Risk Mitigation Strategy in Perishable Product Supply Chains

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Abstract

The supply chain for perishable products is complex and requires careful handling. Uncertain consumer demand will affect required cost climatic conditions, and also affect product quality. This research was conducted on XYZ bakery, it is an industry that produces various kinds of bread. This research aims to determine the causes of risks that affected risks in the supply chain and develop a mitigation plan. The method used is the SCOR model and *House of Risks* (HOR). SCOR model used for mapping supply chain activities and HOR method used for determining risks, causes of priority risks, and coping strategies. This research resulted in 9 risks event with 18 risks causes in the planning process, 6 risks event with 9 risks causes in the sourcing process, 8 risks event with 12 risks causes in the making process, 7 risks event with 14 risks causes in the delivery process and 4 risks event with 7 risks causes in the return process. The resulting recommendations for risk mitigation include: evaluate supplier performance, raw material inventory management, product forecast, increase marketing, allocating orders, add an employee in the production department, evaluate employee performance, conducting training for employee and application of information system.

Keywords
Risk, Supply Chain, Perishable, House of Risk (HOR)

1. Introduction
A perishable product is a product that has a short lifespan during the life of the product (Trihardani, 2016). The national quality standard (1995) stipulates the quality requirements for sweet bread have a maximum moisture content of 40%. High water content affects the resistance of bread to storage and microbial growth which causes bread to be damaged quickly (Arlene et al., 2009). According to Salin (1998), the perishable supply chain is very complex and easily damaged. Uncertain customer demand will affect the costs required, as well as affect product quality. The complexity of risk assessment ex nature will cause many disturbances. Then, the amount of consumer demand is uncertain. In a week XYZ bakery can receive orders in large quantities, namely on average above 1000 pcs per day for 5 consecutive days, but in the following week, the number of orders is in the normal category, which is an average of 600 pcs per day. Delivery of raw materials from suppliers also often experiences a delay of 1-3 days. Besides, the products produced by XYZ bakery do not use preservatives, so that the effect of the product life is not long, which only lasts a maximum of 4 days. According to Sazvar et al., (2016) short product life also affects the company side. If the age of the product has expired but has not yet reached the consumer, then the product has no selling value and the company suffers a loss. An important step taken is to formulate a strategy in managing, where the output obtained is in the form of a risk strategy, risk policy, or risk management plan (Magfiroh and Wibowo, 2019). Based on the background explanation above, this study aims to design strategies to reduce the risks that occur. In addition to knowing all risks, the source of the causes is also identified. The House of Risk (HOR) method is used to achieve the stated research objectives. The use of this method is expected to identify risks, sources of risk, and appropriate management strategies. In the process of risk identification, it is mapped using the SCOR model so that it is known which process the 3 risks come from among the five processes, namely: plan, source, make, deliver and return. In addition, it is hoped that from this research, a mitigation strategy can be obtained that can help XYZ bakery in dealing with supply chain risks so that they can be prevented and reduce losses.

1.1 Objectives
The aim of this research are knowing the priority risks that occur in XYZ Bakery supply chain, design and propose a mitigation strategy that can control risk event.

2. Literature Review

In realizing an efficient supply chain system, supply chain management is needed which is useful as an approach to achieving these goals for suppliers, manufacturers, warehouses, shipping services, retail and consumers. Efficient means the number of goods produced according to the right production time and place, as well as minimum costs but in accordance with the objectives of service level a good (Levi et al., 2003). According to Pujawan (2005), to survive in the competition to achieve strategic goals, which must produce products that have cheap, timely, varied and quality criteria. Perishable products are subject to weathering or wear and tear causing the usefulness and function of the product to gradually decrease and disappear in a short time if it is not used or sold for a certain period of time. When producing products perishable, the entire supply chain involved is uncertain, which means the risks involved are high. The value of the effectiveness of a supply chain is seen from the inventory planning factor, controlling the lead time and forecasting demand product (Mehrjoo, 2014).

Winanto and Santoso (2017) conducted research on risk analysis and formulated mitigation strategies in the shallot supply chain using fuzzy FMEA and AHP (Analytical Hierarchy Process) methods. In carrying out risk identification, the parties involved in the supply chain are involved, namely farmers, distributors and retailers. The identified risk priority measurement uses the fuzzy FMEA method and the determination of mitigation strategies in the supply chain uses weighting using the AHP method. Risk priority for farmers regarding government policies relating to import regulations, risk priority for distributors regarding competitor risks with importers and risks for retailers regarding competition between retailers. The alternative mitigation strategies formulated based on the existing risks are 6 strategies with the greatest priority or what needs to be done first is to choose the right type, cooperate, maintain quality, price stability and supply.

Melly et al. (2019) conducted a study that aims to determine the sources and risk factors that occur in the supply chain of brown sugar cane, so that they can evaluate and control the risks that occur using the ANP (Analythical Network Process) method. Sources of risk that occur based on the greatest weight are the production, marketing, human resources (HR), financial 7 and institutional division. There are 5 sources of risk that produce 20 types of risk. The types of risk with the highest priority are the quality of saka or sugarcane, price volatility and government. The priority strategies undertaken to manage risk are to reduce risk, avoid risk, then transfer risk and risk insurance.

Magdalena and Vannie (2019) conducted a supply chain risk analysis for the manufacture of light steel, roof tiles and other roofing needs. The risk analysis focuses on the company's operational risk at the L8 plant. The purpose of risk identification is to obtain ISO 90001: 2015 certification, namely "actions to address risks and opportunities" that can expand company opportunities, namely PT Tatalogam Lestari. Obtained 21 risk events and 20 risk agents based on data processing using the House of Risk (HOR) method. In phase 1 HOR, there were 8 risk agents, which were 80% of the causes of problems in operational activities. Risk agents that are the cause of problems in operational activities based on the largest ARP value are errors in data input, negligent labor, no application of the FIFO system, incomplete inspection processes, old accumulation of goods, too many product variations, machine setup errors and new employees still running training. In dealing with these risks, in phase 2 HOR, there are 8 mitigation strategies for risk prevention

Prakash et al. (2017) conducted research on risk identification in the supply chain for perishable products, namely the dairy industry. The methods used are FMEA and Interpretive Structural Modeling (ISM). Brainstorming sessions and literature review with managers and engineers were conducted to determine what risks occurred and obtain 4 risk categories, namely environmental risk, inventory risk, demand risk and process risk with a total of 17 risks. The ISM method plays a role in determining the interdependence between the risks that have been identified and the 5 risks with the highest dependence are obtained, namely the ability of suppliers, technology changes, transportation problems, forecast errors, point of sale (POS) data errors. The five risks can be caused by various factors, as many as 20 causes. With RPN value from FMEA method, the factors that cause risk to be the most influential are the inadequate livestock health care system, low production output, lower access to credit, fluctuating milk demand and high lead time. The mitigation strategy chosen is based on the largest risk mitigation number (RMN) value, namely a better health system, more efficient scheduling of production in factories, inventory management, decentralized processing processes and upgraded machines with newer technology.

3. Methods

Data collection methods used were literature studies, interviews, and questionnaires. Data obtained from literature studies on theories related to research, which come from previous research or books. Interviews were conducted to obtain information about the condition of the company, supply chain activities, risks that arise, and sources of risk. The data obtained from interviews were in the form of an assessment of the severity and occurrence of risk that occurred, and the correlation between the causes of risk and risk events, then the correlation between the dominant risk agent and the formulation of the handling strategy.

Pujawan and Geraldin (2009) developed a method derived from the concept of the House of Quality and the concept of Failure Models and Effects Analysis (FMEA), the method developed is the House of Risk (HOR) which is a model in risk management in the chain. supply. The purpose of the HOR model is to identify the risks that occur and formulate appropriate treatment strategies. In this model, the treatment strategy focuses on risk agents who are the main factors for risk emergence. By formulating a treatment strategy that targets risk agents, the likelihood of risk events is reduced. The first step of this research is observing XYZ bakery and conducting interviews with the owner to identify the problems that occur. Then proceed with exploring the identified problems by understanding the existing theory. After understanding the problem, it is continued at the stage of formulating research objectives. Then, identify activities related to the company's supply chain. The collection of activity that has been identified, continued to mapping activity based on the SCOR model. The purpose of grouping is to ease the process of identifying risks and knowing where these risks occur in supply chain activities. Based on the results of the mapping supply chain activities, proceed to the risk identification stage. Besides, identification is also made regarding what causes the risk to occur, the probability of the risk occurring, what effects will be generated and what strategies the company has implemented to deal with the risks that will or have occurred.

The result of the risks and the causes of the risks proceed to the assessment stage. This stage is carried out by providing a questionnaire that contains the severity (impact) of risk, the occurrence (probability) of a risk agent, the correlation between risk and risk agent. The scale of severity and occurrence used was under the company's situation and has been approved by the owner XYZ bakery, as the assessor in this stage. The results of the assessment in the previous stage were used as input in determining the ranking of risks agent. The ranking is determined by ARP value, the greater the ARP value then the higher that ranking that obtained and vice versa. The ARP value is also used to create a Pareto diagram with principle, 80:20 which is arranged based on the highest to the smallest ARP value. The principle worked in a way if 80% of problems are handled, then the other 20% problems are resolved. In this research, this principle is used that 80% of risks agent that handled will solve 20% of the existing risks agent. The risks agent included in 80% of the Pareto diagram proceed to the risk mapping stage. The objectives risk mapping using a probability impact matrix to find out how dangerous the risk is. If it is not dangerous based on the color in the table below, then it is not continued to the next process. However, if it is included in the hazardous category, it will proceed to the mitigation design process. The risk map used in this study is the probability impact matrix as in table 1. The colors shown in table 1 (BPKP, 2010) describe the level of risk, the action that needed for each risk is described in table 2 (BPKP, 2010).

Table 1. Probability Impact Matrix

Probability	Impact				
	Trivial	Minor	Moderate	Major	Extreme
Very Likely	🟧	🟧	🟥	🟥	🟥
Likely	🟨	🟧	🟧	🟥	🟥
Moderate	🟩	🟨	🟧	🟥	🟥
Unlikely	🟩	🟩	🟨	🟧	🟥
Rare	🟩	🟩	🟨	🟧	🟧

Table 2. Risk Level category

Risk Level	Action
Low	No action needed
Moderate	If resources are sufficient, it is advisable to take action
High	Action needed to handle risk
Extreme	Need serious attention and immediate action

After obtaining priority risks agent that needs to be handled, proceed to the stage of designing a mitigation strategy that was obtained from the results of the interview and SWOT analysis (Strength, Weakness, Opportunity, and Threat) so the mitigation strategy was by the conditions of company and could be implemented properly. The mitigation strategy that has been designed is continued to determine strategy priority in implementing the overall strategy or called the house of risk phase 2. The strategy determination was done by assessing the difficulty level of each strategy, the correlation between priority risks agent and mitigation strategy, and the ARP Value of priority risk agent also taken into calculation. The result obtained the value of the effectiveness to difficulty ratio (ETDk), the highest of the value that obtained then the higher priority to implement a strategy. The results of the HOR method are discussed further. This stage is defining the conclusion based on research objectives. In addition, researchers also provide suggestions to the company to deal with emerging risks and for future research.

4. Data Collection

4.1 Mapping Supply Chain Activity
Supply chain activities that occur at XYZ bakery were obtained from interviews, then proceed with mapping activities based on the type of process. Supply chain activities are carried out starting from all planning until the product is in the hands of consumers. In Table 3 there are 16 supply chain activities of the XYZ bakery.

Table 3. Risk Map Activity Based on SCOR Model

Process	Activity
Plan	Raw Material Planning
	Financial Planning
	Production Planning
	Delivery Scheduling
	Order Acceptance
Source	Determination of Suppliers
	Receiving Raw Materials
	Payment to Suppliers
Make	Preparation Phase
	Production Execution
	Packaging Process
Deliver	Order Calculation before delivery
	Sales Process
	Order Delivery
Return	Return of Raw Materials
	Complain from Customers

In the planning process, 9 risks were identified due to 18 causes. In the source process, 6 risks were identified due to 8 causes. In the make process identified 8 risks caused by 12 causes. In the deliver process identified 7 risks caused by 14 risks and in the return process identified 4 risks caused by 7 causes of risk.

5. Results and Discussion

5.1 House of Risk Phase 1
The results of the assessment of severity and occurrence of risks and causes of risk produce ARP values in the calculation of House of Risk Phase 1. The ARP value is used to create a ranking that is used as a pareto diagram input to determine the causes of the risk that have an effect. The results of the Pareto diagram are categorized into a risk map to determine the hazards posed that show at Table 4. The following is a risk map of supply chain activities at XYZ Bakery:

Table 4. Risk Map XYZ Bakery

Probability	Impact				
	Trivial	Minor	Moderate	Major	Extreme
Very Likely			A2 (Source)		
Likely			A1 (Source)		
Moderate			A4 (Plan) A9 (Make)	A2 (Plan) A2 (Make)	
Unlikely				A4 (Deliver)	
Rare					

In the planning process, there are 2 risk agents which are continued to the next stage, namely: sudden orders (A2) in the extreme category and delivery of raw materials by suppliers late(A4) in the high category. In the source process there are 2 risk agents which are continued to the handling stage, namely the company does not implement performance evaluation supplier (A2) in the extreme category and the agreement not agreed upon supplier (A1) is in the high category. In the deliver process, there is 1 risk agent who is handled which is a changing market condition (A4) in the high category. In the return process, the identified risk agent is still in the safe and moderate category, so there is no need for any handling action.

5.2 Formulation of Proposed Mitigation Strategies
At House of Risk Phase 2, it aims to determine a risk agent handling strategy that is in the high and extreme category. The formulation of the handling strategy at this stage uses SWOT analysis to see the strengths, weaknesses, opportunities, and threats of XYZ bakery. The results of the SWOT analysis obtained are as follows:
(i)   Strength: The product that sells is favorite by many people, XYZ bakery are flexible in accepting customer requests, the product is not using preservatives, price that offered is cheap, the agreement on the benefits of cooperation with retail can be negotiated, when it is difficult to sell the product, sales that using motorcycle get a discount on sales fees and leeway of the day to do deposit.
(ii) Opportunity: The trend of bread flavors continues to grow, so by following it, it's easy to get new customers.
(iii) Threat: There are a lot of competitors, so it's hard to gain customer loyalty, Inconsistent supplier readiness in providing raw materials, Raw material markup that not certain, XYZ bakery still using conventional systems, they haven't keep up with technological developments.
(iv) Weakness: Lack of human resources, the capability of the employee in the production department are not the same, data recap does not organize properly.

Based on that SWOT analysis there are 4 types of strategies are formulated to be used to handle the risk agent that occurs, along with these strategies:
a.   SO Strategy (Strength-Opportunity)
    −   Allocation Order: The growth of bread variants can attract new customers, so orders can increase. To overcome this, the allocation strategy can maximize the handling of new customer orders, especially orders in large quantities.

- Application of Forecast: The existence of new customers means that demand also increases, to create readily available conditions, the company can implement of forecast strategy to have guidance to manage human resources, raw materials, finance, and others.
b. WO Strategy (Weakness-Opportunity)
  The opportunity that the company has is the presence of a new customer when the emergence of a new variant that follows the trend. The results of the strategy obtained are as follows:
  - Addition of employees in the production department: The opportunities that exist allow for increased orders, with the condition lack of human resources, the company can increase the number of employees, especially in the production section so that the effectiveness of the production process is maintained.
  - Application of employee performance evaluation: Increasing order opportunities can improve existing deficiencies, especially shortages on the part of employees. The existence of a performance appraisal from the company will increase the effectiveness of employees at work.
  - Conduct Training for Employees: This strategy can be done to improve existing deficiencies, namely the abilities of employees who are not the same, with this strategy the opportunities that are owned can run optimally if the ability of employees is following company standards.
c. ST Strategy (Strength-Threat)
  The result of the strategy is improved marketing. One of the threats faced is the number of competitors so that marketing improvement strategies can be implemented to keep the company afloat. Additional cooperation with retail and motorbike sales can be increased to reduce the threats.
d. WT Strategy (Weakness-Threat)
  - Raw Material Inventory Management: This strategy is formulated to reduce threats related to suppliers. The existence of raw material inventory management can reduce problems with suppliers such as delays in delivery. This strategy can also reduce the burden on the company if an increase in raw material prices occurs, especially in terms of costs because the company still has stock in the warehouse.
  - Application of supplier performance evaluation: Unpredictable supplier performance can disrupt the production process. The implementation of this strategy is intended so that suppliers can find out their performance based on company assessment so that suppliers can improve it. Suppliers with good performance will help the company provide raw materials so that the company's warehousing system will be better.
  - Application of information systems: Data recap in the company still using a conventional system. To keep up with current developments, a strategy for implementing information is formulated. The implementation of this strategy can also improve the condition of the company to be better, thus can reduce errors regarding data recording.

5.3 House of Risk Phase 2

House of Risk Phase 2 generate results of the calculation of effectiveness to difficulty ratio (ETDk) for each strategy formula, the order of priority for implementing mitigation strategies to address risks that occur is presented in the Table 5:

Table 5. Rank Mitigation Strategy

Code	Handling Strategy	ETDk	Ranking
PA4	Implementation of supplier performance evaluation	21294	1
PA3	Raw Material Inventory Management	12960	2
PA5	Implementation Forecast	11136	3
PA6	Increase Marketing	8001	4
PA1	Order Allocation	5153	5
PA2	Additional Employees at Production Department	4572	6
PA7	Implementation of Employee Performance Evaluation	4397	7
PA9	Conduct Employee Performance Evaluation	2931	8
PA8	Implementation of an information system	2375	9

The important factor in creating a competitive supply chain is doing supplier performance evaluation. The supplier performance evaluation strategy is one strategy to form a company that can compete and maintain service levels to meet consumer needs so that consumers do not feel disappointed (Rochmoeljati, 2012). The proposed criteria for doing evaluate supplier performance is using QCFDR model (Cost, Delivery, Flexibility, and Responsiveness). The first criteria are cost, the price offered by the supplier, then the delivery time following the agreement, the third criteria

is the supplier's ability to meet changes in delivery time and quantity and the third criteria are the supplier's ability to respond to the problem that occurs.

The raw material that the company needed was obtained by purchasing once every 3 days, the reason is they want to reduce the risk, decreasing the quality of raw material. Ordering raw materials too often leads to neglected warehouse management and the data history of purchasing raw material was not recorded properly. The company relies more on purchasing raw material when it's running low storage. The purchase type affects to cost that is required and the supplier's ability if raw materials are needed quickly. With the existence of raw material inventory management, the company can implement safety stock to deal with sudden order, so the company doesn't need to order raw material repeatedly, because they still have stock in the warehouse. Before implementing this strategy, the company must improve its performance in terms of recording raw material purchases and recording stocks, so the data can be used to determine the safety stock of raw material requirements. The implementation of this strategy can help in handling sudden orders because the company has a stock of raw materials in the warehouse.

The company has implemented a product forecasting strategy to estimate the amount of production, by producing less bread at the beginning of the month, then increasing bread production at the end of the month or on the 25th day of each month. An increase in the amount of production has also occurred before Eid. Forecasting conditions with trend patterns as explained were not always successful, so two methods were proposed for forecasting demand, namely, the weighted moving average method for detectable trend data patterns is single exponential smoothing, double exponential smoothing for erratic data patterns. This method can be an option with the conditions that occur, then the results of the forecasting are selected based on MSE (Mean Square Error Smallest) value for each method. According to Prasetio (2014) to map demand based on the results of the forecasting method using the smallest MSE value.
Marketing improvement strategies are carried out to increase sales. When market conditions decreased, the company takes several ways to increase profits. To increase sales, the company adds motorcycle sales, so the sales area getting wide, and adds sales partner specifically retail with an agreement that profit-sharing can be negotiated. The other strategy is to make a purchase promo "*buy 3 get 1 free*". Then, doing an endorsement on social media every 3 months. The order allocation strategy is a strategy that has been carried out by the company to handle sudden orders from consumers. The way this strategy works is if there is a sudden order and the time is limited, the production department allocates another customer order to fulfill the sudden order. This strategy is used when the production department has time left to produce the initial customer order, otherwise, the company will reject the sudden order. Another strategy that the company used to handle a sudden order is by applying overtime costs. But under these conditions, the workload of employees increases and causes excessive fatigue. So the suggestion mitigation strategy is adding 2 employees in the production department.

Employee performance appraisal aims to provide suggestions for improvements regarding employee performance during the work process so that employees can improve their ability to decrease these deficiencies based on the results of the assessment. The company can provide an incentive for an employee who has excellent performance, thereby other employees getting motivated to achieve the same goal. When accepting new employee, the company also conducts training for new employees but the training is only applied for 1 day, then after the training day has passed, the employee works like the old employee. The strategy proposed for this condition is to conduct training for 2 weeks. The objective is the employee can prepare himself and his skills well. During the training, the company can assess the performance and personality, whether it is in accordance with the culture and needs of the company.

The strategy proposed for implementing the information system is that there is an admin who can do enter, edit, and delete data, then the user can only display the data. In this information system, the admin is for the owner of the company, the employee assigned for inputting data, and the employee assigned for managing the outlet. Then, there is the menu for material input (in and out), order list, delivery list, and outlet conditions (*stock*). This strategy aims to facilitate the employee to comprehend and receive the updated information. The implementation of this strategy can reduce the incidence of human error related to miscommunication. When receiving a sudden order is getting easier to monitoring order details, the shipment, and the availability of raw material. The owner also can control anytime and anywhere outlet conditions. The employee assigned to manage the outlet can notify the system regarding checking time for bread condition and the stock of bread in the outlet.

6. Conclusion

Based on the results of the calculation in the house of risk phase 1, in the planning process, there are 9 dominant risks agent with 7 risks agent in the safe category, 1 risk agent in the high category, and 1 risk agent in the extreme category, namely late delivery of raw materials (A4) in high category and sudden order (A2) in the extreme category. In the sourcing process, there are 4 risks dominant risks agent with 2 risks agent in the safe category, namely the agreement was violated by the supplier (A2) and 1 risk agent in the extreme category, namely the company does not implement supplier performance evaluation (A1). In the making process, there are 6 dominant risks agent with 3 risk agents in the safe category, 1 risk agent in the moderate category, 1 risk agent in the high category, namely sudden order (A2), and 1 risk agent in the extreme category, namely human error (A9). In the delivery process, there are 6 dominant risks agent with 5 risk agents in a safe category and 1 risk agent in the high category, namely market fluctuates (A4). In the return process, there are 4 dominant risks agent in the safe category.

Nine mitigation strategies proposed to maintain risks agent, namely: implementation of supplier performance evaluation, raw material inventory management, implementation forecast, increase marketing, order allocation, additional employees at production department, implementation of employee performance evaluation, conduct employee performance evaluation, and implementation of information system.

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