are well met. The community receives clean water supply evenly and smoothly. This clean water comes from drilled well facilities built in front of the complex. There are 7 drilled wells that are still in good condition and continue to operate. Water from this well is pumped using a machine to flow into people's homes through a network of pipes installed through the bottom of the house. Each resident pays a fee which is coordinated by the local village government as part of the operational maintenance of these wells.

For the septic tank waste disposal needs of the floating village, each house has a temporary storage tube. The tubes in each house are connected to iron pipes that lead to a final storage tank located outside the floating house complex. In 2019, the final storage tank was renovated but the workmanship was considered poor because it caused air pollution in the form of a foul smell. However, when the research was conducted, the problem of air pollution was resolved and the stench was no longer there.

![Figure 3. Iron pipe connecting the temporary storage tube in the house and the final storage tube (a); clean water line (b); one of boreholes facility.](image)

From the picture, it can be concluded that the sanitation needs of the residents, both access to clean water and disposal of septic tank waste have been accommodated properly. So even though it is located above swamp water, the supply of clean water for living and sewerage is not a problem.
3.2.2.3. Environmental road facilities
Each house is directly connected to a road facility with a width of 2 meters. This road is considered very suitable to function as a connecting infrastructure because it is built with a solid structure and can be passed by three-wheeled vehicles freely. The use of three-wheeled vehicles in this complex is becoming common because it is used to transport marine products as well as household handicrafts. The shape of the road that uses the letter “H” makes connectivity between houses that are built arranged in longitudinal rows easily available. The complex road network at the end of the complex is directly connected to the main road which happens to be a provincial road that connects two districts.

![Road network in a residential complex.](image)

Based on the data above, it can be concluded that the floating system applied in Kuala Bubon Village is proven to be adaptive to the environment. Furthermore, based on the data collected in the table of needs above and the accommodative ability of the floating system applied, it is known that floating villages also have the potential to become objects of the tourism industry.

4. Conclusion
Based on the description above, it can be concluded that:
1) The floating system design applied in the floating village in Kuala Bubon village is proven to have good adaptability to the environment. These adaptations include adaptation to natural challenges as well as adaptation to socio-economic conditions, especially to daily activities and the local economy;
2) Its accommodating nature to the needs of the residents, plus the position and location of the floating village makes this complex ideal for becoming a tourist attraction as an industrial development in the future. Departing from the floating design which is very interesting and unique

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