

Successful Model of Implementing Risk Management in Supply Chain Distribution Channels

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Abstract— The agricultural sector, especially in the highland vegetables, is considered to have potential and prospects in supporting food diversification so it must have a comparative advantage. Comparative advantage is obtained with supply chain management and risk management, therefore an optimization model is needed. However, often in agricultural activities risks are often encountered, especially in supply chain distribution channels. Risk management is very important to minimize risks that are part of supply chain management. The objectives of this study are (1) to analyze supply chain flow in the highland vegetables of Karo district and Dairi district, North Sumatra, (2) to know the optimization and risk management model of the vegetable supply chain distribution channel in Karo District, North Sumatra, and (3) analyzing the minimalism of microcos in vegetable distribution channel of the Karo Regency and Dairi regency, North Sumatra. The results of this study will provide an optimization model and risk management in the highland supply chain distribution channel to have comparative value.

Keywords— Hyrarchi Analysis Process, Interepretive Stuctural Model, Optimization model, Supply chain, Supply chain management.

1. Introduction

Entering the era of acceleration, which causes globalization in all sectors including the agricultural sector is demanded to have competitive and comparative superior value. So that Indonesian agricultural products are expected to compete with agricultural products coming from abroad (imports). However, often in agricultural commodities have a high enough risk. Therefore, risk requires management called risk management. Risk management helps reduce the

level of probability of uncertainty that can be quantized can cause losses or losses [1]. Risk analysis is part of supply chain management that must be done to avoid or reduce the occurrence of business failures in conditions that are full of uncertainty. Comparative advantages other than those obtained with risk management are also obtained with supply chain management [2]. Supply chain management is a complete cycle of production business, starting from management activities in each chain of production activities to being ready for use by users [3,4]

The agricultural sector is still a flagship for a country to prosper its country. The Indonesian government is currently focusing on the agricultural sector. This can be seen in 2017, the contribution of the agricultural sector to Indonesia's national income is based on the magnitude of the increase in the value of Gross Domestic Product (GDP), which is based on current prices of Rp1191.4 trillion, increasing to Rp1290.4 Trillion. In 2017 it grew 3.97% [5]. Agriculture has a strategic role in the national and regional economy, even in the Reformation era it is expected to play a role at the forefront in overcoming the economic crisis. The agricultural sector in the North Sumatra region has increased, namely 22.19% to 23.05%. The biggest contribution came from Karo Regency, North Sumatra, which is also a very potential region as a producer of horticultural commodities, especially vegetables. Spread at an altitude of 600-1,400 meters above sea level with the topography is not surprising that the district with a population of more than 42 thousand people still rely on the agricultural sector as economic activity. This is proven that 75% of the community's business fields there work in the agricultural sector. As one of the centers of vegetable production, Karo District has

a significant contribution in the export activities of North Sumatra vegetables which continues to increase at the end of 2017.

The agricultural sector in globalization must be competitive and comparative. So that Indonesian agricultural products have a value that is not inferior to agricultural products of other countries. Competitive advantage is obtained by applying supply chain management and optimization models of alternative chains that lie along the supply chain. Supply chain management is a complete cycle of production business, starting from management activities in each chain of production activities until they are ready for use by users [6]. Upland vegetables are potential vegetables and have good prospects to support food diversification programs in order to achieve sustainable food security. Efforts to provide food needs, as well as improving the welfare of farmers, can be done by increasing production and productivity. Increasing farm production can be done by developing and adopting new technologies and increasing farm efficiency.

Based on the description above, the problems in this study can be formulated as follows:

- (1) What is the flow of supply chain for highland vegetables in Karo Regency and Dairi Regency, North Sumatra?
- (2) What is the optimization model and risk management in the vegetable supply chain distribution channel in the highland area of Karo Regency and Dairi Regency, North Sumatra?
- (3) How to minimize the risk to the highland vegetable distribution channel in the Karo District and Dairi District, North Sumatra?

In accordance with the problems formulated, the objectives of this study are (1) analyzing supply chain management in highland vegetables in Karo Regency and Dairi Regency, North Sumatra, (2) knowing the optimization model and risk management in vegetable supply chain distribution channels in Karo and Dairi highland areas, North Sumatra, and (3) analyzing how to minimize risk in the highland vegetable distribution channel in Karo Regency and Dairi Regency, North Sumatra.

2. Research Method

This research was conducted in Karo District and Dairi District, North Sumatra on purpose. This research was conducted in September to November 2018. The data used in this study are primary data and secondary data. In this study, primary data were taken from interviews, observations, and distribution of questionnaires to two experts related to the research topic, namely farmers' counselors and the head of Gapoktan (Association of Farmers Groups). Secondary data were obtained from literature studies, namely

books, literature, and previous research.

Data processing and analysis used are descriptive and quantitative analysis. Descriptive analysis was used to obtain a picture of the distribution channel of the highland vegetable supply chain in the Karo Regency and Dairi Regency, North Sumatra. While the process hierarchy analysis based on Saaty [7] and Interpretive Structural Modeling (ISM) based on Raessi et al [8] is used to compile a model of optimization and risk management in the distribution channel of highland vegetable supply chains in the North Sumatra region.

3. Results and discussion

3.1 Analysis of the Highland Plain Distribution Model in Brastagi District, North Sumatra

The structure of upland vegetable distribution in Indonesia has different chain characteristics. The main difference in the vegetable distribution system is the type of vegetables and the quality produced. The difference in quality is caused by the use of seeds that are not standardized by farmers. To improve the quality of potatoes, farmers are expected to be able to use standardized seeds. The structure of potato distribution found in the Potato center in Brastagi District, North Sumatra, generally follows the pattern as shown in Figure 2. The flow of potato commodities in the supply chain model above is divided into chains, as follows:

3.1.1 Supply chain structure 1

Farmers sell their goods to collectors who will be brought to traditional markets. In the study, one farmer was found who also worked as a collector so that he could directly bring his harvested potatoes to the Berastagi District main market. Buyers who are in the central market of Berastagi District are wholesale buyers who will sell their products again outside the region.

3.1.2 Supply chain structure 2

The collectors in the village of Gurusinga also formed a partnership with the exporter, namely Pamanda Santejati Utama. This company markets Potatoes to Singapore. Potatoes are sent to Singapore at the most within a week. Potatoes from collectors in 1 day directly to exporters. After that, from the exporter to Singapore, the product usually enters the warehouse for 2 days for the washing, grading, and packaging process, from the exporter's warehouse to the port of Belawan takes 6 to 10 hours, and is in belawan for 1 day. Exporters and collectors already have long-term cooperation contracts. The contract loads the order quantity, quality and price. However, the implementation of the contract was not optimal due to problems at the farm level. Farmers sometimes do not meet the required amount of production because they have sold their potatoes to other parties

who bid higher. As a result, collectors have difficulty meeting the amount of production that must be given to PT. Alamanda Sejati Utama.

3.1.3 Supply chain structure 3

Potato farmers in Brastagi Subdistrict also have a direct collaboration with the Exporter Warehouse. This cooperation contains a contract of quantity, price, and quality. Many farmers prefer to sell more potatoes to their exporters because whatever supply the farmers have, the price will remain the same. Selling prices at exporters are also higher than selling prices in the market. In the third distribution structure, potatoes from farmers directly enter the warehouse without sorting by farmers first. Sortation is carried out by the exporter warehouse. The exporters usually divide the potatoes from farmers into three parts, namely mini containing gradeB potatoes, Medium, grade A potatoes, and finally XL with potatoes gradesuper. The exporter warehouse found in the study was PT. Alamanda Sejati Utama, which carried out a special export for NTUC Fairprice Cooperative Ltd, Singapore.

3.1.4 Supply chain structure 4

In this structure, usually the potatoes that have been brought by farmers to the Berastagi District Main Market are weighed and immediately valued right away with the auction system. Potatoes that have been purchased by wholesale buyers will be sold to regions such as Medan, Aceh or Jakarta if the supply of potatoes in Jakarta cannot meet the needs. Potatoes brought by farmers are only separated between good potatoes and shredded potatoes which are not sold and immediately thrown away. Farmers say that the price of potatoes has fallen on the market lately due to the entry of potatoes from Bangladesh, India. As a result, farmers will just let the potatoes that should have been harvested until prices will stabilize again.

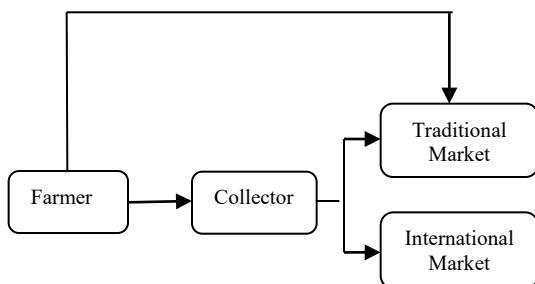


Figure 1. Structure of supply chain of highland vegetables in Gapoktan

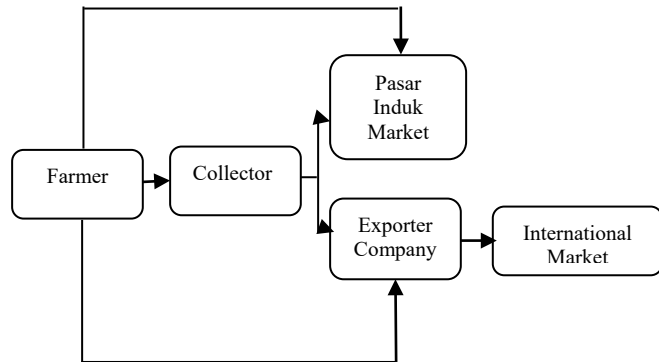


Figure 2. Distribution Model Vegetable in Karo District North Sumatera

3.2 Results of the Optimization and Risk Management Model in the Sumatra Highlands Region Supply Chain Supply Channels using HAP

Based on the results of expert questionnaires using the Hierarchy Analytic Process (HAP), it is obtained a pairwise comparison between the main focus as a control and an obstacle and it will be seen which one has the most influence. Figure 3 shows the hierarchical structure in the optimization and risk management model of the highland vegetable distribution channel in Karo District and Dairi District, North Sumatra. The change in human resource skills (HRD) which is limited to the hierarchy of constraints has the greatest weighting of 0.584. Then in the second hierarchy, the goals obtained from the comparison between the constraints as the main control and the objectives, the results that have the greatest effect are the improvement in the quality of vegetables with a weight of 0.499. The fourth hierarchy obtained from the comparison between the objectives as a control and the perpetrators, gives the results of the local government with a weight of 0.673 as the biggest influence giver, and in the last hierarchy obtained from the comparison between the actors as a control and the community segment and gives the land owner the greatest influence. in the fourth hierarchy.

After evaluating using HAP, an optimization and risk management model has been prepared by combining the priorities in each hierarchy. Based on the results of HAP, in the first hierarchy the most influential is limited HRD skills. In the second hierarchy that is the goal, which gives the greatest effect is improving the quality of vegetables, so to encourage the achievement of optimization models and risk management, training and education on HRD skills carried out by the local government is needed by making a program by involving all landowners in Karo Regency, all landowners are mostly at the same time working as farmers who are members of Gapoktan. The optimization model and risk management that is obtained is in an effort to improve the quality of vegetables, the local government has created a program on education and

training to build HRD skills (farmers) that must be followed by all landowners who also work as farmers who join Gapoktan.

3.3 Risk Minimization Analysis for Each Element and Sub-element

After discussing the optimization and risk management model in the highland vegetable supply chain distribution channel in the Karo Regency and Dairi Regency, North Sumatra, the next research will discuss how to improve a system on each element based on four ISM elements consisting of constraints, objectives, actors, and affected segments. The relationship between sub-elements in each element will be discussed to minimize risk by including the optimization and risk management models that have previously been discussed using HAP so that it will maximize the performance of variables in each element.

The most influential element in the optimization and risk management model of the highland vegetable supply chain distribution channel based on Figure 3 is the affected segment element (4). Variants at the top level have low driving power and interdependence between variables, which means they will have dependence on variables that are at the middle level and bottom level.

Variants that are at this middle level will have a considerable influence on variables related to the connected variables. Actors (3), and goals (2) at the middle level can only be achieved if they make improvements at the bottom level first. The variables at the bottom level have a driver characteristic or a strong influence on the variables at the top level so that fixing the constraints on the supply chain distribution channel (1) can indirectly improve the performance of the optimization model and risk management in the supply chain distribution channel plateau vegetables in minimizing risk. The basic model of interaction between sub-elements constraints on ISM can be seen in Figure 3.

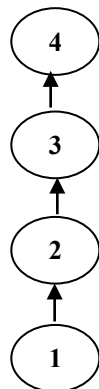


Figure 3. The basic model of interaction between elements on ISM

3.4 Risk Minimization Analysis Using ISM in Karo District, North Sumatra

3.4.1 Resistance

Based on the results of studies on the elements of constraints in the District of Brastagi, North Sumatra, poor quality of agricultural equipment (3), delivery time that is not on time (4), the amount of vegetables sent is not appropriate (5), rising fuel prices affect transportation costs (7), and the unclear payment and ordering system (8) is the variable that most influences on the constraint element.

Poor quality of raw materials (2), limited HR skills (1) are variables that are at the middle level. Variable HRD skills that are limited to the analysis of optimization models and risk management using AHP are prioritized variables so that by improving limited HRD skills (1) able to minimize risks due to these constraints and optimize them by means of the local government making a program on education and training to build the skills of the local government (farmers) which must be attended by all landowners who also work as farmers who are members of GAPOKTAN so as to minimize obstacles and help improve the quality of vegetables. Then, the variables on the middle level can only be maximized by improving the bottom level first. Variants that are at the bottom level have the nature of a driver or a strong influence on variables that are at the top level. The variable that is at the bottom level is poor handling of post-harvest distribution (6). Improving the handling of post-harvest distribution that is not good first can help the performance of the variables above it to be better. The basic model of interaction between sub-elements of constraints on ISM can be seen in Figure 4.

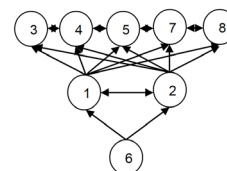


Figure 4. The basic model of interaction between sub-elements constraints on ISM

3.4.2 Purpose

In the objective element, the variables for improving the quality of human resources (1), increasing access to resources (capital, technology, and raw materials) (3), improving farmers' welfare (4) and independent farmers (5) are variables that are at the top level and most influence purpose element.

The variable at the bottom level is improving the quality of vegetables (2). Variables for improving vegetable quality (2) in the analysis of optimization models and risk management using HAP are prioritized variables so as to minimize risk and optimize it using the following method: the local government creates a program on education and

training to build HRD (farmer) skills that are must be followed by all landowners who also work as farmers who are members of Gapoktan to achieve increased mutusayuran (2). So by increasing the quality of vegetables accompanied by an optimization model by minimizing the risk, it indirectly improves the system's performance on the overall objective element. The basic model of interaction between the goal sub-elements in ISM can be seen in Figure 5.

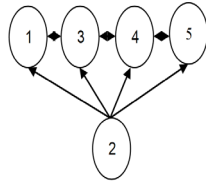


Figure 5. The basic model of interaction between objective sub-elements at ISM

3.4.3 Actor

In the actor element, the regional government (1), is banking and related financial institutions (2), university variables (3) specialized financial guarantee institutions for farmers (4), improving the contribution of the Education and Skills Institution (LPK) (6) is a variable is at the top level and most influences the actors element. Based on the analysis of optimization models and risk management using HAP local government variables (1) are prioritized variables so that variables at this level can optimize their contribution with the optimization model as follows: local government creates a program on education and training to build HRD skills (farmers) which must be followed by all landowners who at the same time work as farmers who are members of the Gapoktan to achieve the improvement of the quality of vegetables so as to minimize the occurrence of risks that occur, such as the risk of lack of contribution from actors in this element.

The variable that is at the bottom level is the NGO variable (5), this variable has the nature of a driver or a strong influence on the variables that are at the top level so that by improving the contributions of NGOs or maximizing NGO contributions to efforts to improve the quality of farmers indirectly will improve the performance of contributions from the offender element. The basic model of interaction between sub-elements of actors in NGOs can be seen in Figure 6.

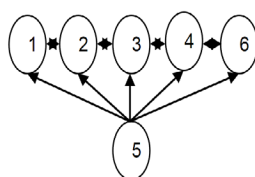


Figure 6. The basic model of interaction between sub- elements of actors in ISM

3.4.4 Affected Community Segments

In the elements of the segmented communities, local government variables (1), landowners (2), entrepreneurs / micro-entrepreneurs in the agricultural sector (3), entrepreneurs or micro-businesses in the informal sector (4), and Gapoktan (6) are variables that are is at the top level and most influences the elements of the affected segment of society.

Land owner variable (2) is a priority variable based on the analysis of optimization models and risk management using HAP so that the land owner variable (2) is prioritized to maximize the impact felt by the community. However, in an effort to maximize the impact on the community segment there is a risk of deviation of the affected segments other than those in the elements of the affected community segment, therefore an optimization model is needed, namely in the effort to improve the quality of vegetables, the local government makes a program on education and training to build HRD skills (farmers) which must be followed by all landowners who also work as farmers who join Gapoktan.

The variables at this bottom level are farm laborers (5). Variants that are at the bottom level have the nature of a driver or a strong influence on variables that are at the top level so that it can. Focusing on is a good start if to expand the impact that will be felt by the community. The basic model of interaction between sub-elements of segments of society affected by ISM can be seen in Figure 7.

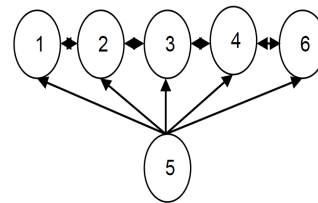


Figure 7. The basic model of interaction between sub-elements of community segments

3.5 Risk Minimization Analysis Using ISM in Dairi District, North Sumatra

3.5.1 Resistance

In the constraint element, the variable quality of agricultural equipment is not good (3), the time of delivery is not on time (4), the number of vegetables that are sent incorrectly (5), and the increase in fuel prices affects transportation costs (7). most influences on the obstacle element.

Poor quality of raw materials (2), poor handling of post-harvest distribution (6), and unclear payment and ordering systems (8) at the middle level can only be achieved by making improvements at the bottom level first. Variants that are at the bottom level have the nature of a driver or a strong influence on variables that are at the top level. The variable that is at the bottom level is limited HRD skills (1). This variable in

the analysis of optimization models and risk management that uses HAP is a prioritized variable so as to improve limited HRD skills (1) able to minimize risks due to these constraints and optimize them by means of the local government making a program on education and training in order to build HRD skills (farmers) that must be followed by all landowners who also work as farmers who are members of GAPOKTAN so as to minimize obstacles and help improve the quality of vegetables. The basic model of interaction between sub-elements constraints on NGOs can be seen in Figure 8.

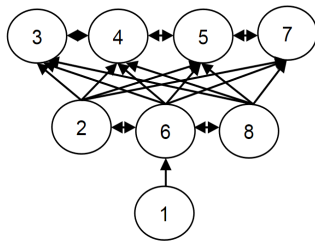


Figure 8. The basic model of interaction between sub-elements constraints on ISM

3.5.2 Purpose

In the objective element, the variables for improving the quality of human resources (1) and the independence of farmers (5) are those that are at the top level and most influence the objective elements. Increasing the welfare of farmers (4) at this level can only be achieved by first improving the bottom level. Variants that are at the bottom level have the nature of a driver or a strong influence on variables that are at its upper level. The bottom level variable is improving the quality of vegetables (2) and increasing access to resources (capital, technology, and raw materials) (3). Variable improvement in vegetable quality (2) in the analysis of optimization models and risk management with HAP are prioritized variables so as to minimize the risk and optimize it using the following method, namely the local LG creating a program on education and training to build human resource skills (farmers) that must be followed by all landowners who also work as farmers who are members of the Brothers Gapoktan to achieve mutusayuran improvement (2) and increasing access to resources (capital, technology, and raw materials) (3) The basic model of interaction between destination sub-elements in ISM can be seen in Figure 9.

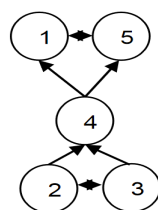


Figure 9. The basic model of interaction between objective sub-elements at ISM

3.5.3 Actor

In the actor element, the university variable (3) and NGO (5) are the variables that are at the top level and most influence the actors element.

The variables that are at this middle level are local government (1), banking and related financial institutions (2), and special financial guarantee institutions for farmers (4). Local government variables (1) in the analysis of optimization models and risk management using HAP are prioritized variables so that although the variables at this level can maximize their contribution when reforming contributions at the bottom level first, the local government variables that will prioritize their contribution to minimize risk. Variants that are at the bottom level have the nature of a driver or a strong influence on variables that are at the top level so as to minimize the risk arising from the lack of contribution or role of the variables contained in the elements of the actors and to optimize efforts to improve the quality of vegetables, local governments The local government made a program on education and training to build HRD skills (farmers) that must be followed by all landowners who also work as farmers who are members of GAPOKTAN. Improving the contribution of the Institute of Education and Skills (IES) (6) in improving the quality of farmers will indirectly improve the contribution performance of the actors. The basic model of interaction between sub-elements of actors in ISM can be seen in Figure 10.

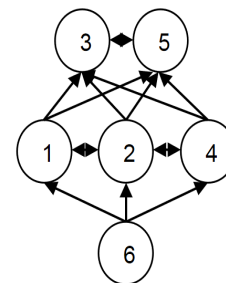


Figure 10. The basic model of interaction between sub- elements of actors in IS

3.5.4 Affected Community Segments

In the elements of the affected community segment, the entrepreneur variable or micro business in the informal sector (4) is the variable that is at the top level and most influences the elements of the affected community segment.

The variables at this bottom level are local government (1), landowners (2), micro entrepreneurs / entrepreneurs in the agricultural sector (3), and farm laborers (5). Landowner variable (2) is a prioritized variable based on analysis of optimization models and risk management using HAP so that landowner variable (2) is prioritized to get a greater impact although at this level to feel a large impact must first have an impact on the variables in bottom level. Variants that are at the bottom level have the nature of

a driver or a strong influence on variables that are at the top level so as to minimize the risk of deviations from the affected segments other than those in the affected community segment elements and optimize efforts to improve the quality of vegetables, local governments make a program about education and training to build HRD skills (farmers) that must be followed by all landowners who also work as farmers who join GAPOKTAN. Focusing on GAPOKTAN (6) is a good start if to expand the impact that will be felt by the community. The basic model of interaction between sub-elements of segments of society affected by ISM can be seen in Figure 11.

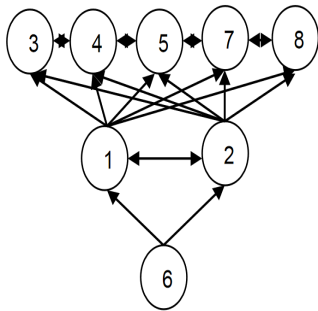


Figure 11. The basic model of interaction between sub-elements of community segments

4. Conclusion

The highland vegetable supply chain distribution channel system in Dairi District, North Sumatra consists of three distribution channel models, first upstream at farmers then collectors and ending at traditional markets. The two farmers gave the harvest of highland vegetables to the collectors then the collectors took them to markets outside the province. Third, farmers bring their own vegetables directly to the market and then sell them at the local traditional market. Whereas the distribution channel system in Brastagi District, Karo Regency, North Sumatra consists of four distribution channel models, first originating at farmers then collecting and ending at the Brastagi District main market traders. Second, farmers give the harvest to the collectors later, the collectors hand it over to the exporting companies and finally the exporters bring the crops to foreign markets such as Singapore. Third, farmers give their crops directly to exporters and then exporters bring them to foreign markets. Fourth, farmers directly bring their harvests to the main market in Brastagi District, Karo Regency, North Sumatra.

As global competition becomes more open, it causes more competition between commodities and products from other countries, including agricultural products. Therefore we need a way to improve the quality of farmers' skills in the activity of the highland vegetable supply chain distribution channel. There are several constraints and lack of contribution from some actors in the supply chain

distribution channel, so we need an optimization and risk management model in the highland vegetable supply chain distribution channel. This model was made aiming to improve the quality of vegetables by the local government to create a program on education and training to build HRD skills (farmers) that must be followed by all landowners who mostly work as farmers who are members of Gapoktan. Then the effort to minimize risk by incorporating optimization models and variables that are the priority of each hierarchy on the HAP into the four ISM elements, namely the elements of constraints, objectives, actors, and affected segments of society that can help fix the existing system on each element so as to improve performance each element by fixing the variables that are at the bottom level first and prioritizing the variables based on the HAP analysis which will later have an impact on the level above it.

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