Design of strategic risk mitigation with supply chain risk management and cold chain system approach

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Abstract. Marine fish commodities are perishable food. Many risks that can damage the catch of marine fish includes not stored and carried in low temperature conditions. Therefore, risk mitigation is required to reduce the risks that occur. This research aims to identify, analyze, evaluate and design the strategic risk mitigations with supply chain risk management and cold chain system approach. The supply chain risk management consists of: risk identification, risk analysis, risk evaluation, and risk mitigation in the entire of supply chain. The cold chain system is carried out from upstream to downstream in the activities of fishermen at the Karangantu Fisheries Port, Serang, Banten. The results are identified 16 risk events, 5 priority risk agents, and 5 proactive actions. The proposed strategic risk mitigations are: counseling on how to handle good catch results; adding the Port Operational Section in the field of Fish Demolition Inspection; giving penalties for fishermen who do not handle catching results properly; preparing to unload the results of fishing when the ship is on the dock, and proposing the procurement of fishing aids to the Ministry of Maritime Affairs and Fisheries.

1. Introduction
Karangantu Fisheries Port is the only fishing port in Banten which is the main source of fisheries catching in Banten, especially in the coastal area of Karangantu Fisheries Port, Serang City. Marine commodities as a result of fisheries have a property that is vulnerable to damage (perishable) because of that fisheries capture result have a high level risk [1]. Many risk events that might occur at Karangantu Fisheries Port related to handling fish catches starting from fish storage, fish washing, until the fish distribution process to consumer. To deal with this matter, it is necessary to do a risk management to prevent or reduce losses to fisheries port and customers. In the supply chain system, fisheries catching results must use low temperature for the storage media (cold storage). This system called cold chain system [1]. The purpose of this study is to mitigate risk in the cold chain activities at the Karangantu Fisheries Port by identifying the number of risk event with Supply Chain Operation Reference (SCOR), identifying priority risk agents based on Aggregate Risk Potential (ARP) and providing proactive action based on the biggest Effectiveness toDifficulty (ETD) value. The benefits of this study are expected to reduce the risks in the cold chain system at Karangantu Fisheries Port so that the quality and freshness of the fish are well maintained from the start of fishing, storage, unloading, until delivery from distributors to customers.
Supply chain is a network consisting of companies that work together to create and distribute a product to the end user [2]. There are three types of supply chain flow that must be managed, namely raw materials, money and information. All parties in a supply chain must work with one another as much as possible to improve their services. Thus, goods and services can be distributed in the right amount, time and location to minimize costs to meet consumer needs [3]. Risk can be defined in various ways. For example, risk can be defined as an adverse event. Another definition that often used is the possibility result obtained deviating from the expected [4]. The risks that occur in marine catches include decreasing the quality of marine catches. The intended quality is the freshness of the catch, hygiene of the production process, and the cleanliness of the packaging of the catch that will be distributed [5]. Risk management is the implementation of management functions in risk mitigation, especially the risks faced by companies, organizations, families, and communities [6]. Risk management can increase value or protect value or both. Risk management is done by risk identification, analysis by determining the level of impact and frequency of risks, evaluation risk to determine priority risk that will be given handling actions, then carrying out corrective steps to reduce or eliminate risk priorities [7].

Supply chain risk management is handling risk based on supply chain structure. Risks can occur in supply chain activities for example technology, scheduling, and uncertain costs [5]. Supply chain risk management is collaborated between supply chain management and risk management process [8]. Previous studies were related to risk in the supply chain include [9] identified risks and design mitigation strategies using the HOR method by mapping supply chain activities based on the SCOR model; [10] designed application of the House of Risk (HOR) model for risk mitigation in the supply chain of leather raw material; and [11] designed a dynamic system simulation in risk mitigation for the procurement of excavators using FMEA (Failure Mode Effect Analysis) and Fuzzy AHP (Analytical Hierarchy Process) method.

Cold chain is a supply chain system that takes into account the temperature level in the process. Cold chain is a system that keeps frozen or cold products in a low temperature environment both during production, transportation, storage, process and sales. This is intended to maintain product quality [12]. Handling fishery products must be done quickly to slow decay. One way to maintain the freshness of the catch is to do the freezing process, which is lowering the lowest possible temperature, usually close to the liquid temperature of the ice, which is 0 °C [5]. Previous research was related to cold chain system is [13] investigated the application of cold chain systems at the Vannamei shrimp freezing plant and [14] discussed risk mitigation priority in handling Scombridae fishes with the House of Risk (HOR).

According to [15], SCOR is a framework for describing business activities between supply chain components from upstream (suppliers) to downstream (customers) to meet customer demand and the objectives of the supply chain. SCOR is a reference model of supply chain operations. The SCOR model also divides the supply chain into five core processes, i.e. plan, source, make, deliver, and return [3]. House of Risk (HOR) is a modification of FMEA (Failure Mode and Effects of Analysis) and a House of Quality model (HOQ) to prioritize the source of risk which is first chosen for the most effective action to reduce the potential risk from the source of risk [6]. HOR 1 was developed through the following stages [16]: identifying risk events that can occur in each business process; estimating the impact of several risk events (if they occur); identifying risk sources and assess possible occurrences of each source of risk; developing matrix relationship; calculating the Aggregate Risk Potential (ARP) is a result of possible events from the risk source; and making a ranking of risk sources build upon a collection of potential risks in decreasing order from the big to the lowest value.

2. Research Method
This research is a cross-sectional study with qualitative and quantitative approaches. Quantitative data processing in this research is data from Aggregate Risk Potential (ARP) calculation, risk evaluation with Pareto Diagram, and calculation of Total Effectiveness of Proactive Action. While qualitative data
processing is processing data from observations, interviews and brainstorming with expert consultants regarding risk events, risk agents, and risk mitigation actions to be carried out at Karangantu Fisheries Port. In this study using the model of Supply Chain Operations Reference (SCOR) for mapping cold chain activities in Karangantu Fisheries Port and House of Risk (HOR) methods for identifying, analyzing, and evaluating risks and providing proposals for mitigation strategies (proactive action). This study also uses statistical tools in the form of a Pareto Diagram to determine the risk agent priority that will be mitigated. This research follows the steps as shown in Figure 1.

Figure 1. Steps of research flowchart.
3. Results and Discussion
In this study identified there are 16 risk events consisting of seven risk events in the process plan, two risk events in the source process, five risk events in the make process, and two risk events in deliver process. In this study, the plan process includes preparatory activities before the operational process of catching fish, namely checking the condition of the ship, checking the condition of the ship's engine, planning the amount of ice to be used, and checking the condition of the Global Positioning System (GPS). The source process consists of two sub-processes, namely the procurement of ship fuel and procurement of ice. The make process consists of two sub-processes, namely the process of fishing operations and handling of catch results during the unloading process.

Then, there are identified 13 risk agents. Furthermore, at the risk analysis stage, it is determined the severity value which is the level of impact caused by the risk and the occurrence value which is the frequency of risk. Then determined Aggregate Risk Potential (ARP) and Priority Risk used the severity and occurrence values (HOR). The next stage is the risk evaluation stage. The risk evaluation phase is a step to determine the risk agent priority that the mitigation process will do. At this stage, it is assisted by statistical tools, namely Pareto Diagram by sorting ARP values from the largest to determine the risk agent priority. This classification of risk agent priorities is based on principle of 80:20 from the Pareto Diagram that around 80% of problems are caused by 20% of causes [5]. There are five priorities of risk agent in Table 1 at the evaluation stage, namely A11, A12, A13, A4, and A7.

Based on 5 priority risk agents, 5 proactive action proposals are designed to prevent the risk of harming customers or producers at Karangantu Fisheries Port. The proposed mitigation strategy takes into account the availability of resources, management policies and cost requirements [6]. There are the priority risk agents to be mitigated as shown in Table 2.
Table 2. Risk agent to be mitigated.

| Code | Risk Agent                                                                 | Category                                      |
|------|----------------------------------------------------------------------------|-----------------------------------------------|
| A11  | A good handling of catching results is ignored                            | Priority Risk agent is very important (A)    |
| A12  | There is no preparation time for unloading results                         | Priority Risk agent is important (B)         |
| A13  | Use of ice in the distribution process does not follow the rules           |                                               |
| A4   | The age of the ship's engine is old                                       |                                               |
| A7   | The Global Positioning System (GPS) engine is broken                       |                                               |

After proactive action is designed, then the relationship between the risk agent and proactive action is determined. The difficulty level of proactive action is determined, then the calculation of total effectiveness (TEk) is carried out by multiplying the ARP value with the correlation value between risk agent and proactive action. Then the value of Effectiveness to Difficulty (ETDk) is determined by dividing the TEk value with the difficulty performing action value (Dk). From ETD values obtained proactive action priorities are proposed sequentially in Table 3.

Table 3. Rank of proactive action.

| Code | Proactive Action                                                                 | Rank | TEk     | Dk  | ETDk |
|------|----------------------------------------------------------------------------------|------|---------|-----|------|
| PA1  | Counseling on how to handle good catch results                                   | 1    | 14904   | 1   | 14904|
| PA3  | Giving penalties for fishermen who do not handle catching results properly       | 2    | 23328   | 4   | 7776 |
| PA2  | Adding the Port Operational Section in the field of Fish Demolition Inspection   | 3    | 28512   | 3   | 7128 |
| PA5  | Proposing the procurement of fishing aids to the Ministry of Maritime Affairs and Fisheries | 4    | 7857    | 3   | 2619 |
| PA4  | Preparing to unload the results of fishing when the ship is on the dock          | 5    | 5832    | 3   | 1944 |

Determination of proactive action priorities is carried out to find alternative proactive action assessments that can be implemented with regard to cost limitations, human resources, and several other aspects of the company [17]. The implementation of these proactive action proposals requires the cooperation of all parties in the cold supply chain at Karangantu Fisheries Port so that they can mitigate the risks that may occur. The
risks in the cold chain system at Karangantu Fisheries Port are expected can be decreased so that the quality and freshness of the fish are well maintained.

4. Conclusion
There are 16 risk events were obtained from the identification process, consist of: 7 risk events in plan process, 2 risk events in source process, 5 risk events make process and 2 risk events in delivery process. Risk agents that are the priority of handling the cold chain system at Karangantu Fisheries Port are: a good handling of catching results is ignored, there is no preparation time for unloading results, use of ice in the distribution process does not follow the rules, the age of the ship's engine is old and the Global Positioning System (GPS) engine is broken. The proposed proactive actions are as follows: counselling on how to handle good catch results, giving penalties for fishermen who do not handle catching results properly, adding the Port Operational Section in the field of Fish Demolition Inspection, proposing the procurement of fishing aids to the Ministry of Maritime Affairs and Fisheries and preparing to unload the results of fishing when the ship is on the dock.

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