Fisherman Settlement and Housing Innovation based on Bioclimatic Design in Surabaya

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Abstract: Fisherman settlements at the eastern coast of Surabaya are characterized by densely populated areas, some substandard houses and poor infrastructure conditions. Since some houses are crowded and substandard, innovation of the settlement and houses become very important. The innovation, as the process of introducing new idea should be directed to create more healthy and comfortable settlement, with adequate infrastructure, at least for the next 50 years. The aim of research was to find an innovative design of fisherman settlement and houses based on bioclimatic design. The bioclimatic design was chosen, since this was based on the strategy to give comfort to the house dwellers, bearing in mind the climatic conditions of the coastal environment and climate change in the future. Together those, improvement in the sanitation and infrastructure will create healthier fisherman settlement. The method used in the research surveyed in the crowded settlement and houses, to indicate the inadequate settlement and house design, which made the conditions uncomfortable to the dwellers. Mapping of the settlement’s infrastructure and sanitation was done, to indicate the improvement required. The result of the research shows that the innovation of the settlement and houses based on bioclimatic design was acceptable to the fishermen, if the innovation was matched to their activities.

Keywords: Bioclimatic design; fishermen settlement; houses; innovation

1. Introduction
The appropriateness of fishermen settlements is closely related to the sustainability of Surabaya city development in the future as a coastal city, especially in line with the occurrence of climate change and the rising of sea level (Isworo et al, 2014). Therefore, the good arrangement of fishermen settlement becomes very significant, mainly due to two things; firstly, by improving the quality of fishermen settlement, it will have a positive impact on the improvement of fishermen’s economy which is still at the lower level. Secondly, the importance of fishermen role in preserving coastal ecosystem in Surabaya in the framework of more extreme climate change (RTRW Surabaya, 2010-2020). Generally, the condition of fishermen settlement is barely making a noteworthy progress, fire-prone buildings, lack of sanitation, occupy unsuitable areas, scarcity of decent water and sanitation (Defiana et al, 2016). The Innovation or
new idea for the fishermen settlement and houses improvement were based on bioclimatic design, since this approach can provide the more comfortable living for the people. The research limitation is that this research should be done in two phases due to budget limitation. Phase one is the design proposal based on bioclimatic and phase two is the use of simulation of the proposed design. The intention is to integrate the practical implication with social implication. The social implication of the innovation of the settlement and houses also cover in phase two. This paper is based on the result of phase one while the phase two research has not been conducted.

2. Theoretical Review

2.1. Fishermen Settlement

Fishermen settlement is residential environment with basic infrastructure and the most population is fishermen that have a special bond among the people, and between the fishermen. The sea is a place for generating their income, though some of them are still connected with the land (Umbara, 2013). Along with city development, fishermen settlement develops in disorderly and denser due to natural population growth and urbanization.

The healthy living settlement is an environment consisting of organized healthy houses and have adequate infrastructure (such as roads, sewerage, toilets, clean water resources) and environmental centres, such as school, office, health/medical centre and place of worship (Patandianan and Zenaide, 2011).

Houses were built by the process, depended on the needs of the inhabitants (Turner, 1972). For example, adjusting the houses or adding some parts of the house. The settlement pattern usually follows the geographical condition of the natural environment. The existence of water affects the form of the settlement, be it linear or circle, following the physical shape of the water (Cakaric, 2010). The topographical aspect of the coast also dictates the settlement pattern and house form (Santosa et al, 2015).

2.2. Bioclimatic Design

Bioclimatic architecture was initiated by the thought of Olgyay (Olgyay, 1963). The Olgyay’s bioclimatic chart simply introduce the climate potential in determining the position of the thermal comfort zone. The accuracy degree of climate analysis holds the key factors in bioclimatic concepts which is useful for designing building (Zuhairy and Sayigh, 1993). In its development, bioclimatic architecture involving elements of form, material and its building system (Hyde and Sunaga, 2008). The characteristics of humid tropical climate are high humidity level, uncomfortable temperature and high wind speed in coastal areas.
Figure 12: Graphic of average air temperature, humidity and wind speed in Surabaya in 2009-2014 (source: BMKG Perak, 2014). With climatic conditions as mention above, if it is applied to the Szokolay psychrometric chart (2004), the expansion of bioclimatic comfort can be done through the utilization of wind speed.

3. Design Method

The data were collected through field survey to obtain primary data of settlement arrangement, physical conditions, settlements structure and people activities related to housing and existing spatial design. The respondents were 20% of the households. Settlement and housing condition were documented with photograph and drone to obtain an overview of activities, settlement structure and problems. The compilation data of survey result and secondary data are the main material that will be analysed to formulate the innovation of housing pattern and future housing design in accordance with fishermen need and coastal environment preservation.

Design criteria, arranged in this research, were based on questionnaire and field analysis results. Design criteria, based on natural condition of coastal, is the adequate distance between buildings and also distance between settlement and the coastal line.

Other criteria are the width of the road, which separates the building, is 2 meters based on the existing condition. Those distance between buildings aims to provide the flow of wind and the use of natural lighting. Wind flow is needed to keep the spaces not become moist. It is proposed to give a minimum 8-meter distance between buildings, at the side and back.

The design criteria to increase the fishermen welfare and social relation, are giving common space, fish processing space, marketing space and space for repairing the boats and nets. Fish processing space was needed to avoid the usage of road in front of fishermen houses to process their fish.

4. Result and Discussion

4.1. Climate Analysis

The climate was analysed as consideration in formulating the concept design with nature as the context. Climate data from BMKG Perak which is set as open country climate, were used as the data source. Climate data, used to formulate the concepts, are temperature, humidity and wind velocity in five years (2009-2014).
Highest humidity (85%) is in December-April and the lowest (66%) is in August-October. The lowest humidity, which is in October, is in dry season. The highest air temperature in October is about 29.8°C which is also the highest air temperature during the year. The lowest air temperature is in January which is also in the highest humidity. Average macro wind velocity is quite high in 7.4 m/s. The highest wind velocity in August was 7.8 m/s and the lowest wind velocity in December was 5.7 m/s. In those months fishermen usually do not go to sea.

4.2. Settlement Arrangement

In general, the existing condition of fishermen's settlement is in line with the coastline. The alleys leading to shore, houses orientation was set to face each other with the alleyway in the middle. Occupancy coinciding in the back and sides. The other condition is settlements adjacent to the coast (Figure 2).

![Wind direction](image)

Figure 13: Existing condition of fishermen settlement and the wind direction in research location
(Source: Google Earth)

The proposed concept from this research is intended to settlement that is adjacent closely to the coast. The ideal H / W (Height/Width)-related carrier ratio is 0.5 for areas with low latitude (Oke, 1988). In relation to the proposed mass arrangement, the concept is to provide distance with H / W ratio of 2. This is based on the wind velocity in the open country which is very high, this opportunity could be used as a natural ventilation. This distance is adjusted to the existing condition in order not to make extreme changes but still achieves the availability of natural wind and natural lighting. However, settlement arrangement should still pay attention to coastline border (Figure 3).
4.3. Spatial Configuration

Based on the questionnaire results, the building area is limited to 24-50 m². The consequences are the limited spatial function and the activities blend in some spaces till utilizes the road to do some activities. To anticipate, it is proposed to provide communal space, flexible living room space and ease of access to the coast where their boats are moored.

In general, they use brick wall as a building envelope and roof tile. With that composition, it has a time lag of about 5-6 hours. This means that if the building envelope receives solar radiation at 15:00 then the inner space will receive heat at 20.00-21.00 at night. Therefore, it retains the existing building envelope material, including using wood materials for roof construction.

The proposed plan for the fisherman's house innovation is shown in Figure 5. This proposal considers also the material age and the possibility of developing business activities within the next 50 years. For toilet and fish processing space on the front, it can shorten the distribution network of clean water and used water.
There are 2 alternative house designs namely landed and floating level house. The landed level concept is made to adapt to the existing building character at this time. While the floating-level concept is proposed to reduce the impact when the tide occurs from the sea, in addition to add a flexible space at the first floor.

Spatial arrangement and function of existing buildings have been accommodated in the new space design concept considering all the functions that occur in the existing building. Flexible space that located on the outside of the 1st floor can be used to accommodate activities related to cleaning and processing fish catches and also for household activities. While flexible space on the inside can be used as a gathering space for families, kitchen and dining room for the residents. While bedroom with this new concept is increasing its number into 3 bedrooms with a more feasible size than the existing buildings.

The proposed building form considers several factors: the limitation of existing land so that the development towards the vertical. The material used are materials that available around the environment which is fabrication materials. The building orientation is north-south. Openings and ventilations are set according to the standards of the Ministry of Public Works (2010) which is 20% of the total area.

Figure 16: Proposal of Fishermen House Plan 1st Option
4.4. Building Systems

Building system in the fishermen settlement consists of ventilation system, natural lighting system, sanitation, and drainage. With the distance between buildings that meet the H / W ratio then it has opportunity to provide open space. The availability of open space supports the application of WWR (window to wall ratio) 20-40% (Evans,) and uses the window shutters with jalousie model in order to set the opening angle.

4.4.1. Natural Lighting System

Narrow distance in existing condition will reduce the natural lighting utilization. Aperture is designed to meet the requirements of 10% of the floor space. The existence of these openings is expected to support natural lighting utilization. To meet the natural ventilation and natural lighting, building is designed for two floors.

4.4.2. Ventilation System

The distance between buildings that meet the requirements can create openings that face outside building. Those openings are likely to flow the wind and continue the natural lighting. In addition it can reduce the humidity inside the room. Good natural ventilation is with cross ventilation. Therefore it is proposed to provide the distance between building at back and side the building of 80 cm. This distance is predicted to provide the difference in air pressure that can deliver air.

Natural ventilation and lighting applications can reduce the use of electrical energy with standard of use of 35 watts / m2 / hr of overall energy (SNI 03-6389-2011). Therefore artificial lighting is used in spaces that have a long duration of occupancy, such as flexible room.
4.4.3. Sanitation

According to Regulation of Ministry of Public Works Number 14/2010, every person needs about 60 litres of clean water every day. This is counted for all activities for example bathing, cooking, washing, drinking, etc. In this research, the needs of clean water supply would be more than 60 litres because they need more water to process the fish. Clean water should be supplied to the houses directly and to the communal space. Furthermore, it is need that the waste water system should be well maintained. The recycle water can be used by people in the site. Sewerage is need for fish processing also. Since they use much water to processing fish, in consequence they need good sewage system so the used water will not back to the sea directly.

4.4.4. Drainage

Drainage should meet the requirement of public works regulation. According to the regulation, drainage should be provided in settlement area to prevent inundation in the settlement. In existing condition, several houses were built on the vacant land without adequate infrastructure. Sewerage and drainage should be built bellow the alley way since the width of alleyway is only 2 meters.

![Figure 18: Proposed Building Façade 1st Option](image)

![Figure 19: Proposed Building Façade 2nd Option](image)
4.5. Affordability

The innovative housing design concept is possible to be realized with the help of cooperation of various related parties. Various related stakeholders such as local municipalities, local universities, private parties and the citizens themselves.

4.5.1. City government

City government could be the program providers. The program can also associated with self-help schemes which are provided by the central government. There are several self-help fund schemes, for example stimulant fund aid. With this stimulant fund, residents are expected to be stimulated to make more liveable housing. In accordance with the terminology of stimulant funds, the funds provided are in limited budget because it is only used as initial stimulation. A stimulant aid that is properly utilized by the community would stimulate not only the housing development but also would stimulate the people to be more developed in the future. The government would also able to arrange various housing development-related policies.

4.5.2. Local Universities

Local universities can help in facilitating the community in realizing the innovative housing design concepts. As a facilitator, the university can be a liaison between various parties that can accommodate the process. This facilitator also could help in assisting the community to decide several decisions related to the development.

4.5.3. Private Sector

The private sector may support community’s needs for development. The private sector does not support all needs, the community itself should provide some of the development’s needs. The private sector can help through the Corporate Social Responsibility (CSR) program. This is commonly done by several companies in support of prominent kampong programs in Surabaya.

4.5.4. Community

The community as the main actor should always be included in the development process. The role of community is very important since it is the one who will occupy this house. It involvement in the entire process is expected to gain their sense of belonging. The community can role also in providing some resources, including development funding, or sweat equity.

Development schemes can also be done differently. Funds from the government and CSR can be forged the construction of foundation, house on the 1st floor, post beam, to the roof. To add a wall and any other features on the 2nd floor can be a self-help by the community. Community can gradually build according to their abilities.
5. Conclusion

Innovation of settlement and houses based on bioclimatic design was suited with the existing condition. There is minimum distance between building which is generated from H/W and window to wall ratio (WWR). Those gaps will provide the opportunity for wind to flow naturally (natural ventilation) and daylight to enter the building. Furthermore, based on activities analysis, fishermen need a communal space for most of their activities especially for processing the fish. The design concepts also proposed the provision of communal space. Aside from answering the fishermen needs, this communal space also helps in implementing WWR for the buildings. This research has resulted in providing a settlement and housing concept that answer the need of spatial accommodation and answer the nature condition. It is needed a further research that deepening the bioclimatic design for fishermen settlement and other research that deepening the feasibility of providing this houses and settlement for fishermen.

References