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Original Paper

THE IMPROVEMENT OF BUILDINGS AND INFRASTRUCTURE CONDITION TO ANTICIPATE DEGRADATION PROCESS OF FISH-SMOKING CENTRE IN BANDARHARJO, SEMARANG

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ABSTRACT

The fish-smoking area in Bandarharjo is one of the significant industrial centers that processes fish as coastal resources. Its existence is crucial to support the characteristic of Semarang as a coastal city. The fish-smoking area, located on the bank of Semarang River, has existed since 1986. Local people keep maintaining the activities of smoking fish regardless the poor physical condition of the buildings and environmental infrastructure as a result of the high tide. In order to maintain the sustainability of fish-smoking activities, a research on the convenience of working space, physical condition of the building, and environmental infrastructure is needed. Considering that fish-smoking industry can provide jobs for low educated people and produce alternative food for the people living in Semarang, therefore, the degrading condition of the buildings and environment in Bandarhardjo needs to be anticipated by applying the concept of space, building and environmental infrastructure quality improvement.

Keyword : Fish-smoking buildings; high-tide; degradation; infrastructure

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INTRODUCTION

The fish-smoking industry is considered as local people industry since it is directly connected with the utilization and processing of coastal resources. The area was initially located in the housing area until it was relocated to the present location in 1986. Fish-smoking industry has survived through the poor physical condition of the buildings and unpleasant environment in order to provide jobs for the low educated people and poor people, and to produce alternative food for the consumers. (Ridho, 2001). Poverty in the city became a serious problem. For that reason the existence of fish-smoking centre in Bandarharjo, Semarang should be seriously maintained in order to save the job for the poor people.

Based on the poor condition of the space, building, and environment, a further research on the field of architecture involving space, building, and environment is required to complete the previous research conducted in this area. The objective of this research is discovering the problems in order to formulate a concept used as a solution to anticipate and prevent the degradation process of the quality of the buildings and environment.

Roseland (1997) explains that Many urban ecosystems are already seriously degraded or subject to unsustainable pressure, and many communities have lost their most valued qualities. Hence, all efforts taken to anticipate the degradation process of environment in the fish-smoking area in Bandarhardjo are expected to give contribution in preventing urban ecosystem degradation in general.

By improving the physical quality and quantity of the environment, the sustainability of fish-smoking centre can be maintained. Therefore, it will lead to the enhancement of economic and socio-environmental aspects (Grigg,1988)

The objects of research are specifically focused on the condition of the buildings and

ISSN : 1410-5217
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spaces and the environmental infrastructure problems. The reasons are due to the poor physical condition of the buildings and the environment in 2011 that may influence the sustainability of fish-smoking industry in Bandarhardjo.

Masithoh (2008) states that fish-smoking centre in Bandarhardjo is located on a high tide and flooded area that the yard is muddy because of the water backup from the high tide. In addition, the geological condition indicates that the area is located on a subsidence area. Therefore, the buildings are prone to collapse.

Based on the condition of the environment, a proper solution needs to be made in order to maintain the continuity of fish-smoking industry. The solution must involve an accurate construction concept of the building and an appropriate system of environmental infrastructure in high tide and flooded area.

MATERIALS AND METHODS

Study Area

The area of fish-smoking industry is located on the bank of Semarang river. It can be reached from Lodan Street and Artery Street. People can use public transportation like pedicab, motorcycle, three-wheel motorcycle, and it is possible to cross over the river using a small boat to get to fish-smoking center.

The area was relocated from the housing area into the present location in 1986. The main reason of the relocation was the problem occurred because of the mixing between fish-smoking industry and the use of dwellings as home-based business. Thus, the local government of Semarang relocated the fish-smoking centre on the present bank of Semarang River as a special location for fish-smoking industry under the name of Bandarhardjo fish smoking centre. It encompasses a land area of about 2000 m^2, and the sea level is 0.5m (**Fig.1, Fig.2 and Fig.3**).

Fig. 1. View of Fish-smoking Centre in Bandarharjo, Semarang.

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

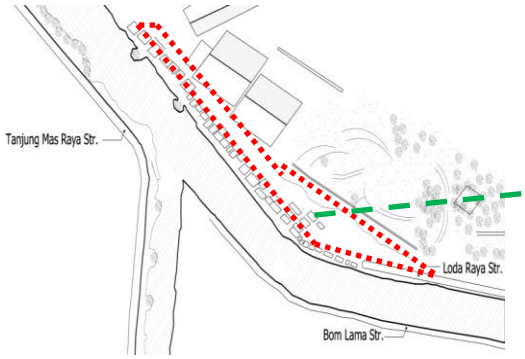


Fig. 2. Location of Fish -smoking centre in Bandarharjo. Semarang.

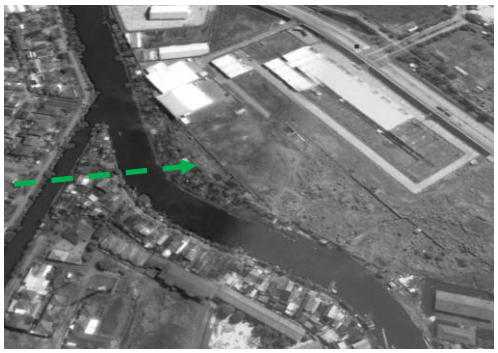


Fig . 3. Remote sensing-Map of Fish - smoking centre in Bandarharjo Semarang.
Source: https/maps.google.co.id

Data collection

The research data, consist of primary and secondary data, data collection was conducted in 2011. Those data were collected through direct interview with the smoke fish owners and labors and the head of coop.While data about buildings, infrastructures and environment were collected by measuring and taking photos. ‘’Photographic images as data to provide more explanatory power to the research’’, (Gaber, 2004). Thermal condition measured by thermometer and hygrometer “Lufft”, lighting condition measured by ”Lux& Fc Light Meter type Krisbow KW 06-288”. In order to undertake the research the methodology used was descriptive method with quantitative and qualitative approach in Laboratory of Building Science, Department of Architecture, Faculty of Engineering, Diponegoro University.

The activities at fish smoking centre in Bandarharjo.

In 2011, the number of fish smoking businesses reaches 42. One fish-smoking business can have one or more fish smokestacks (**Fig.1**). Among the buildings specifically designed for fish-smoking industries, there is one dwelling used as both a home for the family and a fish-smoking place. At the north end of the location, there are four dwellings occupied by some workers from out of Semarang.

The fish smoking industry as the main business in Bandarhardjo processes stingray, skipjack tuna, and other kinds of fish into smoked fish. The by-products of fish-smoking process are acquired from the fish processing waste and fuel waste.

Coconut shell as the source of fuel for fish-smoking process leaves the residue in the form of coconut charcoal. The coconut charcoal cannot be used in the fish-smoking process since it does not emit smoke. The charcoal is dried and sold to some distributors. Some *satay* sellers use the charcoal to grill chicken or meat. There are also restaurants, which use the charcoal to grill fish. The charcoal is also important as the raw materials for filter and briquettes. Meanwhile, the fish bones are processed into fish flour for fishing bait and fish feed. The rest of the fish waste is boiled to get fish oil. Fish oil is particularly advantageous to smear fish before grilling process begins. The oil is important in preventing the fish from sticking to the grill. Further, fish farmers use the fish viscera as fish feed.

The various activities in fish smoking industry require several spaces to accommodate the activities—a space to cultivate raw materials before the smoking process, a drying chamber, and a space for processing fish waste. There are also other rooms with different functions, such as, rest area functioning as a storeroom as well and a space for raising livestock—chicken, duck and goat—at the back of the building. All the rooms look shabby and dirty. The area does not provide prayer room, dining room for the workers, and hygienic toilet. The ground floor of the building is only 10 cm above the front yard surface causing the high tide to enter the building easily. Such as fish-smoking building belong to Mr. Rustiono. **(Fig.4).**

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

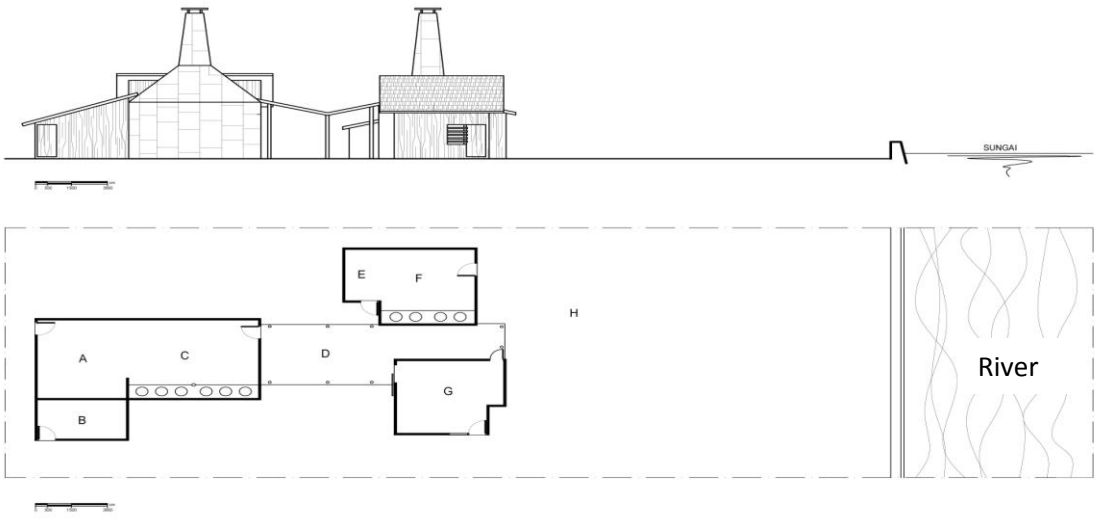
The owner usually runs the business from generation to generation. Every owner of the fish-smoking industry has some freelance workers. More workers will be hired if there is plenty of fish supply. On the other hand, only a few workers are hired when supply of fish decreases. Workers seldom work over time since the owners or members of the family usually take over the job after 6 p.m. The activities at fish smoking centre start at 8 a.m. to 6 p.m. unless there is abundant supply of fish that smoking activities may last till 10 p.m. The workers come from the surrounding area nearby the location of the fish-smoking industry. Most of the workers are residents of Bandarhardjo village. From respondents, 95% of them are residents of Bandarhardjo, while the other 5% live outside of Bandarhardjo. There is also a married couple from Sayung, Regency of Demak, working at the fish-smoking centre. The interview reveals that 10% of the workers are elementary school graduates, while 90% of them did not finish their study at elementary school. The average daily income ranges from 25,000 rupiah to 50,000 rupiah.

The demand to fulfill the basic needs has made low educated workers get used to working in any conditions. They ignore the facts that working conditions at the fish-smoking centre are far from being perfect.

Physical condition of the Buildings and the environment

The general structure and construction of the buildings use timber and bamboo with no foundation. The ceilings are covered with roof-tile and tin roof. Each industry has varied number of chimneys. The chimneys apply a very traditional technology that does not include smoke filter inside the chimneys. As a result, the people living nearby the fish-smoking centre complain of the smoke coming out of the smokestacks. This environmental impact is an inevitable consequence of government policy to relocate the fish-smoking centre in this area. Based on the research conducted by Fransiska (2010), the levels of CO in Kuningan village, the closest area to the fish-smoking centre, is 349.7 μg/Nm$^{3.}$ Further, the level of dust in Kuningan village is 117.5 μg/Nm^3, which is still below the ambient air quality standard, based on the decree of the Governor of Central Java Province number 8, year 2001.

The results of the interview also explain that the condition of the buildings is not a major concern for the workers since they have adapted to the situation, moreover, the most important matter for them is to get a job and wage to survive.



A.B.E.G= Storage, C.F= Fish Smoking area D= Row fish processing area H= Row fish draying area

Fig. 4. Plan and elevation of Fish-smoking Building belong to Mr.Rustiono

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

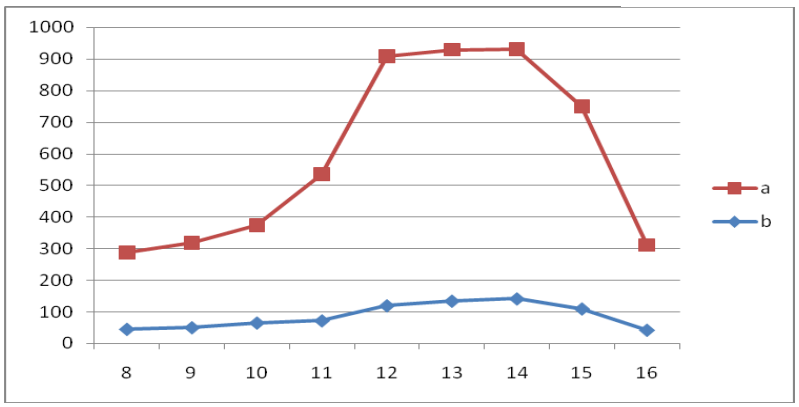
Visual comfort and thermal condition inside the fish smoking area

The lighting in the workplace relies entirely on the natural light from the sun. The light in the fish smoking room is rather dim since the only opening for the light is the entrance. Here, too many openings on the wall will disrupt the coconut shell smoke used in the fish smoking process **(Fig. 5 and Fig.6).** Based on the measurement results conducted in the sunny weather at 12 a.m. by using "Lux and Fc Light Meter type Krisbow KW06-288", the lighting condition in the smoking room with four sidewalls is 120 Lux. Meanwhile, the lighting condition of row material process with two sidewalls is 789 Lux. The brightest lighting condition measured from 8 a.m. to 4 p.m. can be seen on the graph in **Fig.7**. When it rains, the light fades away and it is time to use other sources of light. However, the workers state that they do not have any problems at all with the lighting. The light radiating from the ember of the coconut shells is bright enough to illuminate the fish smoking process.

According to Indonesian national standard 03-6197-2000 for Energy Conservation for lighting system. The illumination for the rough industrial activities range between 100-200 Lux. Therefore data in **Fig.7** for the smoking room with four sidewalls is below the requirement of properly illumination. But based on the interview with the worker, they don't have any problem with the lighting, because they are already accustom to the given environment. The illumination in the row material processing area with two sidewalls from 8 am to 6 pm is always suitable with the requirement of properly illumination.

Fig. 5. Row fish processing area with two side walls.

Fig.6. the smoking room with four sidewalls



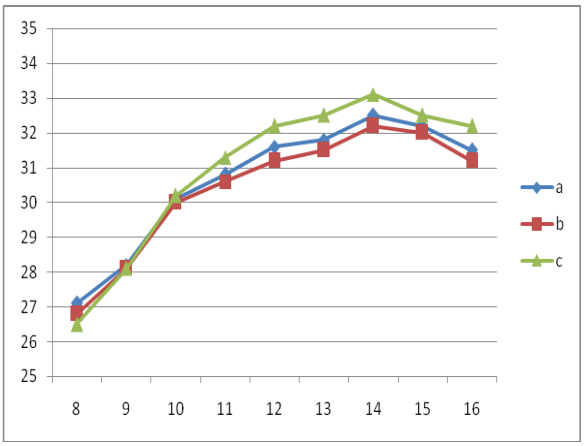
a: Raw material processing area with two sidewalls

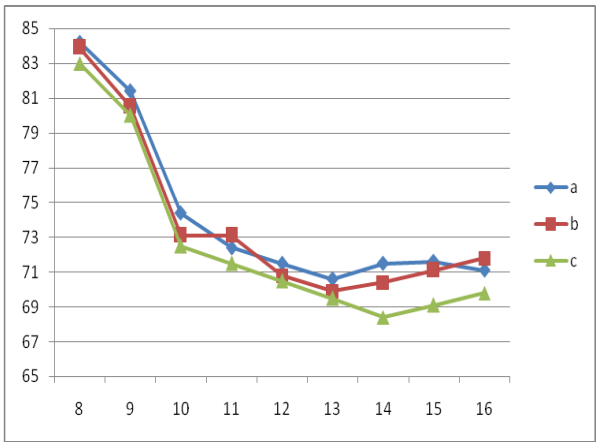
b: The smoking room with four sidewalls

Fig: 7. Natural Lighting illumination.

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

The thermal condition at 12.00 mid day inside the four sidewalls fish smoking room is 31.6^{0}C; RH 71,5 % measured by using thermometer and hygrometer "Lufft". On the other hand, the thermal condition inside the Raw material processing area with two sidewalls is 31,1°C; RH 71%. The temperature and relative humidity at 8 a.m. to 6 p.m is in accordance with the graph **Fig. 8** and **9**.





a: The smoking room with four sidewalls. b: Row material processing area with two sidewalls. c: Out door area.

Fig. 8. Temparature

Fig.9. Relative Humidity

Data Analysis

The buildings and infrastucture

The research concludes that low quality of the buildings needs to be improved. Examples should be provided as a reference while renovating the building. The present building looks skewed; therefore, it must have foundation to stabilize its position and to avoid skewed position. The structural joints are made knockdown so that they are easily dismantled when the floor needs to be elevated in order to avoid the high tide. The use of timber and bamboo is appropriate for a knockdown building since they are relatively light and easily available. Stage house style is suitable for rest area, storeroom, and small mosque. The high position prevents it from high tide and it gives a healthier environment since the floor is not moist.

To improve the quality of the smoke fish building, it is important to take into consideration the character of humid tropical climate. ''Tropical architecture has been represented as a form of critical regionalism'', (le Rouxa, 2003). According the research in Tambak Lorok Semarang, conducted by Purwanto. 2010: "Building settlements with "*rumah panggung*" (stage house) construction can be a good solution in danger of sea level rise".

Stage house is suitable to anticipated the humid tropical problems in Bandarhardjo: to enable the air movement below the raise floor, to avoid the humid and wet floor. Besides that, stage house can solve the critical condition in smoke fish centre Bandarhardjo such as flood and high tide because of land subsidence. ''Area surround the Semarang river suffering continuously the land subsidence'', (Sophian, 2010). The land subsidence in Bandarhardjo area is getting worse and worse every year. The land gradually shinking. Based on data, the land subsidence in Bandarhardjo Semarang could reach 8 cm per year (Sophian, 2010). Therefore, to anticipate such problem, the knockdown stage building could be one of the best solution. When the land is going down, the construction could be easely reconstruct. To rebuilt the building is even costless.

The front yard of the house is supposed to be an entryway; however, high tide has created puddle that impedes vehicles to the access of the location. Visitors have to detour to the backyard in order to reach the fish-smoking centre. The results of the interview indicate that

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

high tide and flood are the most troublesome situation even though the local government has built an embankment along the bank of the river. The area is still flooded with water. The problem occurs as the height of the embankment is not the same and parts of it are swept away by the flood. In some certain circumstances, high tide water bursts into the room as high as the ankle that workers need to wear plastic boots. The fish smoking can still be carried out by raising the place for grilling fish. High tide is a very difficult problem to solve since the land surface is almost equal to the surface of the river. When the river overflows its bank, water will drown the surrounding area. The problem is even worse when the water pump does not work properly since it exceeds its capacity.

Infrastructure conditions of fish-smoking areas very poor. The water waste could not easily thrown away due to the drainage facilities get stuck by garbage or mud, no clean water facilities, no health public toilet, limited electricity, no fire extinguisher, etc. Therefore, there are many problem occurred regarding that matter. Moreover, the fish smokers had habit to always thrown away part of raw fish not in proper place but most often in front yard.

Thermal comfort

Based on the data of temperature and relative humidity using Psychrometric diagram with effective temperatur (**Fig.10**), the effective temperature is in accordance with the graph in **Fig.11**.

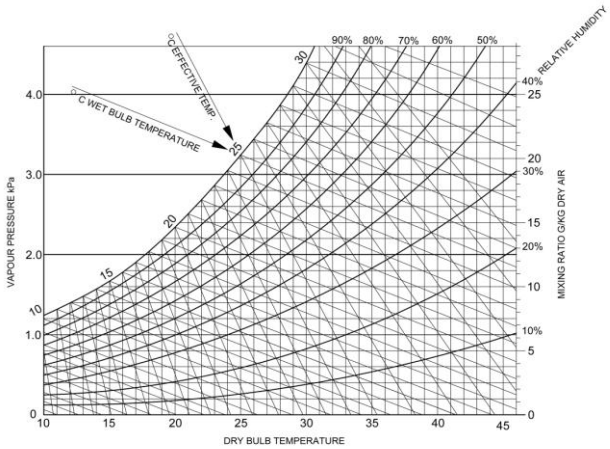
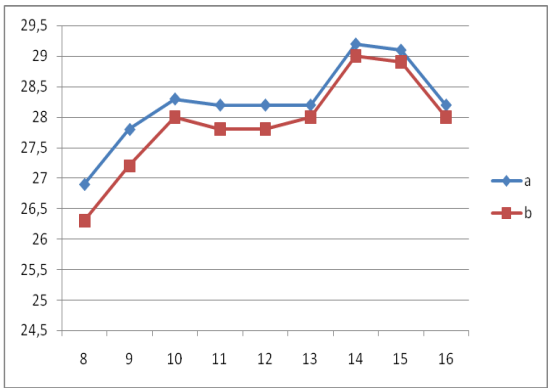


Fig.10. Psychrometric diagram with effective temperatur.



a: the smoking room with four sidewalls.
b: raw material processing area with two sidewalls.

Fig. 11. Effective Temperatur

Thermal comfort based on the data, related with Mom standard (Lippsmeier, 1980) which range between 20 – 26 °C ET (Effective Temperature). Reveal that thermal comfort condition by wind still in the Fish-smoking room with four sidewalls is not comfortable. The comfort thermal in half opened room for example in raw material processing area with less than two sidewalls is more better. Due to the habit and adaptation ability so that thermal comfort problem don't play an important role for the fish-smoking worker, they don't mind with the thermal comfort. As long as they are able to make money form they activities.

RESULTS AND DISCUSSIONS

Clean water and dirty water

The research shows that significant infrastructures needed by fish smoking centre in Bandarhardjo include clean and hygienic water, waste management, and environmental sanitation. The source of water is divided into

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

drinking water and water to wash fish. Drinking water comes from bottled water taken from home or gallon since Water Company does not cover this area. Conversely, water to wash fish is obtained from wells. The construction of the wells is too simple (**Fig.12**). The well at the front of the building is located 4m from the river with maximum diameter of 1m. The water is dirty as the result of river water infiltration. The salty water of the river makes the water in the well at the front building salty as well. Yet, the water in the well at the rear of the house has better condition even though it is far from being hygienic. The water in the well becomes dirty during the dry season. It is used to wash fish and the hands and feet of the workers. At the front yard of the building, puddle of dark stinky water comes from the water used in washing fish. In the northern part of the fish-smoking centre, the dirty water flows through the drainage into Semarang River. The drainage system sometimes does not work well that the water is stuck. It creates puddle of stinky water causing the neighborhood looks shabby.

Industrial waste

Some of the industrial wastes are used for other benefits. Fish farmers use fish entrails as fish food. Non-recycled waste is thrown into the river including paper and plastic. The rest of the waste is neglected in front of the building. It shows the workers' lack of awareness toward sanitation and health. The sewage system for non-fish waste--such as paper, plastic, leaves and others--is not related to town waste system. Therefore, the waste from the fish-smoking centre is not sent to the temporary garbage disposal, which later on is taken to the final garbage disposal.

Sanitation

The toilet is built on the riverbank that the waste directly flows into the river stream (**Fig.12**). Users need to bring their own water taken from the nearby well to wash their hands. There are three toilets in the fish-smoking centre. The toilets are not properly built that they may endanger the users. Besides, the toilets also spoil the aesthetic of the environment. There are no permanent toilets built on the ground and the toilets built by local government have long been out of order.

Fig. 12. Shallow well. (left); Toilet is on the riverbank (right).

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

Electricity for Lighting.

Electricity is used for lighting only. There is only one electricity meter for all the buildings in the fish-smoking centre. Each building in the area only spends approximately 10,000 rupiah to 25,000 rupiah per month. The need of electricity is not so big since the operation hour stop at 6 p.m. Each building only has 1 to 3 fluorescent lamps of 18 watt. The electricity meter is placed outside the building without proper protections, in which short-circuit shock may occur. Here, distribution panel is needed to distribute electricity. It needs more than one distribution panel to accommodate the whole area.

Fire Alarm System

Based on the facts that fire often becomes major disaster that destroys business area, the fish-smoking area needs a good fire alarm system. There have been four times of fire since 1999. The location of the buildings that stands along the bank of the river should make it easy in handling fire since people can use buckets and fill them with water from the river to put the fire out. However, fire mostly happens during the night when workers have finished the activities in the fish-smoking centre. Nobody stays in the area to guard the location and it makes the handling toward fire difficult. The ember of the coconut shell causes fire that burnt down combustible materials in the area. Hence, an open space between one building and the others is required in order to avoid fire.

Thermal comfort

The result of the interview reveals that thermal condition is not considered as a significant problem. The cross ventilation factor has made the fish-smoking room with both sides open to have a relatively better thermal condition. Nevertheless, it becomes a dilemma when strong wind comes. The wind will make the smoke fill the room and disturb the respiratory system of the workers.

CONCLUSIONS

In order to realize the concept of comfortable working environment that supports the sustainability of the environment, it can be concluded that :

- The physical condition of the buildings using timber with simple structure and construction system can be improved by giving proper direction and designs. A model of appropriate building suitable with the condition of the land surface in Bandarhardjo needs to be developed. The model should use cheap materials from nearby resources such as timber, bamboo or coconut trunks. Knockdown system must be applied so that it is easier to dismantle or install the building anytime the foundation needs to be elevated to avoid high tide and the decline in land surface. It is also crucial to renovate the storeroom, rest area, and prayer room by applying stage house model to avoid mud and damp floor. The model can be a guidance for other owners of fish smoking business when they repair or renovate their buildings (**Fig.13**) . Considering the facts that some of the owners of fish smoking business also raise livestock- such as chicken, duck, and goat- there should be separation between fish smoking area and barn-raising to avoid contamination from the waste of the cattle.

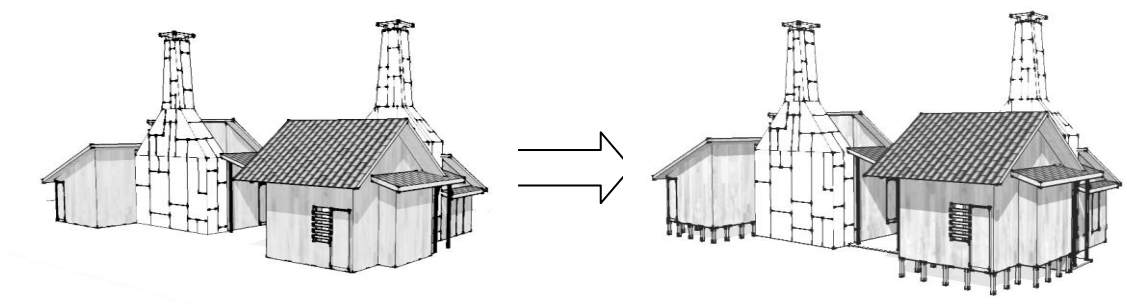


Fig. 13. Applying knock down semi-raised platform house model to avoid mud and humid floor.

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Acrredited : 83/Dikti/Kep/2009

- The pleasant working condition needs to be created to maintain the health and the performance of the workers. Extra lighting is needed to support the evening activities especially when the weather is cloudy or the workers have to work overtime after 6 p.m. The fish smoking room requires more glass windows and cross ventilations to let the natural light from the sun in. The window can be closed when there is strong wind blowing.
- A significant concept is needed to improve the quality and quantity of the environmental infrastructure, such as the establishment of temporary garbage disposal to collect non-fish waste (paper, plastic, sack) periodically taken and sent by the garbage man to the final garbage disposal.
- In order to avoid the infiltration of river water and surface water, shallow well must be replaced by deep well. Clean water should be distributed to all buildings in the fish-smoking centre to maintain the hygienic of the smoked fish. The area must consider the use of water from Water Company in the future.
- Proper toilets need to be built to prevent people from using the toilets at the riverbank.
- It is important to plant more trees in the fish-smoking area. The trees can reduce the emission resulting from fish smoking activities. Trees also provide shady spaces for parking area, rest area, and spots for vendors selling food and drink.

It is recommended that financial aid and healthy environment extension are not enough to prevent the degradation of quality and quantity of fish-smoking centre, in term of its comfort, buildings, and environmental utilities. The construction of deep well and the realization of clean water system from the Water Company can trigger the improvement of fish smoking centre in Bandarhardjo.

The local government of Semarang needs to develop a pilot project on fish-smoking centre suitable for area with frequent high tide. The building applies knockdown system made of timber, bamboo or coconut trunks that it can be dismantled and installed on the new elevated foundation to avoid high tide and the decline in the land surface.

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REFERENCES

Ball, A. and Paul. 2001. *Environmental Psychology*, Harcourt College Publishers, New York.

Fransiska, D. 2010. *Evaluation of Environmental and economic performance of multistage smoking at Bandarharjo smoking Fish Center Semarang*, Thesis Program magister Ilmu Lingkungan PPS Undip-Semarang. (in Indonesian)

Gaber, J. and S.L. Gaber. 2004. If you could see what I know: moving planners' use of photographic images from illustrations to empirical data, *J. Architect.Plan.Res*.21:3: 222-238.

Grigg, N.S. 1988. *Infrastructure Engineering and Management*, John Wiley & Sons, New York.

Le Rouxa, H. 2003. The networks of tropical architecture, *The J. Architect*, 8(3), 2003: 337-354

Lippsmeier, G. 1980. *Building in the Tropics*, Calwey Verlag, München.

Masithoh. 2008. *Environmental Management of the Center of Fish Smoke Home Industries Bandarharjo Semarang Municipality,* Thesis Program magister

ISSN : 1410-5217
Acrredited : 83/Dikti/Kep/2009

Ilmu Lingkungan PPS Undip-Semarang. (in Indonesian)

Purwanto, E. 2010. "*rumah panggung*" for the settlement with sea level rise problem in the fishermen settlement of tambak lorok semarang. *J. Coast. Dev.* 13(2) : 1 – 14.

Ridho, M.A. 2001. *Poverty in the City*, Unissula Press. Semarang. (in Indonesian)

Roseland, M. 1997. *Eco City Dimensions*, Healthy Communities Healthy Planet, New Society Publishers, Gabriola Island.

Sophian, R.I. 2010. Penurunan muka tanah di kota-kota besar pesisir pantai utara Jawa (Studi kasus kota Semarang), *Bull.Sci. Contribut.* 8, (1), 2010: 4 1-60. (in Indonesian)

Szokolay, S.V. 1980. *Environmental Science handbook,* The Construction Press, Lancaster.

Thomas, R. and T. Gamham. 2007. *The Environments of Architecture,* Tatlor & Francis. New York.