Supply Chain Model of Catfish Production and Trade in Yogyakarta, Indonesia

Kuncoro Harto Widodo, Joewono Soemardjito, and Dwi Ardianta Kurniawan

Abstract—Currently, the demand for marine and fisheries commodity in Yogyakarta, Indonesia continues to increase. The existing condition shows that the aquaculture supply cannot be supplied by Yogyakarta region itself, but still need to be supported by regions outside Yogyakarta. The effort to optimize the market is initiated by reviewing and designing the supply chain of production and trade of aquaculture commodity in order to create the implementation of aquaculture production and trade commodity optimally.

This formulated supply chain model indicates 4 performance indicators of measurable success in terms of: (1) efficiency; (2) flexibility; (3) responsiveness; and (4) quality. These indicators had been exercised as the success benchmarks for priority marketing management in local level as well as national level.

The result of this research indicates that if the catfish fishery system is managed as business as usual then the catfish demand in Yogyakarta region will experience to increase in the future. The increase of demand is inline with the increase of number of people in Yogyakarta and also the fluctuation of catfish consumption per capita. The highest production of catfish will experience in the third year approximately 30,118 tons. Other result of the research indicates that the catfish demand in Yogyakarta region cannot be supplied yet from the local region. Therefore, to fulfill the supply from outside Yogyakarta region, the local farmers should improve the supply through land extension. The fluctuation of commodity price will experience in the future annually and the catfish supply from outside Yogyakarta region will be lowering the price in the market.

Keywords—Supply chain model, catfish, efficiency, flexibility.

I. INTRODUCTION

CURRENTLY, the demand of marine and fishery commodity tends to increase. In the national level, it is predicted that the aquaculture supply will experience to increase in 2014 as well as fisheries with number approximately 22.4 million tons. In the supply side, this also will experience to increase with number approximately 12.1 million tons. The supply of fishery commodity is as national economy potential that could be utilized to meet the need of domestic consumption. In addition, Indonesia as one of the largest fishery producer, the fishery commodity could be the national competitive commodity in the global level.

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The marine and aquaculture fishery development in Yogyakarta is still facing the problem in the production process. The aquaculture development in Yogyakarta region and surroundings cannot meet the demand of Yogyakarta people supply therefore this should be supplied from other regions outside Yogyakarta region. The need of catfish supply for Yogyakarta people is estimated around 12 to 16 tons per day. Meanwhile the supply contribution from Yogyakarta itself is only 30% of total demand or around 4.2 tons per day. To fill the gap of demand, the supply should be provided from other regions e.g. from Central Java Province such as Boyolali Regency approximately 60% of total supply and East Java Province.

The existence of aquaculture distribution network from other regions outside Yogyakarta has a vital role in creating the market dynamic of fishery trade in Yogyakarta. The existence of catfish suppliers from outside Yogyakarta has stimulated the market dynamics of fishery trade therefore this situation has created a competition at the producer level. In conditions as illustrated above, it needs a strategy to create the proportion of required supply of aquaculture in Yogyakarta which is ideal to improve the role of local actors, to encourage commodity supply chain scheduling of aquaculture commodity to meet the need of sustainability of fish supply, and to improve the infrastructure to support the supply chain process as well as the optimization of on-line information system development to support the product trade process.

To achieve the goals mentioned above, this will need support from all stakeholders in the whole process from the production aspect, manufacturing process including handling and processing until marketing or trading aspect. The review and design of supply chain will be one of the efforts that can be exercised to support the optimal production and trading of aquaculture commodity in order to be able to contribute for the implementation of fishery and aquaculture development program, especially to improve level of Yogyakarta people consumption.

Research activity that has been conducted is aimed at formulating a logistics and supply chain model to support the production and trade of aquaculture commodity especially for catfish in Yogyakarta region and its surround.

II. LITERATURE REVIEW

A. Fishery Supply Chain Model in Some Other Countries

Management and distribution network of fishery products is one of important parts in the success of the Indonesian Vision

2015 to become the Largest Marine and Fisheries Producers in the World. This is a logical consequence of the globalization of fishery production and market that demands a sustainable supply of products and quality. However, the distribution of fishery products still have many disparity problems on the product such as high price, inefficient market chain, not proportional profit margin, quality and the assurance of product availability. Therefore that it causes the consumers will bear the distribution problem with paying unreasonable price of products.

Marine and fishery commodities are one of commodities that is difficult to control in the process of product loss for the freshly harvested, although the loss can be decelerated slowly through material handling such as cooling or freezing process of harvested products. This will give an impact on the incremental cost as a consequence of the choice to eliminate the loss of quality. Related to this such matters, it needs a constructive measure which is involved the stakeholders through an integrated Supply Chain Management (SCM) approach in the face of constraints on supply, quality, price,

efficiency of production and raw material costs, the implementation of quality assurance and chain system (cold chain), tracking and tracing of product and ecolabeling, are some common problems that will be the key to successful penetration of Indonesian fishery products in the global market. SCM is a set of approach that is applied to integrate suppliers, companies, warehouses and all entities involved in the business process efficiently so that the resulting product can be distributed at the right quantity, right location and right time in order to reduce the costs and to achieve the customer satisfaction.

Fishery products distribution process is closely related to the concept of SCM. Commodity supply chain model of marine fishery has more complex structure of the supply chain model of the product in general. Network structure in fishery commodity supply chain involves many parties, including the fishermen, small traders, wholesalers, manufacturers, exporters, government, and also society as the end consumers. United Nations Environment Programme [1] describes the general structure of the supply chain in Fig. 1 as follows.
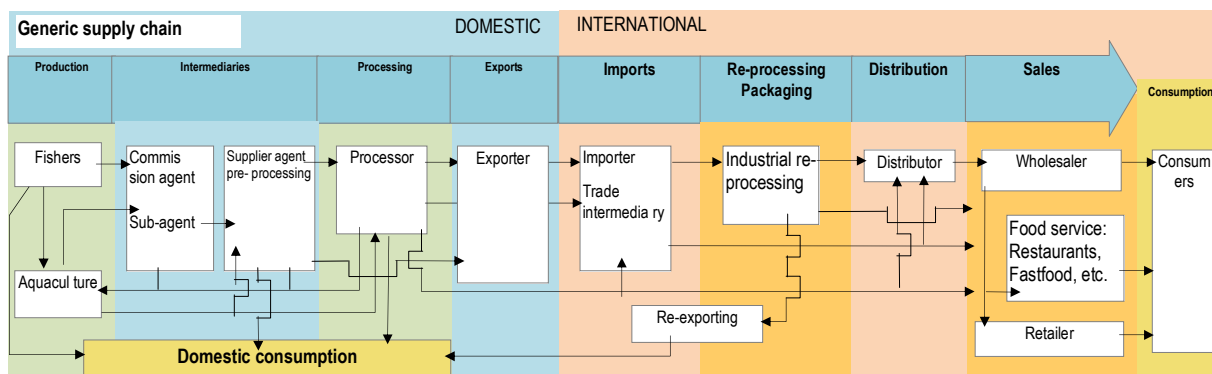

Fig. 1 Generic fish and fish product supply chain

The structure of supply chain in practice is strongly influenced by geographical, political, economic, and cultural social factors on each of the actors involved in the entire supply chain process from upstream to downstream. One of the chain structures of fishery commodities supply Indonesia chain in Indonesia can be classified into 4 models (see Fig. 2) [2].
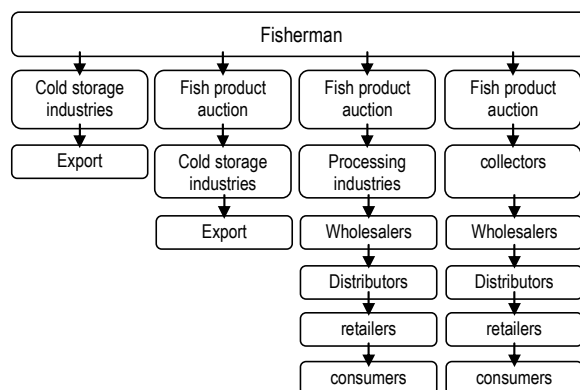

Fig. 2 SCM model of fishery products in Indonesia [2]

The distribution channel of fresh marine fishery products in traditional market in Jakarta can be classified into 2 destinations, i.e. for local demand and for demand outside Jakarta area (see Fig. 3) [3].
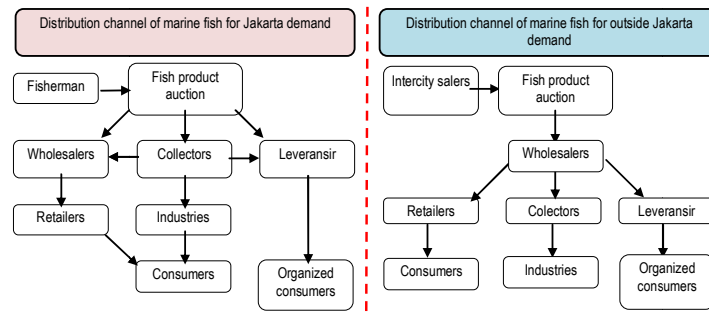
Fig. 3 Distribution channel of marine fishery product in Jakarta area

The application of fishery product SCM in developed countries such as USA (see Fig. 4) and Japan has been developed in SCM concept implementation [4]. These countries are able to succeed because of the effective coordination, cooperation and collaboration among the actors who involved in trading activities or business from upstream to downstream.
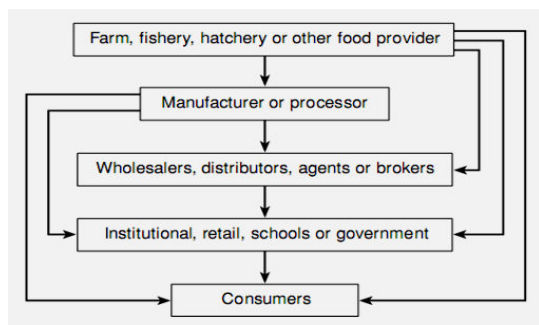

Fig. 4 Fishery product supply chain structure in USA

In Japan, the implementation of fishery product SCM is well known as "Keiretsu". The principle of Keiretsu is establishing a supply chain network. The nature of network is long-term and generally co-exists when one chain is not functioning or collapse for any reason or problems that arise. Fig. 5 illustrates the structure of "Keiretsu" model that is implemented in Japan and this model has been effectively applied in Tsukiji fish market.
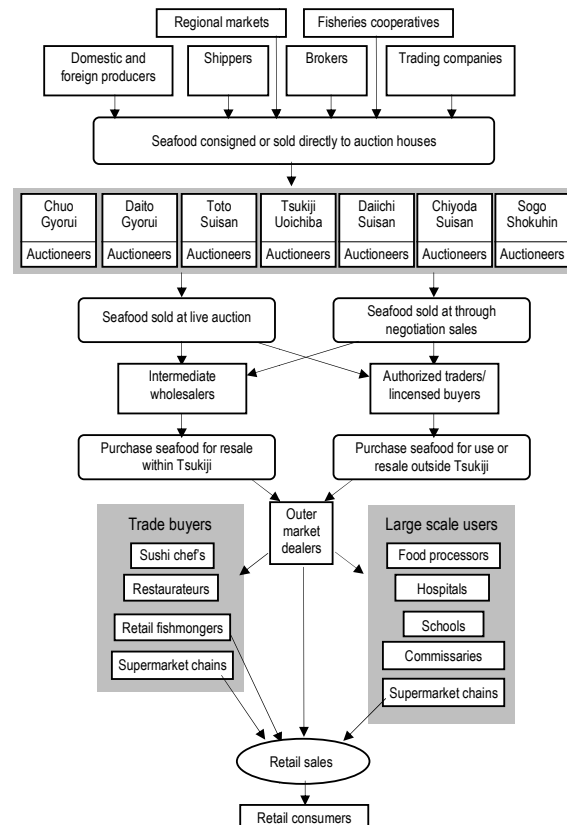

Fig. 5 Supply chain structure in Tsukiji fish market, Japan

In the activity of moving goods from upstream to downstream, the implementation can make the gaps as follows [5]:

a. Geographical gap that is caused by differences in the center of production to the location of the consumer. Thus the farther distance raises an important role to distributors.

b. Time gap that is caused by the time gap between production and consumption of products. This time gap raises time utility (value of time), meaning that the product should be available whenever it will be needed.

c. Quantity gap that is caused by the large scale of production to gain the lower cost per unit while the consumption occurs in smaller quantities.

d. Variety gap that is caused by most of manufacturers produce variations of a particular product but those products could not meet the consumer needs. Quantity and Variety gaps raise a value of form utility, means that benefits are created by the changes in an effort to improve a product.

e. Communication and information gap that is caused by the consumers who often do not know the sources of the production of the required products while manufacturers do not know who and where the potential consumers are. This gap raises a possession utility that indicates the change of activity.

All of the five values cannot be separated. Consumers are unable to obtain finished goods without any transportation of goods to transfer products from origin to the place of destination, and without storage until it is needed. When a consumer uses a product, consumers should get all the use-value. Therefore, the key of successful of SCM implementation is how to meet between the availability, proximity and ease.

B. Performance Indicator of Supply Chain Structure

The successful of supply chain structure of a commodity is affected by 4 factors, i.e.: efficiency, flexibility, responsiveness, and quality. Fig. 6 shows the example of performance of supply chain structure of food and beverage products.
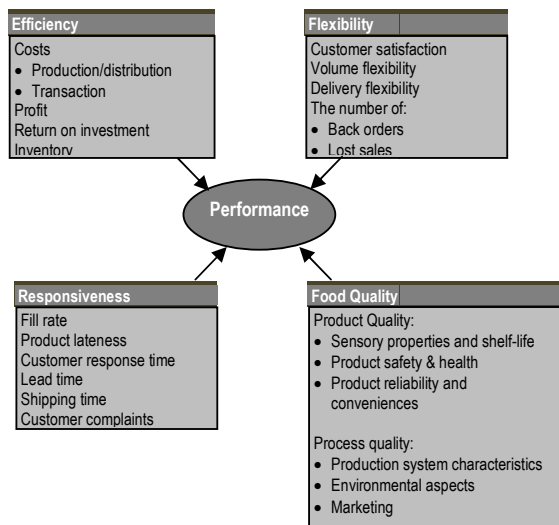

Fig. 6 The measurement of supply chain performance Indicators

C. The Relation between Product Dimension and Relation among the Actors in Supply Chain Management

Conceptually, the supply chain of a product commodity is an economic system that is enabling to distribute the benefits and risks to all the involved actors. Each supply chain is connected by shared information and reciprocal scheduling, product quality assurance and committed transaction volume. The linkage of the various processes that occur can create value-added commodities, however demanding every actor or entity activities in the supply chain to coordinate their

activities with each other as a process of continuous improvement. Therefore, we need an effective SCM model that should be developed on marine and fishery commodities to optimize total customer satisfaction.

Competitive advantages of SCM are laid on the mechanism or how to set up the flow of goods or products in a supply chain. In other words, SCM models apply a network of production and distribution of a company to be able to work together to meet consumer needs. SCM applications will improve the efficiency of the distribution, so as to improve the quality of the products that in turn provide customer satisfaction, reduce costs, and improve all the results of the entire supply chain of the product [6].

SCM model configurations that are illustrated in Fig. 7 reflect the policy or tactical decisions that will affect in the activity [7]. There are 4 relationships that are illustrated in 4 quadrants represent the policy or tactical decisions in the SCM model configuration, as further described below.

a. The relationship between product design and network design of product will generate configuration and network, which includes a strategy or policy in: (1) determining the type of product and type of services to be offered to the involved actors and need each other; (2) making the type of coordination of the most effective and efficient will be applied.

b. The relationship between product design and interface optimization will result in product design in the supply chain, which includes a strategy or policy in optimizing the internal and external resources.

c. The relationship between production and network design will result in formation of production network, which includes a strategy or policy in minimizing cost, taking into account the production facilities, the vertices of the source of raw materials, and specific production cycle time.

d. The relationship between production and interface optimization process optimization will result in the supply chain, which includes strategies or policies in optimizing the supply chain with the ultimate goal to minimize the costs through the use of information technology, optimization efforts using simulation models.
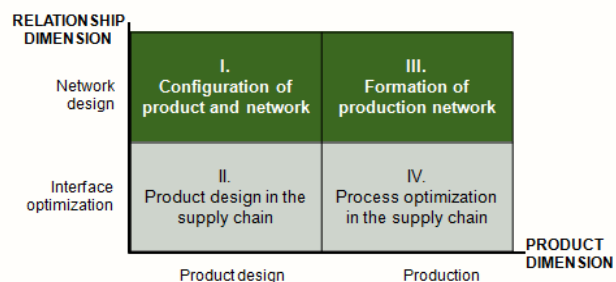

Fig. 7 The Product-Relationship-Matrix of SCM

Each of these strategies and policies mentioned-above can then be derived in the form of activities, as Table I.

TABLE I
THE STRATEGY OF ACTIVITY BASED ON MATRIX OF RELATIONSHIP BETWEEN PRODUCT AND NETWORK

Type of relationships and Network	Activity
Configuration of product and network: • Determining of type of product and services that will be offered to other entities. • Type of effective and efficient coordination **Product design in the supply chain:** • Strategy to utilize internal resources or outsource **Formation of production network:** • Minimizing cots through considering the product facilities, material raw resources location and time-cycle of specific product **Process optimization in the supply chain:** • Optimizing supply chain with the final target to minimize the cost by: IT utilization, optimization through modeling, etc.	• Identifying type of product • Identifying the trade mechanism that has been conducted (retail) • Model of existing trade partnerships. • Identifying existing: infrastructure; institution; and actors involved in trading commodity. • Identifying the existing distribution channel • Identifying the characteristic of supply-demand. • Identifying information system and communication in the commodity • Optimizing model for supply chain commodity

III. METHOD

A. Logical Framework

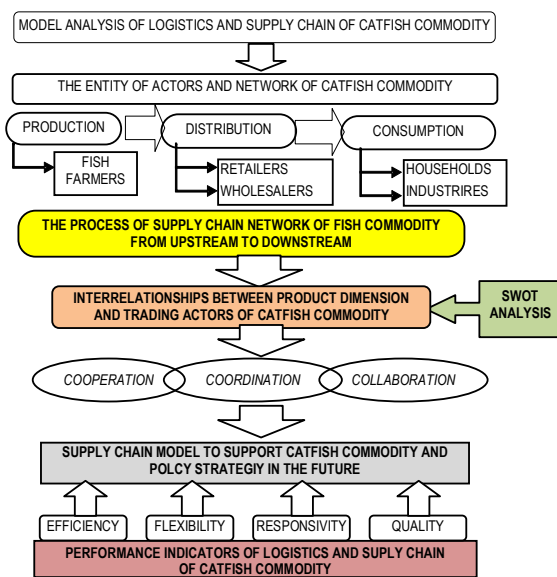The logical framework for conducted research can be seen in the following figure.

Fig. 8 Logical framework

The supply chain model formulated in this research indicates 4 measurable indicators, i.e. (1) efficiency; (2) flexibility; (3) responsiveness; and (4) quality. These indicators have been exercised in this research to assess the success of fishery product marketing management, particularly in Yogyakarta region, Indonesia with the study case on catfish product.

B. Method of Analysis

The analysis of marketing efficiency level of aquaculture products in Yogyakarta, Indonesia has been conducted with the approach that can be seen in Fig. 9.
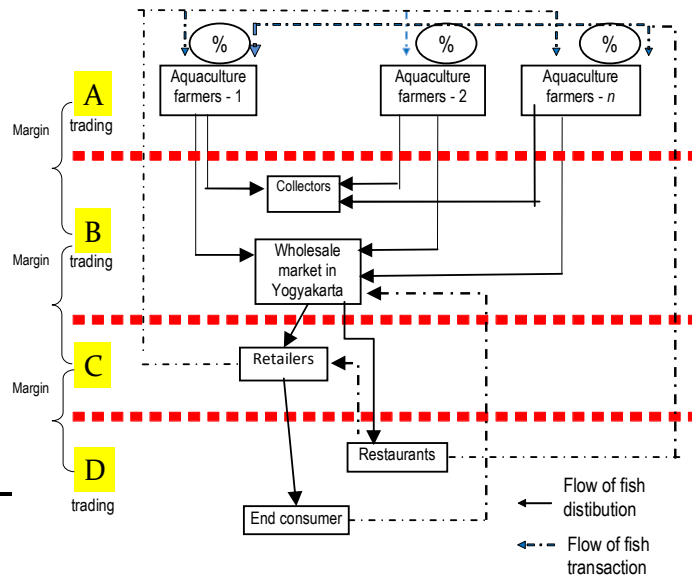

Fig. 9 Method of analysis

The Fig. 9 shows that the process and mechanism of catfish products through some entire steps. Each step indicates the margin profit that is obtained from the fishery trade mechanism.
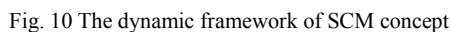
The hypothesis is that the greater the margin obtained in each phase of the fishing trade, the greater the ultimate cost is borne by consumers. It means that, the larger the final price of catfish in the consumer level indicates problems that need to be reviewed in any process of marketing and distribution lines. Thus, efforts to improve efficiency will be looking at the stage where it needs to be optimized.

One method of efficiency analysis used in this study is dynamic models using a software application namely POWERSIM. Dynamic model framework is constructed in this study can be seen in Fig. 10.

In the established model of SCM there are 6 phases, i.e.:

1) Problem identifying and defining: Problem identify usually is conducted through analysis, either through neither qualitative nor quantitative method. One of the analytical tools that can be used to formulate and identify problem is SWOT analysis (Strength, Weakness, Opportunity, and Treat).

2) Formulation of the preparation of conceptual causal loop system of identification and relationship problems relationship subsystem: Causal loop shows how the flow of information and the way work are going on in the system.

3) Formulation of the model is translated into a conceptual model of the computer media for learning. Formulation of the model is conducted with software POWERSIM.

4) Simulation and model validation is a model that has been created and will be run by POWERSIM software. Simulated the model to see how the behavior of the model which describes the behavior of the real system. Therefore, the model has been created to be simulated must be tested to see the truth of the model structure and see if the model can truly represent the actual system as a means of studying the real system. In this study, the simulation model is focused on the object study of aquaculture commodities especially catfish fishery in Yogyakarta region.

To construct a dynamic model, this needs to identify a causal relationship that describes the influence of each aspect on the distribution of fishing that goes.

Fig. 10 The dynamic framework of SCM concept

IV. RESULT AND DISCUSSION

A. Model Form

Powersim dynamics model used to analyze catfish supply chain showing on Fig. 11.

Fig. 11 Catfish supply chain dynamics model

Fig. 11 is causal loop showing causality between catfish supply chain sub system. Based on that figure, it is known that consumer demand can increase the interest of farmers to undertake cultivation of catfish that have an impact on increasing farmers' income. Increased interest in the cultivation can also increase the supply of catfish in DIY Province. Supply of catfish in DIY Province is not only influenced by local supply, but also influenced by the amount of supplies from outside the region such as Central Java and East Java. If the supply increases, the price can be lowered in accordance with the laws of supply and demand. If prices fall then consumer demand will rise.

When the growing consumer demand cannot be met, it will increase the price. The price increase could also increase the interest of farmers to undertake cultivation of catfish. An increasing number of consumer demand is also affected by the increasing purchasing power and high product quality.

Besides influenced by the elasticity of demand, the price is also influenced by some components of the price of the fixed costs and variable costs such as distribution costs and the cost of feed.

B. Analysis of Catfish Supply Chain

1) Assumptions Used

a) Commodity fish that were reviewed is catfish, which is a result of the identification of the dominant fishery commodities in DIY Province,

b) The base year used is 2010, so that year 0 = 2010,

c) Base calculations are at the district / city that forms at the provincial level as a condition of the area,

d) Basic values used in the calculation, such as land area, production levels, productivity and growth rate refers to the historical conditions in each city.

2) Supply Chain Analysis

a) If the catfish fishery system is maintained as it is now, the demand for catfish in the province will experience a rise in demand from year to year. Increase peak demand occurs in year 4 of 3.384 tons. After 4 years, the demand will decrease and then stabilize. The increase in demand is caused by an increase in population from year to year as

well as fluctuations in the number of catfish consumption per capita per year

b) Production of catfish will experience an increase in peak 3 is equal to 30,118 tons. Catfish production shown by these images is the sum of all catfish production in the entire district and city in the province based on historical data forecasting suit each region

c) Demand in DIY Province date cannot be met by production in the province. From dynamic simulation models we obtain that demand is increasing and the peak occurred in year 4. However, in year 3, the need can be met by production in the province, although in year 4 to 10 production has decreased. Supplies from outside the region fluctuated in year 1 up to 3 but will continue to increase in the year to 4 up to 10 due to the decreased production of DIY Province. To overcome the shortage of outside regional government and farmers need to increase the number of DIY production with the addition of such land.

d) Occurs price fluctuations from year to year. In the 3rd year, the price per ton of catfish due to the large decrease in the production of DIY, but in 5 years the price has increased sharply due to supply shortages. Supplies from outside the region can lower the selling price of catfish in DIY Province.

3) Model Verification

e) Verification is done by simulating the model to determine whether the relationship between elements of the prevailing logic goes like, for example, whether the increased production of catfish, tilapia and carp in the DIY affecting demand and downward pressure on prices and declining supplies from outside the region.

f) Validation using the principle of the average ratio between the two simulation results with the actual condition of the data cannot be done because the actual data are very limited, so the test statistic cannot be used. Therefore, validation of the model in this study is done by inserting extreme inputs to the model. The extreme condition such as commodity production of fish is 0 (zero). By entering the input then the market equilibrium will be 0, the price is formed is 0 and there is no supply from outside the area.

g) Supply chain fisheries models built in this study is valid in accordance with the model validity using extreme conditions. This model can be used to predict the fishing conditions in the DIY future. However, the accuracy of the simulation results is affected by data validity in each Department of Fisheries and Marine Resources in DIY. A data base system in every Department of Fisheries and Marine DIY is needed in order to accurately capture real condition, analyze the relationship each subsystem properly and may make planning policies that will come from the results of the simulation forecasting system.

V. CONCLUSION

Important issues must be considered in order to achieve efficiency and superior effectiveness catfish fisheries arrangement in Yogyakarta, including increase farmer productivity, quality assurance of fish production, guarantee the availability and affordability of fish seed and feed, modern marketing system, fluctuations in fish supply is erratic, unhealthy price competition that can be deadly business, micro and small business development (capital, management, erratic price fluctuations), quality control of fish from outside the area, policy coordination with other local agencies, improved quality of road infrastructure, and minimize the effects of climate change and environmental degradation.

Recommended supply chain model is a model of the supply chain from producers to consumers who pay attention to the flow of goods and the flow of accurate information on each element of its subsystems. Information is one of the essential elements for creating a conducive market resulting in a perfectly competitive market where supply and price information on the open for all elements of the supply chain. With the creation of perfect competition then automatically manufacturers will improve their performance in order to compete with other producers and consumers benefit in getting a quality product at an affordable price.

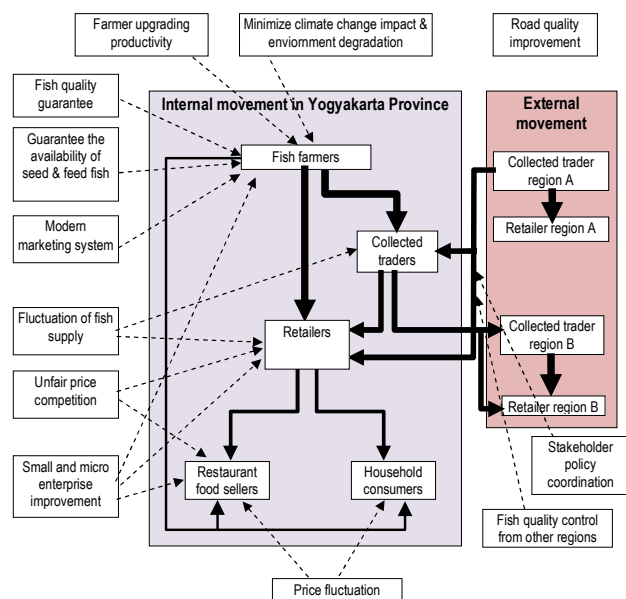Based on the analysis, supply chain models featured catfish fishery in Yogyakarta Province is presented in Fig. 12.

Fig. 12 Model of supply chain catfish product in Yogyakarta

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