

AN ANALYSIS OF INDONESIAN MILKFISH UPSTREAM SUPPLY CHAIN: SYSTEM DYNAMICS APPROACH

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Abstract Milkfish is common aquaculture product consumed by Indonesian people. However, the ponds of milkfish in Indonesia manage by Small Medium Enterprises scale of farmers which have problems in sustaining the business. This study proposes supply chain analysis in the upstream level to develop strategic to improve the profit of milkfish farmers. Milkfish supply chain is a network of many actors that work together to create and deliver milkfish and its culinary products to the end-user. It defines the partnership strategies between the farmers and suppliers as well as the support from government as facilitator and regulator. Moreover, system dynamic approach analyses the scenarios of partnership to outline the benefit obtain by the milkfish supply chain. Finally, the simulation results recommend the partnership to fertilizer supplier will give significant increase in profit of the milkfish farmers.

Keywords: milkfish, upstream supply chain, partnership, system dynamics

1. Introduction

A supply chain is a network of companies that work together to create and deliver a product to the end-user. These companies usually include suppliers, factories, distributors, stores or retail and supporting companies such as logistics services companies. A supply chain can also be defined as a physical network of supply chain management, namely companies involved in supplying raw materials, producing goods, and sending them to end-users [1]. The supply chain is very important to ensure the supply of materials for production activities is available and ensure the products reach the consumers with the right quality and

quantity. The goals of effective supply chain activity are to have precise amount of specific products, to be available in the right place, and to cost with the right range of price [2]. To improve fisheries supply chain we can use Product Relationship Matrix approach [3]. Fish farm of milkfish has potential markets in the local, regional, and global market. It is a popular food in Asia, including Indonesia, Filipine, and Taiwan [4]. In pond aquaculture in East Java, milkfish cultivation in aquaculture with the highest production compared to other aquaculture. Table 1 is present the production and value of fishery aquaculture production [5].

Tabel 1. Aquaculture Production Milkfish in East Java

Districts	Production (tons)	Value (IDR 1000)
Gresik	39,912.0	515,006,958
Sidoarjo	31,026.2	527,445,400
Surabaya	4,760.7	109,041,957
Pasuruan	4,494.6	75,345,418
Sampang	1,740.0	34,800,000

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Sidoarjo has a very good area for milkfish

cultivation because the value of the milkfish production is higher Gresik although the production is lower. This is caused the ponds in Sidoarjo use seawater and milkfish cultivation using traditional methods that utilize natural

conditions and make the quality of milkfish better. Milkfish aquaculture is very large in production and causing high competition among milkfish farmers in several pond areas in East Java. The high competition raises several problems that can occur. Among other things, the decline in the selling price of milkfish as a whole, the increasing demand for resources needed, the number of milkfish farmers who

One of the biggest milkfish producing villages in Sidoarjo is Karanganyar village. Lately, milkfish farmers also complained about the increasing production costs while the selling price of milkfish remained relatively stable. To reduce problems that can arise, supply chain management can be applied that can optimize the rate of supply chain and can increase profits. The supply chain organization is defined as a well-structured series of related institutions or enterprises governed by any means of strict rules and structure to control, organize and maintain the flow of the money, materials, and information from its upstream to the final user [8]. Based on the explanation above, a study was conducted by observing the milkfish aquaculture supply chain lines in Karanganyar Village by observing the supply chain paths starting from fish, feed, and fertilizer suppliers for the maintenance of fish to fishponds. The supply chain structure of existing suppliers to fishers is then simulated by a dynamic system approach by looking at the

2. Configuration Of Supply Chain Structures

Supply chain structure of milkfish commodity in Kalanganyar Village is a chain of

2.1 Supplier and Farmers Structure

Suppliers needed include fish seed suppliers, feed suppliers, fertilizer suppliers,

spread seeds in large quantities which can reduce the quality of milkfish, and also make the distributors difficult to control the milkfish supply from farmers. Marketing strategy is a way to turn a business around to improve number of demand [6]. Marketing for SMEs will need support of government including the using of technology such as IT and e-Commerce [7].

variables that affect profits in each supply chain element. In addition, system dynamics make possible the use of variety of mathematical functions which become a strong point of the model [9]. System dynamic models are particularly unique in their ability to reveal important, and often counterintuitive, behavior in systems, which can be a helpful contribution to policymaking [10]. Development of simulation models begins with making causal loop diagrams, developing simulation models with POWERSIM, verification and validation of model, then developing alternative scenarios to coordinate each supply chain structure that can increase company profits. Previous research conducted by Ishardita, Rahmi, and Yoganda (2016) applied the same method, namely a dynamic system used to evaluate the milkfish business supply chain in Sidoarjo. Where this research is based on the excess supply of fish from farmers to collectors and the addition of the structure of the cold storage industry [11].

elements involved to create and distribute the milkfish from suppliers, farmers, distributors, and retailers.

and fish screw suppliers. Figure 1 is present the Supplier and Farmers Structure.

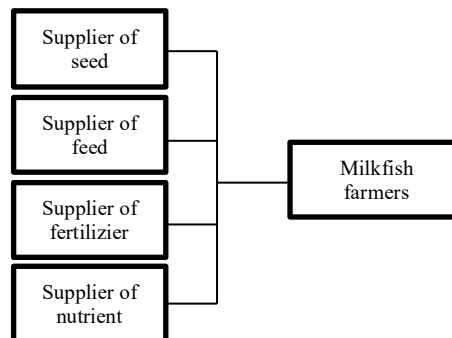


Fig 1 Supplier and Farmers Structure

2.2 Structure of Distributor and Farmers

There is one distributor of milkfish in the Kalanganyar village namely Mr. H. Budi. The Structure of Distributor and Farmers is

shown at Figure 2. Paragraph should be started with 1 cm spacing for the first line and should be given 1 space line each paragraph.

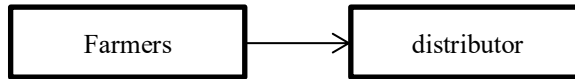


Fig 2 Structure of Distributor and Farmers

2.3 Distributor and Retailer Structure

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columns. If it does not fit the columns, tables and figures should be placed on top or bottom of the page.

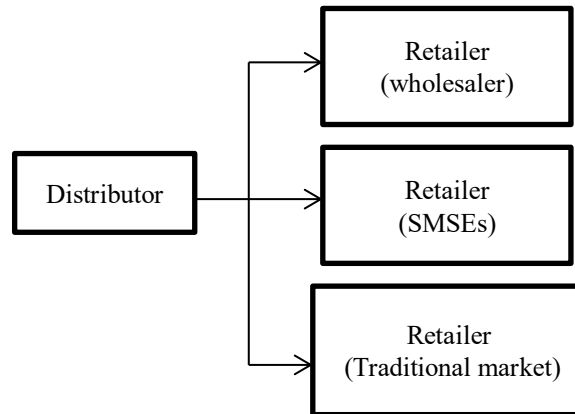


Fig 3 Distributor structure to retailers

2.4 Retailer and Consumer Structure

The retailer distributes milkfish to the

final consumer. The structure of Retailers and Consumers is shown at Figure 4.

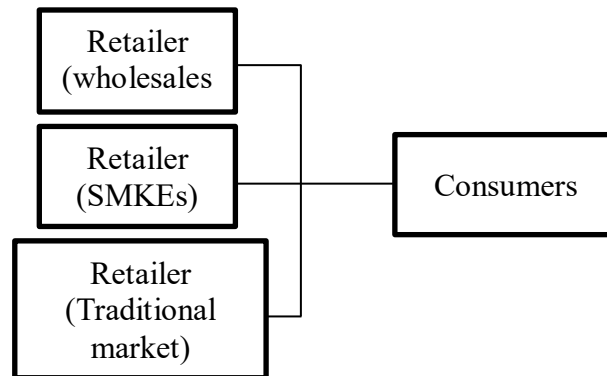


Fig 4 Structure of Retailers and Consumers

2.5 Configuration the Structure of Milkfish Supply Chain

After the supply chain has been arranged separately then the whole supply chain system

is arranged. The whole of supply chain structure in milkfish commodities is shown at Figure 5.

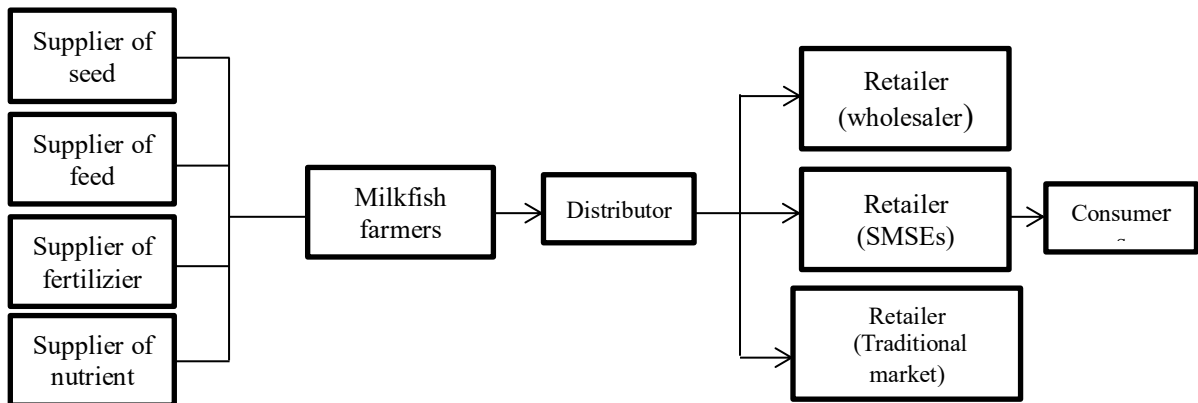


Fig 5 The whole of supply chain structure in milkfish commodities

3. Flow Mapping In The Supply Chain Structure

Based on the configuration of the supply

chain structure, three types of flows can be determined, there are money flow, material flow and information flow.

3.1 Information Flow Maps

Information flow map is a depiction of the results of observations about the flow of

information in the supply chain path. The upstream information flow map is shown at Figure 6.

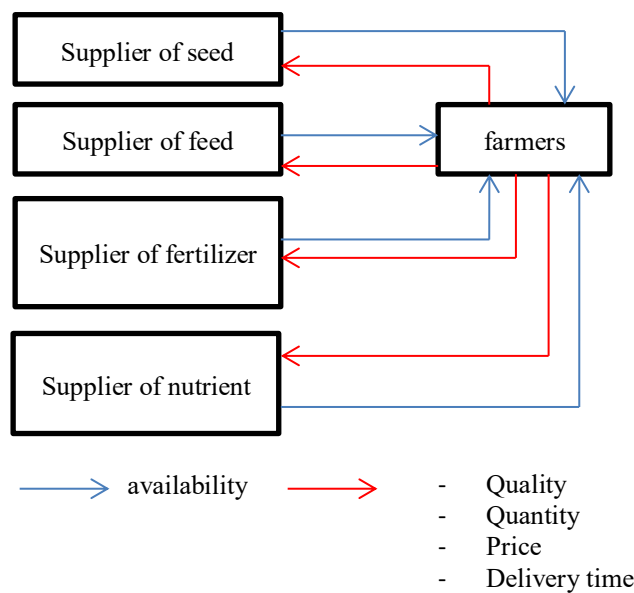


Fig 6 The upstream Information Flow Map

3.2 Material Flow Maps

Material flow maps in the supply chain are used to show the movement of material in one chain to another. At the supply chain,

material flow is in the direction with the supply chain, from the supplier to the consumer. Figure 7 is present the upstream material flow maps.

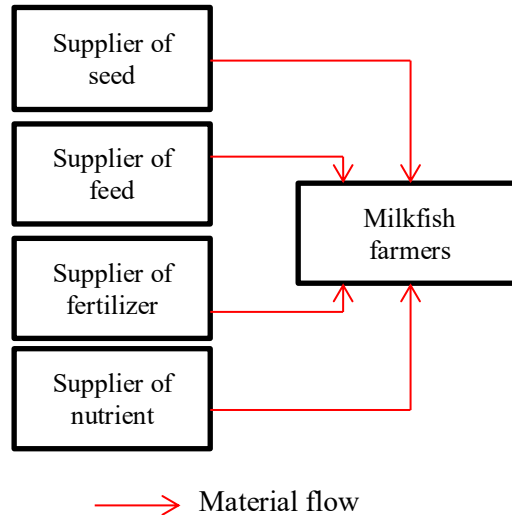


Fig 7 The upstream Material Flow Map

3.3 Money Flow Maps

Money flow map is a map that illustrates how money changes hands from one element to another in the supply chain. The flow of money

usually shows the opposite of material flow because in the transfer of material there is also the transfer of money. The upstream Money Flow Maps is shown at Figure 8.

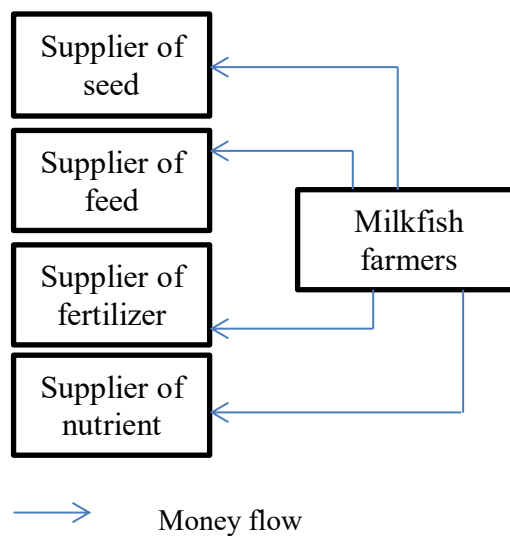


Fig 8 The upstream Money Flow Maps

4. Model Development

The dynamic system model is made based on the variables that exist in each element (chain) in the milk supply chain. These variables are then conceptually modeled into causal loop diagrams to determine the

relationship because each variable is dependent on each other. Then the causal loop diagram is made into a stock and flow diagram and a simulation of a system and dynamic model are performed.

4.1 Determination of Milkfish Supply Chain System Variables

Variables are grouped in general that are

owned in each supply chain structure. Figure 9 is present the interaction between variables.

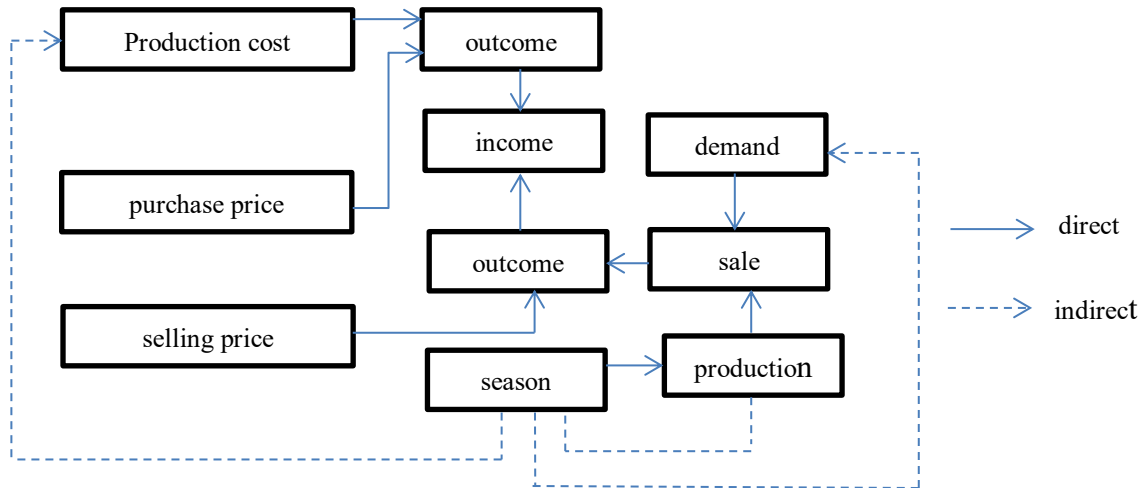


Fig 9 Interaction Between Variables

4.2 Arranging the Input-Output Diagram

The preparation of input-output diagrams aims to analyze descriptively about the need to analyze input factors and output factors in the system. The Input-output diagram includes

several factors, namely, environmental input, uncontrolled input, controlled input, desired output and undesirable output that exists in the milkfish supply chain system.

4.3 Create Causal Loop Diagrams

Causal loop diagrams are displayed in the form of images that connect variables that have been identified with arrows that are interrelated to form a causal diagram, where the base of the

arrow indicates the cause and the tip of the arrow indicates the effect. Figure 10 is present the causal loop diagram of milkfish supply chain.

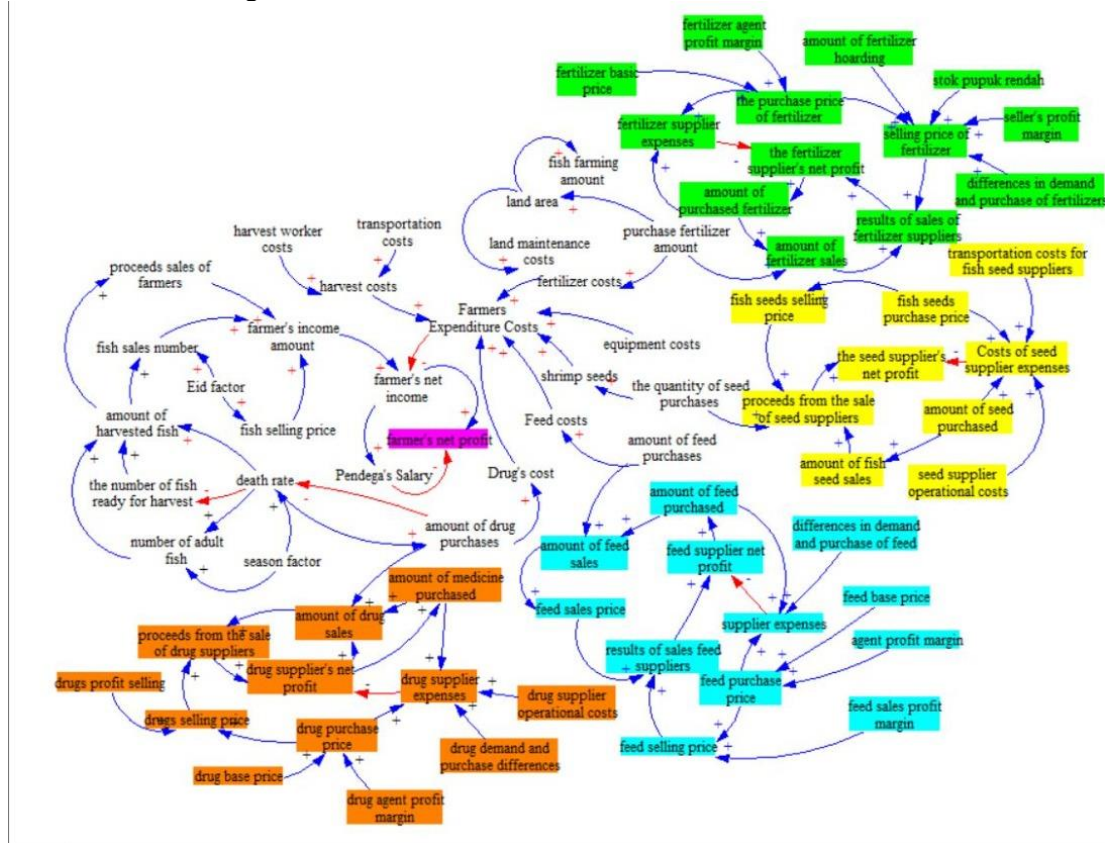


Fig 10 Causal loop diagram of milkfish supply chain

4.4 Create Stock and Flow Diagrams

Making stock and flow diagrams based on causal loop diagrams that have previously been made and by the following variables that have been previously identified. In the stock and flow diagram, there is a level which is the formulation of the profits obtained by each party. Variable stock and flow diagrams that affect the level that is the rate (rate), inflow and the rate of outflow. The inflow in each sub model is the income of actors while for outflow in each sub model is the expenditure of each actor in the system.

4.5 Model formulation

The model formulation is the formulation of conditions that exist in the actual system which are then formulated into a program to be able to represent real conditions that will then be simulated.

5. Scenario of Model

The scenario that can be provided is to increase the allocation of subsidized fertilizer from the government to meet the demand of farmers in the Kalanganyar Village. Fertilizer is the main requirement for farmers because fertilizer can stimulate the growth of the main food source for milkfish. Farmer fertilizer needs

of 2 sacks in each hectare of farmland, and with a pond area in Kalanganyar covering an area of 2900 ha, a total of 5800 sacks of farmers require a single planting period of 6 months. In this policy scenario, a change is made to the fertilizer supplier in its structure and the parameters present in the fertilizer supplier to increase fertilizer allocation. Increasing the allocation of subsidized fertilizers can eliminate the purchase of fertilizer suppliers in the village of Kalanganyar to other villages.

Based on a comparison of the results of existing simulations with policy scenarios, there are differences in results between farmers and fertilizer suppliers. There was an increase in profits to farmers by Rp 420,923,340. This is because in the existing conditions the amount of subsidized fertilizer is less and must buy fertilizer from other suppliers whose prices are more expensive. For fertilizer suppliers, there was an increase in profits of IDR 26,429,808. This is because fertilizer suppliers who previously bought a shortage of fertilizers to other suppliers whose prices are more expensive can sell their fertilizers from the government with higher profit margins. Comparison of overall net income between existing supply chains and policy scenarios can be seen in Figure 10.

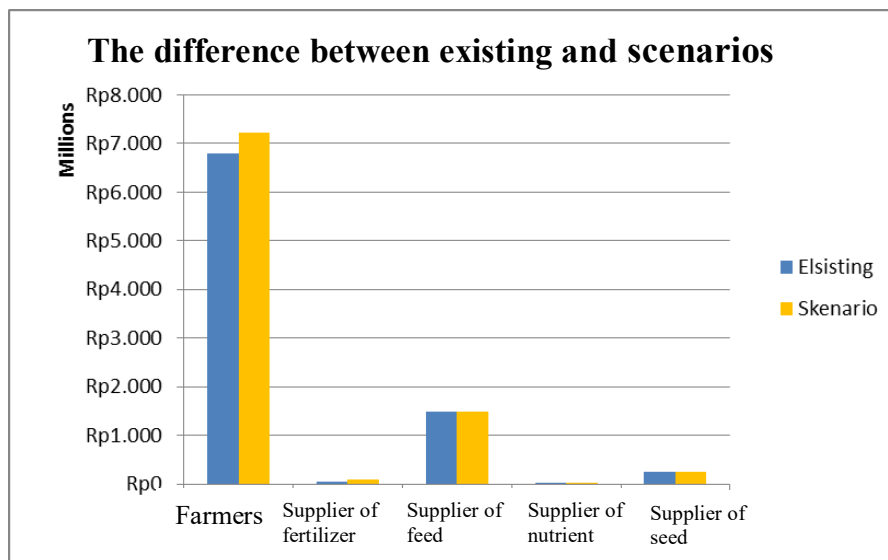


Fig 10 Comparison of overall net income between existing supply chains and policy scenarios

6. Conclusions

This paper has analyzed the configuration structure of Indonesian upstream commodity

fish in SMEs level. The parties start from the upstream supply chain to the downstream, starting from the supplier to the consumer. The

parties involved are suppliers who provide the needs of farmers. Suppliers here include seed suppliers, feed suppliers, fertilizer suppliers, and fish medicine suppliers. After the next party supplier is a farmer who raises milkfish, then there are fish collectors produced by the supplier. After the fish collectors are forwarded by traders, and finally the final consumer. The net profit variable in the system is influenced by the income and expenditure of each element in the supply chain. In addition to the variables in the system, there are also external factors that affect net income. Seasonal factors affect the number of farmers harvested and the size of the fish. With more and more fish being harvested and fish getting bigger, the farmer's profits will be increasingly ponded. Because the season factor influences the amount of fish harvested it will also increase the fish feed requirements by

farmers which will also increase the profit of feed suppliers. The Eid factor will affect the selling price of fish farmers. With the Eid factor, the selling price of fish is higher than the selling price of fish in the normal period and will increase the profit of the farmer.

According to the simulation results, the recommendations for improvement in this study include the application of policy scenarios. This policy scenario is the scenario of increasing the allocation of subsidized fertilizer by the government. The simulation results show that with the application of the policy scenario an overall increase in net profit obtained by the system, which previously total system profits amounted to IDR 8,644,892,417 then after making recommendations to improve the system's profit to IDR 9,092,245,565.

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