Social Mapping Framework to Identify Readiness of Sustainable Community based Offshore Aquaculture: Case Study: South Coast of Malang, Indonesia

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Abstract: Fulfillment of fish demand in the world is generally obtained by capturing fish in the sea or on land, as well as fish farming (aquaculture). Recently, fish production using aquaculture cultivation has rapidly increased either on land or inshore and been expected to be able to exceed the amount of capture fish production in the future. This will become a great potential that should be developed in Indonesia, as an archipelago. However, offshore aquaculture in Indonesia is kind of new and becomes a pilot project adopted from a similar program carried out by Norway. To identify the readiness of this program becoming sustainable to be applied on the south coast of Malang, there is a need to research and conduct social mapping in order to view and analyze socio-culture, economy, environment aspects linking with community engagement. Social mapping is conducted qualitatively and quantitatively by collecting and analyzing demographic, geographic, sociological data, then transferring into the framework and conceptual model. The framework of social mapping will become an input for a sustainable community-based offshore-aquaculture model, which can be simulated to forecast how sustainable the program is in the future.

1 INTRODUCTION

Aquaculture or fish cultivation is specifically defined according to the law of the Republic of Indonesia No. 31 of 2004 as an activity to maintain, to grow, and/or to breed fish and to harvest the results in a controlled environment, including activities that use ships to load, transport, store, cool, handle, process and/or preserve it. Aquaculture cultivation continues to develop rapidly and is widely carried out in open waters, such as rivers, reservoirs, lakes, and coasts. Aquaculture has increased and is very important in recent decades throughout the world due to the escalation of demand for fish and stagnation in capture fishery supply (FAO, 2013). In the next few years, demand for fishery products in developing countries is estimated to rise because people are encouraged to adopt healthier diets and to have the mindset that fishery products are as healthy foods. For capture fisheries, China was quantitatively the top-ranking fishing country followed by Indonesia, India, the United States of America, and the Russian Federation. Nineteen countries caught more than one million tonnes each for fishery products in 2017, calculating for more than 72% of global catches. On the other hand, fishery production from aquaculture in the world has increased steadily to an average of 4.8% during 2011-2017 (FAO, 2019).

Additionally, as aquaculture cultivation gradually develops, the need for suitable space in fish farming has been followed by the development of a sustainable, cost-efficient, and effective environmental methodology as well as offshore aquaculture (Maricchiolo et al., 2011). There are also possibilities that bound the expansion on land and inshore coastal areas, and improvement of operational technology in fish farming studies, have led to broadening the worldwide interest of offshore aquaculture (Ferreira et al., 2012). Offshore aquaculture has some great advantages over inshore aquaculture, such as to prevent possible conflicts between environmental effects in coastal areas and commercial aquaculture technology (Benetti et al., 2010), to allow a wide and rapid dispersal of dissolved waste products as well as the higher flush

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impact in open water (Holmer, 2010; Troell et al, 2009), and to reduce associated benthic stress and local pollution (Naylor and Burke, 2005). Therefore, it seems that offshore aquaculture will be the solution for increasing seafood demand (Wheeler, 2013).

However, the aquaculture cultivation system is strongly interrelated to three aspects of sustainability: its technology, socio-economic, and environmental and climate changes (Trapani et al., 2014). There are some potential risks, such as few conflicts between offshore aquaculture and its activities in regards to recreation, tourism, or coastal esthetics (Teitelbaum, 2011). Moreover, some challenges of aquaculture are related to socio-economic issues and ecological impacts (Suryanata and Umemoto, 2005) as well as the optimal siting, which is a trade-off between factors, such as depth and distance to port (Kapetsky et al., 2013). In order to know further these challenges, there are some research which overcome that challenges, such as the perceived impact of this aquaculture area on small-scale fisheries had been researched using Fuzzy Logic model (Ramos et al., 2015) and using Bayesian approach regarding stakeholder's conceptualization (Ramos et al., 2017), integrated modeling approach in providing the effects of both inshore and offshore aquaculture production and environment in a coast (Ferreira et al., 2014), as well as stakeholder-driven future scenarios for offshore aquaculture development & potential effects on fishermen (Tiller et al., 2013).

In Indonesia, the successful development of the aquaculture cultivation has also been proven to play an important role in increasing national fish production. Aquaculture has some positive impacts which are environmentally friendly and more sustainable. Thus, aquaculture cultivation is needed to meet the national fish consumption needs that increase annually. Besides that, this aquaculture method provides a multiplier effect on employment, both directly and indirectly, and from upstream to downstream. Indonesia's fishery production from aquaculture had gradually reached a 16% average increase during 2006-2016 (BPS, 2019). This certainly illustrates that national fishery production with aquaculture is in great demand in almost all parts of Indonesia. Fish farming using aquaculture is not a new thing for Indonesian people, especially for inland aquaculture, and more recently is inshore aquaculture. Nevertheless, fish farming using the offshore aquaculture method is very new, and the Ministry of Maritime Affairs and Fisheries of Republic of Indonesia made a breakthrough to conduct a pilot project of three Offshore Aquaculture units in 2018.

Furthermore, according to the determined research object on the south coast of Malang, East Java Province, even though there was a significant decrease in 2016, aquaculture production had risen to 57% of the average increase during 2011 – 2015 (BPS, 2019). This definitely raises questions related to the decline in aquaculture production in East Java. In addition to that, fish farming using the onshore aquaculture in East Java only produced 271 tons in 2017 (BPS, 2019). The value of production in East Java was relatively small compared to other provinces in Indonesia, such as Kep. Riau, North Sumatra, Maluku, and North Sulawesi, which were ranked top in the national fisheries production using aquaculture.

Driven to the aforementioned concerns, observations have been made on the South Coast of Malang. Based on observations that have been carried out for fishermen in 2018, it can be concluded that the fishermen's knowledge is very poor regarding aquaculture cultivation, especially offshore aquaculture. With the existence of offshore aquaculture, it will give some positive impacts, such as the community can work for hatcheries, fish farming, loading and unloading workers, transportation workers, harvest workers, to offshore aquaculture stall owners. The fisheries sector plays an important role in Indonesia's economy through the supply of fishery animal proteins, livelihood diversification, revenue generation, and foreign exchange earnings (Tran et al., 2017).

Therefore, it is very necessary to increase fishermen's knowledge in the form of training and assistance on the management of aquaculture operations, especially offshore aquaculture for fishermen in the South Coast of Malang, especially Sidoasri Villagers, and surrounding areas. To achieve the success of this pilot project of offshore aquaculture, a social mapping study is needed to observe the community of Sidoasri Village and surrounding areas. This study aims to provide a comprehensive picture of Sidoasri Village and its community in the form of both potential and challenges. This social mapping can be conducted in identifying the form of mapped locations, including actors who play a role in the process of social relations, social networks, strengths, and interests of each actor in community life, especially in improvement of people's living conditions, existing social problems including the presence of vulnerable groups, and the available potential, both natural, human, financial, infrastructure as well as social capital. Furthermore, another aim of this social mapping is to identify the readiness of offshore aquaculture becoming more sustainable to be applied based on the community in the South Coast of Malang.

2 METHODOLOGY

The methodology of this research combined social mapping activities and System Dynamics modeling. The main research stage of this study is mainly carried out with two stages: (1) preliminary studies of the research area in the case study in order to draw a framework of social mapping and (2) developing the System Dynamics model using Causal Loop Diagram as a mental and conceptual model. In attaining the research objectives, this study shows the existing condition of the system observed and combines the framework with the Causal Loop Diagram, then to perform interdependencies within variables and to show the closed feedback loops formed by variables relationships (Vanany et al., 2019). Firstly, we gathered secondary data and did visualization using a geographic map. Secondly, modeling sustainable community based offshore aquaculture using System Dynamics approach was conducted. Before conducting the main research stage, the understanding of the study area as a research object, and how data to be gathered should be accompanied. The following below is the description of the preliminary studies of the area.

Moreover, relevant data were gathered from two types of data sources, such as primary data – conducting direct observation, including in-depth interviews and surveys with relevant stakeholders as well as secondary data –using literature review (BPS reports and some journals & articles). The stakeholders analyzed in this study were selected by the recommendation of the previous study in the same area through Enabling Community Action (ENACT) (Riniwati et al., 2014). These collected data were identified and were processed then in order to get the relevant variables in the observed system within the chosen variables. It is essential to conduct in order to build the conceptual model.

Nonetheless, some corrections of the model were often conducted in creating model conceptual until the model was assuredly valid and representative. The validation method was performed by using Boundary Adequacy Test and Structure Verification Test (Barlas, 1996). Boundary Adequacy Test takes into account key structural relationships, which are significantly necessary to fulfill the model's objectives. In addition to that, the Structure Verification Test was carried out by directly checking and ensuring model structures with the real system structure.

2.1 Preliminary Study of Area

In the first stage, conducting a preliminary study of the research area is needed. The area observed in this study is exactly Perawan Beach, in the South Coast of Malang. Perawan Beach is administratively located in Sidoasri Village, Sumbermanjing Wetan District, Malang Regency (Figure 1). This village is the result of the division of Tambakasri Village and is about 60 km to the south of Malang City (see Figure 1). The beach is still very beautiful, not yet widely known, even by the majority of Malang residents themselves. Since this beach has not been managed as a tourist attraction, so it is still very rare to know the existence of the beach. This is very different from Sendang Biru Beach, which is a Fishery Port or Tiga Warna Beach, which is already well-known by the community as a tourism destination. Some people call this beach as Sidoasri Beach because it is located in Sidoasri Village or Tambakasri Beach because it used to be in the Tambakasri Village area. Therefore, Perawan Beach has a great potential to be developed more in terms or offshore aquaculture, which will deliver positive impacts for tourism, economy, and socio-culture of villagers.

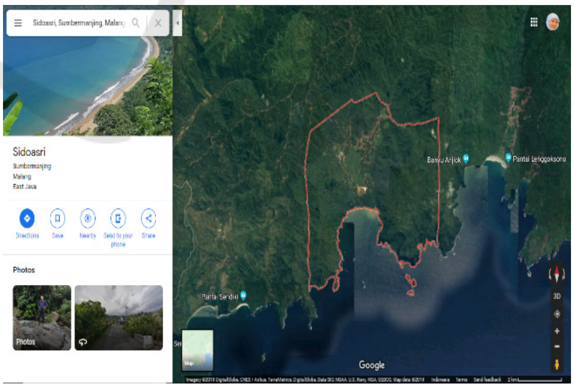

Figure 1: Location map of Perawan Beach, South Coast of Malang (source: google map)

Besides that, from the topography point of view, Sidoasri Village is in the form of lowlands, which is around 0-100 meters above sea level with a slope of 15o and has fertile brown soil for agricultural land. This village has some land with different functions, such as forest (mangrove around the shore), paddy fields, plantation, settlements, and fishpond which are respectively 60%, 16%, 12%, 11%, and 1% of total land (BPS of Malang Regency, 2018). Due to its geography and topography condition, the profession of the villagers is highly dominated by farmers in a paddy field or plantation, and some of them as fishermen with small proportions. However, many villagers have multiple professions, which means that they will be farmers while the harvest time comes. Otherwise, while the weather is suitable for sailing, then they will be fishermen in order to generate revenue for their lives. Based on demography, the total number of Sidoasri Villagers is around 5000 people who are divided into the same proportion of gender, with 50% of women and 50% of men. Regarding the main natural resource products of Sidoasri, there are various fish products, such as lobsters, shrimps, squids, kerapu fish, stingray, and other types of fish as well as agricultural products, such as paddy, coffee, banana, and cloves.

3 DISCUSSION

In this part, there will be sub-topics that will be discussed regarding the objective of the study, which is to create a social mapping framework for sustainable community based offshore aquaculture and to model this aquaculture in terms of a conceptual model.

3.1 Framework of Social Mapping

Social mapping aims to provide a comprehensive picture of mapped locations, including actors who play a role in the process of social relations, social networks, the strengths and interests of each actor in community life, especially in improving people's living conditions, existing social problems including the presence of vulnerable groups, and available potential, both natural, human, financial, and infrastructure as well as social capital.

Based on this study, the following data will be obtained, such as:

1) Village profiles which includes: (a) Demographics, statistics on population composition (sex, employment, poverty level, education level, welfare level, etc.), (b) Socio-economic, cultural, community norms and values, community structure, social relations, social mobility, community leadership, customs and habits, (c) Geographic, including location of the community, location of facilities, access roads, land use, and other geographical aspects.

2) The mapping of social networks includes Relations between actors (stakeholders), both individuals and institutions, and the nature of the relationship. Forums that are used by the community to discuss public interests. Potential in the community which may be developed: natural potential, human resource potential, financial potential, physical/infrastructure potential, and social capital potential. In this study, there are some stakeholders involved, namely village government (Village Council-BPD, Village Community Empowerment Organization-LPMD, Family Welfare Programme-PKK), fishermen and farmers community, youth organization (Karang Taruna), church and mosque community, saving and loan cooperatives, Fostering Community Monitoring Group (POKMASWAS), and Women's cooperative (KOPWAN). These stakeholders provide close engagement with the villagers and social networks among them.

3) Social problems which become obstacles or often arise so that they become obstacles to the development of society.

Furthermore, the social mapping framework had been designed in order to enable and to facilitate the overall mapping activities in the observed community in regard to operating sustainable offshore aquaculture. This framework can be seen in Figure 2.

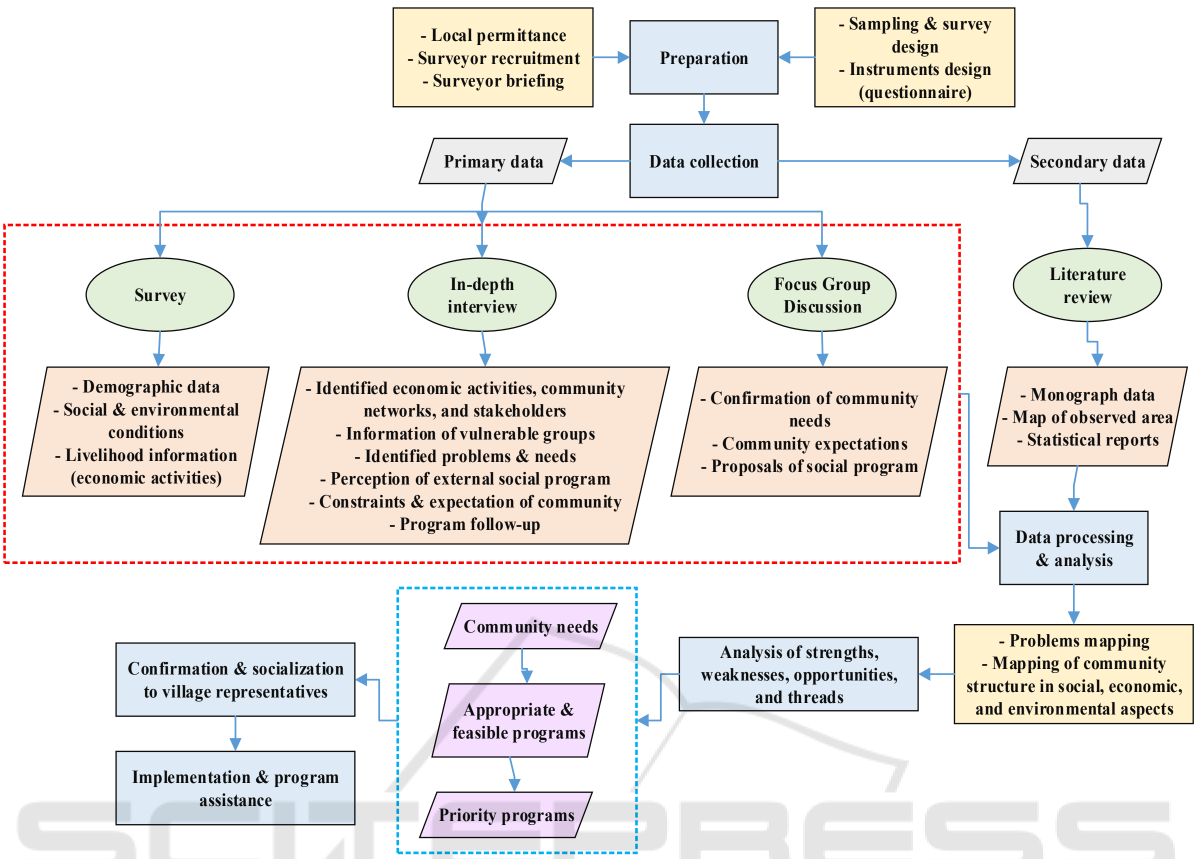

Figure 2: Social mapping framework considering sustainability aspects (socio-culture, economic, environmental) related to community engagement.

3.2 Conceptual Model of System Dynamics

In the second stage, system modeling related to the research object is conducted to comprehend the key leverage elements that contributed to system improvement. Furthermore, understanding the elements of the system can be performed by firsthand identifying relevant variables related to the community based offshore aquaculture system in Indonesia generally and in the South Coast of Malang particularly. Afterward, a system dynamics model is conceptually created using a conceptual model based on the social mapping results of offshore aquaculture cultivation for the community. This mapping framework is used to understand in identifying the main variables in the system easily. A model represents the basis of experimental investigations, which has some advantages, such as relatively inexpensive and time-efficient rather than conducting an experiment in a real system (Forrester, 1968). In this case, the conceptual model of sustainable community based offshore aquaculture was designed using a causal loops diagram (CLD).

In addition to that, the causal loops diagram is essentially built to correlate the main variables that will be depicted in the model. By using causal loops, it is able to easily understand the causal relationship between variables and how far the influence of variables on system behavior is as well as how the impacts of each variable to the others area (Sterman, 2000), such as community-based mangrove cultivation policy (Maftuhah, 2013). In developing the system dynamics model, there are some elements of the causal loop diagram, which are represented as a set of variables, arrows/links, feedback, and feedback loops. The variables of CLD indicate sequences of cause and effect, as well as arrows, represent which variables affect other variables. Moreover, feedbacks indicate positive/negative polarity of the influential relationships, as well as the feedback loops, represent loop types (both in the clockwise direction) - reinforcing loop (R) and balancing loop (B).

Furthermore, reinforcing loops (R) can be defined as a positive loop; otherwise, balancing loop (B) is a negative loop. Each identified variable in the proposed system dynamic model was defined. The model of the system was divided into five sub-systems, namely socio-culture, offshore–aquaculture cultivation, economy and infrastructure, environment, tourism impact, and stakeholders, which can be seen in Figure 3. Then, the main variables within sub-systems were identified for each variable.

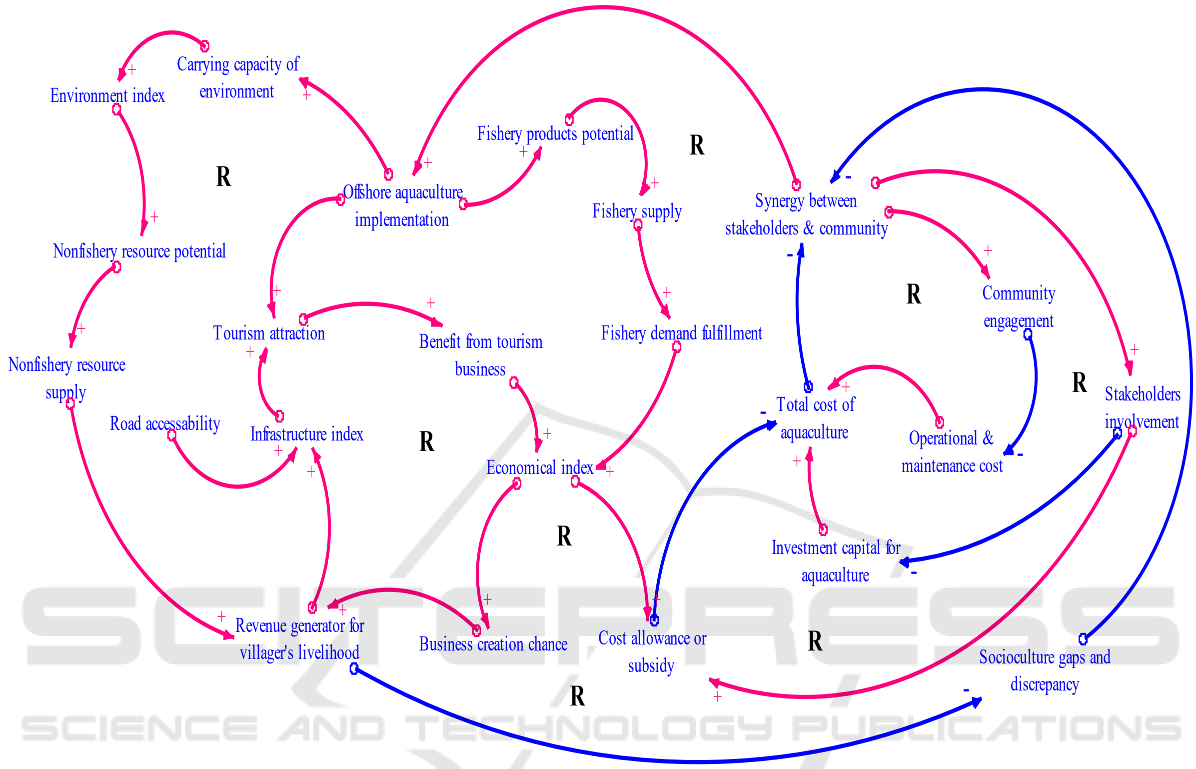

Figure 3: Conceptual model of sustainable community based offshore aquaculture.

4 CONCLUSIONS

In general, the aims of the study had been achieved in order to make a social mapping framework as an input for modeling sustainable community based offshore aquaculture in Perawan Beach, South Coast of Malang. In doing social mapping study, preparation of survey had also been conducted by making questionnaires which involves sustainability aspects, demography, and etc. These questionnaires were distributed to many respondents of villagers as samples, and afterward, the results were processed using statistical analysis. This survey was confirmed with Focus Group Discussion as feedback of survey results. The analysis of survey and Focus Group Discussion shows many critical and potential variables which can be encouraged into better condition, such as villager's perceptiveness of offshore aquaculture, economic and environmental aspects, socio-cultural aspect, and stakeholders involvement which provide social engagement among villagers and them. The result of social mapping is essential for modeling input and completely depends on the direct observation and social network analysis, which has been described in the discussion.

Furthermore, the conceptual model of this study had been created, as well. This model is derived from the results of the social mapping framework with Causal Loop Diagram's rule. Regarding the next research, this conceptual model is for input to do further analysis, such as creating a simulation model and determining the best policy scenarios. By the time the simulation model has been created, there will be a prediction of preparedness of community in implementing offshore aquaculture in a better and more sustainable way in the South Coast of Malang, particularly and in Indonesia generally.

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