Managing quality risk in a frozen shrimp distribution process

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Abstract. Shrimp is a leading commodity of Indonesian fishery exports. Fresh shrimp is a perishable product due to the activity of certain enzymes contained in the body, the activity of bacteria and other microorganisms or because of the process of fat oxidation by air. It causes the shelf life of fresh shrimp can only last less than 24 hours at room temperature. One option in increasing shelf life is in the form of frozen shrimp. Company X is one of the exporters of frozen shrimp. In distributing its product, Company X faces several risks that can cause product damage. The purpose of this study is to identify potential risks in the distribution process of frozen shrimp in order to obtain a priority risk level. The steps taken in risk analysis are activity mapping, risk identification, risk analysis by using the Failure Mode Effect Analysis (FMEA) method, and the development of mitigation strategies. Based on the results of the risk analysis, five risks were identified and the highest risk is the risk of improper container temperature, which has an impact on product damage. Therefore, Company X needs to carry out regular checks during the distribution of frozen shrimp products and conduct maintenance of the cooling machine at the time the container is to be used so that the marketed products are maintained.

1. Introduction
The fishery is one of the sub-sectors that play a role in the national economy. This sub-sector encourages the growth of agro-industry through the provision of raw materials and increasing foreign exchange through exports of the fishery. One of the leading fishery commodities is shrimp. Shrimp was recorded as ranked second in Indonesian fishery exports after tuna, mackerel, and skipjack group with a volume of 11.15% and the export value reached 33.10% [1]. Shrimp is a food source that has very high protein and water content which has high nutritional value, as well as essential amino acids that are important for humans, such as lysine, histidine, arginine tyrosine, and cysteine [2].

Therefore, shrimp is a commodity that is very easily damaged (perishable food) or easily contaminated by decomposing bacteria. One way to maintain shrimp quality and freshness is by freezing the method of preservation. The primacy of the freezing method is to inhibit the process of chemical, microbiological and biochemical degradation that can cause damage or decay in shrimp. Rapid freezing and storage with temperature fluctuations that are not too large will form small ice crystals in the cell so that they can maintain tissue with minimum damage to the cell membrane [3].

One industry that is engaged in exporting frozen shrimp, namely Company X. The company that has been established since 1984 has exported frozen shrimp products in various countries, namely the
United States, Canada, Japan and Europe. Indonesia's frozen shrimp exports in 2013 were valued at USD 663.5 million. In the past five years, the export of Indonesian frozen shrimp to the US has experienced a positive trend of 25, 93%. During the period of January-July 2014, the export value of Indonesian frozen shrimp to the US amounted to USD 518, 3 million [1]. The effort made by Company X so that frozen shrimp products can be exported with good quality assurance is the application of appropriate distribution management. Distribution is a marketing activity that seeks to facilitate and facilitate the delivery of goods and services from producers to consumers. If the distribution process is not carried out properly such as delays in product delivery or storage temperature when the trip is not suitable [4], the product quality will decrease. For example, the product will experience a process of dehydration due to heat transfer that brings moisture from the product towards the evaporator, so the product becomes dry and brown [3]. This can cause financial losses for Company X because consumers will return the product.

One of the strategic steps that Company X can take in ensuring product quality during the distribution process is to apply distribution risk management. Product distribution risk management is a systematic process for identifying, analyzing, controlling the level of risk in the activities of delivering goods from producers to consumers, and to reduce the impact caused by these risks [5]. For consumers to be satisfied with the service of the product that has been ordered, the company must be able to manage good distribution. It is intended that the product reaches the consumer in good condition, with quality that is maintained so that consumers feel satisfied [6]. Therefore, it is necessary to carry out a risk analysis of the distribution process of Company X frozen shrimp. The aim is to identify the possibilities - possible risks that occur during the distribution process, then analyze the control activities that must be carried out on the risk priorities to minimize the impact caused by these failures.

2. Materials and Methods
The method used to analyze the distribution risk of frozen shrimp products in Company X consists of several stages. The first stage is mapping the activities of distributors. Then identify risks in distribution activities through interviews with Quality Assurance and Control managers, marketing and distribution supervisors. The risk obtained is sorted by priority risks using the Failure Mode Effect Analysis (FMEA) method.

Steps in determining risk by using FMEA namely [7]:
1. Identify the failure mode that may and or has occurred in every activity carried out by the distributor.
2. Identify the potential effects of failure, it carried out to find out whether failures that occur during distribution will have an effect on the entire production process as well as on Company X.
3. Determine the Severity scale, a level rating that refers to the serious impact of a potential failure mode. The impact of the rating starts on a scale of 1 to 10, where scale 1 is the best impact while 10 is the worst impact of the rating (Table 1).
4. Identify the causes of failure, done to get the causes that trigger the failure mode.
5. Determine the Occurrence scale, a rating/scale that occurred at several frequencies of product defects. The frequency of failure indicates a frequency of problems that occur due to potential causes (Table 2).
6. Identify process detection modes, which are activities carried out by the company or control procedures carried out during the distribution process.
7. Determine the Detection scale. Detection is a process that is used to detect the root cause of failure specifically and control failures that can occur (Table 3).
8. Calculate the value of the risk priority number (RPN), which is the multiplication of the weights of severity, occurrence and detection.
9. Sort the value of the risk priority number (RPN) based on the highest value.
Table 1. Severity scale [7].

| Rating | Criteria                                                                 |
|--------|---------------------------------------------------------------------------|
| 1      | Negligible Severity                                                       |
| 2-3    | The consequences will be mild, consumers will not feel a decrease in quality |
| 4-6    | Moderate Severity                                                         |
| 7-8    | High Severity                                                             |
| 9-10   | Potential Severity                                                        |

Table 2. Occurrence scale [7]

| Rating | Criteria                                                                 | Event Frequency      |
|--------|---------------------------------------------------------------------------|----------------------|
| 1      | Very effective prevention method. There is no chance the cause might appear | 0.001 per 1000 items |
| 2-3    | The possibility of a cause is very low                                     | 0.1 per 1000 items   |
| 4-6    | The possibility of a cause is very moderate. The prevention method is sometimes less effective | 1 per 1000 items |
| 7-8    | The possibility of a cause is still high. Prevention methods are less effective. Possible causes still repeat | 10 per 1000 items |
| 9-10   | The possibility of a cause is still very high. Ineffective prevention methods. | 50 per 1000 items |

Table 3. Detection scale [7].

| Rating | Description                  | Definition                                                                 |
|--------|------------------------------|---------------------------------------------------------------------------|
| 10     | Absolute Uncertainty         | The product is not inspected or the defect caused by failure is not detectable |
| 9      | Very Remote                  | Product is sampled, inspected, and released based on Acceptable Quality Level (AQL) sampling plans |
| 8      | Remote                       | Product is accepted based on no defectives in a sample                     |
| 7      | Very Low                     | Product is 100% manually inspected in the process                           |
| 6      | Low                          | Product is 100% manually inspected using mistake-proofing gages             |
| 5      | Moderate                     | Some Statistical Process Control (SPC) is used in process and product is final inspected off-line |
| 4      | Moderate High                | SPC is used and there is an immediate reaction to out-of-control conditions |
| 3      | High                         | An effective SPC program is in place with process capabilities (C,) greater than 1.33 |
| 2      | Very High                    | All product is 100% automatically inspected                                 |
| 1      | Almost Certain               | The defect is obvious or there is 100% automatic inspection with regular calibration and preventive maintenance of the inspection equipment |

The next step is the development of risk mitigation based on risk ratings that have been obtained from FMEA and RPN. The method used in developing risk mitigation is a qualitative descriptive
method, namely by interviewing experts. The risk mitigation that has been obtained can then be implemented for the company as a suggestion to improve it.

3. Results and Discussion

3.1. Distributor activities

Activities carried out by distributors are summarized in Figure 1.

![Figure 1. Distributor activities.](image)

The initial activity carried out by Company X was to receive information from consumers about ordering products needed, then order products to the marketing department. The ordering system is carried out following the rules imposed by the company. The consumer conducts a Purchase Order (PO) via email first in the company's marketing department. After being processed by the marketing department, it will then be informed to the Production Planning and Inventory Control (PPIC) section to calculate how much production capacity is in accordance with consumer needs. The data is also a reference for companies to order product packaging to packaging printing parties. The product that has been produced will be stored in the final product storage warehouse to wait for when the product is distributed according to the agreed schedule of the consumer with the company's marketing department. Then the company prepares product pickup transportation at the factory using container trucks. After the container truck arrives at the factory, the warehousing section controls the container temperature (-18°C) and put the product in the container while calculating the number of product orders to be sent. The next activity is to distribute products to consumers according to the amount ordered beforehand and the company receives payments. After the product arrives at the consumer country dock, the product is handed over to the end consumer.

3.2. Risk identification and risk priority determination

Risk identification is an initial stage that relates to the discovery of risks that might occur in company activities. Risks that may occur during product distribution include:

1. Risk of packaging from printing is not ready on time (R1)
2. Consumer risk requires the product to be delayed (R2)
3. The risk of the container type requested by the consumer is not always ready (R3)
4. Risk of improper container temperature (R4)
5. Risk of delivery time exceeds the estimated limit (R5)

Based on the identification of the results of the risk analysis, 5 detected risks can interfere with the distribution process of frozen shrimp. Calculation of severity, occurrence, and detection values is done to obtain risk priority values. After determining the severity, subsequent insurance and detection then calculate Risk Priority Number (RPN). Risks can be prioritized based on the ranking of each risk variable, with the order of the largest value to the smallest value [7]. The results of the calculation of RPN values can be seen in Table 4.

| No | Risk | S | O | D | RPN | Rank |
|----|------|---|---|---|-----|------|
| 1  | R1   | 2 | 4 | 3 | 24  | 5    |
| 2  | R2   | 3 | 3 | 9 | 54  | 3    |
| 3  | R3   | 2 | 4 | 5 | 40  | 4    |
| 4  | R4   | 9 | 2 | 9 | 162 | 1    |
| 5  | R5   | 3 | 7 | 9 | 126 | 2    |

Based on Table 4, R1 gets 3 of severity value because the impact is the loss of consumers due to waiting for the product to arrive more than the agreed delivery estimates, due to a delay in the production process. 3 of occurrence value because the company does not have a machine to print the packaging and have to order from the packaging printing company, which has been several times late in delivering packaging materials. 3 of detection value because this risk is easy to detect, Company X has made a purchase plan for raw materials so that the lead time for ordering packaging to the printing company has been well calculated.

R2 got the 4 of severity value because the impact is that the company must bear additional storage costs until the product is delivered. 3 of occurrence value because this risk is rare, companies and consumers have agreed at the beginning of the purchase that the company does not want to lose due to the cancellation of the purchase so that if the consumer requested that the product be delayed, the product would be sold to other partners, and consumers comply with the regulations. 9 of the detection value is because this risk took place suddenly due to payment constraints from consumers, so the company cannot anticipate it. If the consumers cannot pay off the payment, Company X will not ship the product until the customer has paid the bill.

R3 got 3 of severity value because the impact is a delay in production by the company because the company will produce if the container is available. This has an impact on order cancellations by consumers who don't want to wait too long. 3 of occurrence value because most consumers used the type of container recommended by the company, so that the risk is rare, but there are still some consumers who demand the desired type of container determined by the consumers themselves. 5 of detection value because the company recognized the limited facilities for the type of container currently owned so that if consumers ask for different types of containers that are different from those owned by the company, the company already understands the impact of the risks faced.

R4 got a 9 of severity value because the result is a product contaminated with Salmonella bacteria which can cause digestive disorders such as diarrhea. 3 of occurrence value because this risk is rare, companies have checked container temperatures regularly (once a week) to minimize risk. 9 of detection value because it is very difficult to detect this risk. During shipping, container temperature checking activities are not carried out every time, so the possibility of a defective product being sent in the presence of Salmonella bacteria is very high. As a result, the product is returned to the manufacturer.

R5 got 5 of severity value because it results in additional shipping costs that can harm the company. 7 of occurrence value is because one of the causes of late delivery is weather constraints, where the likelihood of the occurrence is still high and the possibility of the cause still recurs often due to unpredictable weather conditions. This also caused 9 detection values.
3.3. Risk mitigation strategy

A risk mitigation strategy is a program to reduce existing risks, which can affect the company, product, and consumer. Risk mitigation results can be seen in Table 5. The risk of improper container temperatures can result in products contaminated with Salmonella bacteria which can cause diarrhea if consumed by humans. In addition, the appearance of the slimy and smelly product causes these products to be rejected by consumers, resulting in product returns that can cause a material loss for producers. The reason for this risk is that the container coolant is damaged, due to the lack of intensive checking of the machine by the officer during product delivery. Prevention efforts are to periodically maintenance refrigeration machines for each container to be used in order to reduce the risk. If the damage occurred on the way, then the technician involved in each trip must repair the damaged machine. In addition, company must also use insurance services so that if a risk occurs, the loss is not 100% borne by the company [8].

Table 5. Risk mitigation strategy.

| Risk | Impact | Risk Mitigation |
|------|--------|----------------|
| R1   | The growth of Salmonella bacteria | 1. Machine maintenance |
|      |        | 2. Using insurance services |
| R2   | Increased shipping costs | Planning a delivery schedule |
| R3   | Increased storage costs | SOP for product purchases and payments |
| R4   | Cancellation of orders by consumers | Collaboration with shipping container providers |
| R5   | The production process is hampered | 1. Make production planning or scheduling |
|      |        | 2. Add packaging suppliers. |

The duration of product delivery that is more than the estimated time has an impact on the increase in operational costs borne by the company, one of which is the cost of fuel for vehicles. This can lead to decreased company profits. The cause of this risk is the presence of bad weather that is difficult to predict. This bad weather risk usually only occurs in the rainy season. When the BKMG issued a circular it was forbidden to sail on these days and hours, so container ships were prohibited from sailing. If the container ship is on the way and bad weather occurs, then the container ship is encouraged to pull over to the port or the nearest island. This is done to reduce the risk of container ship accidents. The effort made by the company is to make a delivery schedule which has added time to anticipate bad weather. If there is bad weather, the time of delay is still within tolerance and consumers can understand. Conversely, if there are no bad weather shipping goods can run smoothly so that the product can reach consumers faster [9].

Consumer risk asks for a postponed delivery time causes excess storage of cold storage resulting in additional storage costs. This storage cost is borne by the company and can reduce company profits. The reason for the occurrence of consumers ask for product shipments to be postponed is usually because consumers are constrained by financial problems so they cannot pay off payments. Company X will send products if consumers have paid off product payments. Efforts made by the company are the making of product purchase SOP in which the agreed payment period is included, and the consequences which state that if the consumers have not been able to pay off the order, the product will be sold to other consumers [10].

The risk of container type requested by consumers not always ready can cause consumers to wait a long time to get the type of container so that it might have an impact on the cancellation of purchases by consumers. Company X only provides containers with types of 20 feet with a capacity of 10 tons and types of 40 feet with a capacity of 15 tons. In selecting container types, Company X and consumers have the right to choose the type of container that will be used for product delivery. Most consumers used the type of container suggested by the company, but some consumers request the type of container they want to be determined by the consumers themselves, for example, a 45 feet container with a capacity of 20 tons. The effort made by the company to avoid these risks is to provide a large
selection of container types by collaborating with several EMKL services (Shipload Expedition) so that these risks can be minimized. During this time Company X only worked with one EMKL service (Shipload Expedition) [8].

The risk of packaging from a printer that is not always ready on time can hinder the production and delivery process of the product. The reason is the printing company (as the second partner to the packaging material provider for Company X) lacks raw materials. The effort made is that the company needs to make regular planning or scheduling. This aims to give the printer time to prepare everything so there is no delay in production. Thus, the lead time at which the printer must complete the order and distribute it to Company X can be clearly described. The second attempt is made a cooperating with more than one printing partner so that when one printing partner has a problem, the company can order another printing partner [11].

4. Conclusions
The results of this research are divided into two things, namely risk identification and risk mitigation of distributor, as supply chain actor to distribute frozen shrimp product. Based on the results of risk analysis, five risks occurred, namely the risk of packaging from printing not being ready on time, Consumer risk requesting the product to be postponed, the container type risk requested by the consumer is not always ready, the risk of container temperature is not suitable, and the risk of delivery time exceeding the estimated limit. The risk of improper container temperature is the risk with the highest Risk Priority Number. The impact is the growth of Salmonella bacteria on the product. The risk mitigation strategy that is carried out is that the company needs to maintain the cooling machine in the container so that the temperature is maintained (-18°C) and the use of insurance services during product delivery, so that financial losses are not 100% borne by the company.

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