Risk Mitigation Strategies on Supply Chain PT. X

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Abstract. Every supply chain activity in a company is not separated from risk, therefore risk management in a company is strongly required for risk handling. PT. X is a manufacturing company that produces food flavors. Dependence with suppliers and consumers causes uncertainty in the company's supply chain flow. This uncertainty can lead to adverse effects called risk. Risk can be minimized by carrying out risk management. This study aimed to design a risk management by identifying risk events from the company's business processes based on Supply Chain Operation Reference (SCOR), to determine the causes of priority risks and then identifying risk mitigation strategies using House of Risk stage 1 (HOR1), and ranking risk mitigation strategies by considering company criteria in determining risk mitigation strategies using the Analytical Hierarchy Process (AHP). From the results of the study, 21 risk events dan 13 priority risk causes identified, and 9 risk mitigation strategies determined. Risk mitigation strategies' rank sequentially were conducting briefings and evaluations every day, coordinating with suppliers continuously, making signboards at the warehouse, tightening the implementation of Standard Operating Procedures (SOP), providing ongoing training, evaluating supplier performance, monitoring more frequently, demand management with considering safety stock and service levels, and had supplier reserves. So, this study suggests PT.X to implement the risk mitigation strategies for minimizing the risks in the company.

Key word: Analytical Hierarchy Process (AHP), House of Risk (HOR), Mitigation, Risk Management, Supply Chain

1. Introduction

The level of competition in the food industry is increasing, along with the growth of the food industry so it is necessary to create a strategy to increase competitive advantage. One competitive advantage that can be achieved by implementing supply chain management [1]. The challenges of uncertainty, complexity, and the flow of a very wide supply chain network are the main sources in the difficulty of supply chain management [2]. This uncertainty can produce adverse consequences or can be called a risk [3]. Various types of risks and causes of risk can arise in the company's business processes that have the effect of disrupting the smooth running of business processes [4]. Therefore, the risks that occur in the supply chain must be managed appropriately to reduce or eliminate company losses [5]. This approach is known as supply chain risk management. Risk management in the supply chain aims to reduce the probability of risk events and increase the ability to recover from an interruption [6]. Risk management in the supply chain involves several processes namely risk identification, risk assessment, risk evaluation, and risk mitigation [7]. PT. X is a manufacturing company engaged in the processing of
food flavors. The process of procuring raw materials at PT. X is very dependent on the supplier and the production process related to the quantity of production is very dependent on consumer demand. This dependency makes PT. X is faced with uncertainties that can produce risks. Currently, PT. X does not yet have risk management that discusses the proposed risk management and risk mitigation strategies that must be carried out to deal with risk. Therefore, companies need to identify risks, identify the causes of risk and mitigate actions against the causes of risk to minimize or eliminate risks that occur in the company's supply chain so that an effective and efficient production process is formed. This research will identify the risk events of the company's business processes based on 5 core Supply Chain Operation Reference (SCOR) processes, namely plan, source, make, deliver, and return. Furthermore, the identified risk events will be processed using the House of Risk phase 1 method. The HOR method emphasizes the risk causes that affect risk events occur. The risk causes are source that drives the occurrence of risk events. Phase 1 helps for identifying and prioritizing the causes of risk that need to be done in advance of a mitigation strategy based on an Aggregate Risk Potential (ARP) assessment that calculates the severity, the frequency of occurrence of the cause of the risk, and the correlation between the risk and the cause of the risk. The highest ARP value is the basis for decision making for risk incident mitigation strategies. Next, develop a risk mitigation strategy for the risk causes by considering the selection of criteria determined by the company using the Analytical Hierarchy Process (AHP). With the use of AHP method, the ranking of risk mitigation strategies can be done by reviewing the criteria based on level of interest.

2. Methods

2.1. Data Collection
This study discusses the problem of risk events that occur in companies by applying the HOR and AHP method. The HOR method emphasized the risk causes that affect risk events occur, while AHP method was used to develop the ranking of risk mitigation strategies. The initial stage is data collection, where the data collection is done by interviewing and distributing questionnaires to respondents namely factory manager, purchasing manager, quality control manager. The interview stage is needed to collect data relating to problems experienced by companies that are closely related to risk events, the company's business processes, and solutions provided by the company to the problem of risk events and causes of risk. Distributing questionnaires is needed for risk event confirmation questionnaire, risk identification questionnaire, risk assessment questionnaire (severity, occurrence, and relationship), questionnaire determining risk mitigation strategy, paired comparison questionnaire (between criteria and between alternative risk mitigation strategies in terms of each criterion). The five questionnaires were filled out by respondents following their duties and responsibilities in the company's business processes.

2.2. House of Risk Phase 1 Method
The steps to do HOR 1 are as follows:
1. Classifying business processes that occur in the company that can help identify potential risk events (Ei). Identification of business processes can be done using the SCOR model (plan, source, make, deliver and return).
2. Assess the magnitude of the impact (severity) of risk events if they occur (Si). Assessment can use the Shahin scale. The Shahin scale uses a scale of 1-10 where the severity of a risk scale of 1 presents no impact and the scale of 10 represents the extreme impact.
3. Identifying the cause of risk (Aj) from each risk event that has been identified and assessing the occurrence of the cause of risk (occurrence) against each cause of risk (Oi). Assessment can use the Shahin scale. The Shahin scale for the causes of risk uses a scale of 1-10 where the scale 1 presents almost never happens and the scale of 10 shows almost certainly occurs.
4. Develop a matrix of relationships/correlations between risk events and the causes of risk symbolized by Rij. This Rij can be interpreted as how likely the cause of risk j can cause the risk
event to occur. The scale used is 0, 1, 3, 9. Scale 0 presents the absence of correlation and 1, 3, 9, respectively present low correlation, medium correlation, and high correlation.

5. Calculate the Aggregate Risk Potential $j$ (ARP $j$) which is the result of the likelihood of the occurrence of the causes of risk $j$ and a collection of the causal impacts of each risk event caused by the causes of risk $j$ by using the calculation formula:

$$\text{ARP}_j = O_j \sum_{i} S_i R_{ij}$$

6. Make ranking based on ARP value from the largest ARP value to the smallest ARP value.

7. Selecting some of the causes of ARP risk value with the highest ranking, can use the 80:20 pareto principle of ARP $j$.

8. Identify actions deemed relevant to prevent the cause of risk. One cause of risk can be handled by more than 1 preventive measure and 1 preventive measure can reduce several causes of risk.

The next step is to develop a risk mitigation strategy for the risk causes by considering the selection of criteria determined by the company using the Analytical Hierarchy Process (AHP).

2.3. Analytical Hierarchy Process (AHP) Method

AHP method in this study is used to rank risk mitigation strategies based on the weights of the results of pairwise comparisons between criteria and pairwise comparisons between alternative risk mitigation strategies in terms of each criterion. The steps in processing data using the AHP method carried out in this study are as follows:

1. Arrange the hierarchical structure starting from the objectives at level 1, criteria at level 2, to alternatives at level 3. In this study, the objectives used are risk mitigation strategies. The criteria used are the criteria considered by PT. X to carry out risk mitigation strategies. Alternatives in this hierarchical structure are several risk mitigation strategies.

2. Make AHP modelling on Super Decisions software according to the hierarchical structure that has been created.

3. Fill in the pairwise comparison matrix on the Super Decisions software found on the Pairwise Comparison toolbar. This paired matrix value is obtained from the pairwise comparison questionnaire.

4. The ranking of risk mitigation strategies obtained when all paired comparison matrices have been filled and have been consistently shown in the inconsistency value < 0.1 in the Super Decisions software.

3. Result and Discussion

3.1. Identifying Risk Events and Assessing Risk Events

Risk events in a company's supply chain activities are identified by understanding and mapping the company's core processes based on plan, source, make, deliver, and return into its sub-processes. The results of risk identification are 3 risk events in the scope of the plan, 5 risk events in the source scope, 7 risk events in the make scope, 4 risk events in the deliver scope, and 2 risk events in the scope of return. According to the assessment by respondents, the risk event that has the highest severity value is in the scope of make, that is, some products do not meet specifications. In the scope of deliveries, product damage during travel, and in the scope of returns, there are complaints to suppliers and complaints from customers. Risk events that have been identified have varying severity values, in the scope of deliveries, product damage during the trip, and in the scope of returns for complaints to suppliers and complaints from customers. Where, each risk event is worth 9, which means it has a serious impact on the company. The results of this recapitalization can be seen in Table 1.
### Table 1. Identification of risk events and assessment of risk events

| Core Process       | Sub-Process                          | Risk Event                                              | $E_i$ | $S_i$ |
|--------------------|--------------------------------------|---------------------------------------------------------|-------|-------|
| **Plan**           | Material planning                    | The difference in quantity in the system with the actual| E1    | 3     |
|                    | Production planning                  | Incorrect estimation of orders                          | E2    | 5     |
|                    | Scheduling material reception        | A sudden change in production plans                     | E3    | 5     |
|                    |                                      | *Due date of company acceptance not fulfilled*         | E4    | 7     |
| **Source**         | Purchasing of material               | Incompatibility of demand needs with financial planning | E5    | 3     |
|                    | Material inspection & reception      | Delay in checking material specifications              | E6    | 2     |
|                    | Storing material                     | Material received does not match the order             | E7    | 7     |
|                    | Production preparation               | Material placement does not match the type of goods    | E8    | 4     |
|                    |                                      | Error providing product formula                         | E9    | 7     |
|                    | Production process                   | The production process was forced to stop               | E10   | 5     |
|                    |                                      | Postponement of production                              | E11   | 5     |
|                    |                                      | Existing material cannot be used                        | E12   | 7     |
| **Make**           | Inspection of production results     | There are products that do not meet specifications      | E13   | 9     |
|                    | Product packaging                    | Product packaging results are imperfect                 | E14   | 8     |
|                    | Storing product                      | The product label does not match the product type      | E15   | 9     |
|                    | Delivery Scheduling                  | Products accumulate in the transit area                 | E16   | 4     |
|                    | Delivering preparation               | Late delivery of products to customers                 | E17   | 4     |
| **Deliver**        |                                      | *Certificate of Analyst is not attached*                | E18   | 4     |
|                    | Delivering product                   | Product damage during travel                            | E19   | 9     |
| **Return**         | Returning of material to the supplier| There is a complaint to the supplier                   | E20   | 9     |
|                    | Receiption of rejected product       | There are complaints from customers                     | E21   | 9     |

### 3.2. Identification of Risk Agents and Assessment of Risk Agents

Causes of risk are identified based on risk events that have been identified previously. One cause of risk can trigger several risk events. Based on the results of data collection, 34 causes of risk were successfully identified and 2 causes of risk that have a high frequency of occurrence are indicated by a value of 10. The results of identifying the causes of risk and assessing the causes of risk can be seen in Table 2.
| Risk Agent                                                                 | A_j | O_j |
|---------------------------------------------------------------------------|-----|-----|
| PPIC did not immediately update the system                                 | A1  | 2   |
| Lack of monitoring of actual inventory quantities                          | A2  | 2   |
| Warehouse inaccuracy calculates the quantity of material remaining on a card stock | A3  | 4   |
| Fluctuation of demand                                                     | A4  | 10  |
| Seasonal Factors                                                          | A5  | 10  |
| Changes in the quantity of consumer demand                                 | A6  | 6   |
| Some requests must be prioritized                                          | A7  | 6   |
| Sudden material demand                                                     | A8  | 8   |
| Stunted on the way                                                         | A9  | 1   |
| Natural disasters                                                          | A10 | 1   |
| Rely on a single supplier                                                  | A11 | 8   |
| Supplier is late sending material                                          | A12 | 8   |
| Inaccurate price reference                                                | A13 | 3   |
| Fluctuations in the exchange rate of the rupiah against the dollar         | A14 | 5   |
| Documents (COAs and Halal certificates) are incomplete                     | A15 | 3   |
| Material quality does not meet specifications                              | A16 | 9   |
| The quantity received does not match the order                            | A17 | 3   |
| Lack of knowledge of warehouse operators in laying materials               | A18 | 8   |
| Irregularity in material placement                                         | A19 | 8   |
| Material grouping information is not listed                                | A20 | 8   |
| Storage of product formulas is not well ordered                            | A21 | 7   |
| Electricity and / water supply has stopped                                 | A22 | 2   |
| Engine failure                                                             | A23 | 2   |
| There is a WIP product that must be followed up on                         | A24 | 4   |
| Material shortage                                                          | A25 | 9   |
| The careless operator in handling material                                 | A26 | 9   |
| Material is stored for too long in storage                                 | A27 | 3   |
| The operator is negligent in carrying out Work Instructions                | A28 | 3   |
| Operators are less skilled at using work tools                             | A29 | 6   |
| The inaccuracy of production operators in packaging                        | A30 | 7   |
| Request for delivery delay by the customer                                 | A31 | 4   |
| Limited fleet capacity                                                     | A32 | 4   |
| Inaccuracy of the QC                                                       | A33 | 4   |
| Inaccurate handling of products by shipping services                       | A34 | 3   |
3.3. Risk Evaluation
At the risk evaluation stage an Aggregate Risk Potential (ARP) calculation is obtained using equation (1), from the formula there are 3 assessments that affect the risk assessment, namely the severity level of the risk event, the value of the occurrence of the cause of risk, and the correlation value between the risk event and the cause of the risk. ARP calculation results for the causes of A12 risk have the highest value of 864. This shows that it is necessary to prioritize the causes of A12 risk for mitigation measures. The causes of priority risks are presented in Table 3 based on the 80:20 principle from the Pareto diagram.

Table 3. Selected risk agent.

| Rank | Aj  | Risk agent                                      | ARP  | %   | %KUM |
|------|-----|------------------------------------------------|------|-----|------|
| 1    | A12 | Supplier is late sending material              | 864  | 12% | 12%  |
| 2    | A16 | Material quality does not meet specifications  | 810  | 11% | 23%  |
| 3    | A26 | The careless operator in handling material     | 567  | 8%  | 30%  |
| 4    | A11 | Rely on a single supplier                      | 504  | 7%  | 37%  |
| 5    | A4  | Demand is very volatile                        | 450  | 6%  | 43%  |
| 6    | A5  | Seasonal Factors                               | 450  | 6%  | 49%  |
| 7    | A29 | Operators are less skilled at using work tools | 432  | 6%  | 55%  |
| 8    | A25 | Material shortage                              | 405  | 5%  | 61%  |
| 9    | A30 | The inaccuracy of production operators in packaging | 378  | 5%  | 66%  |
| 10   | A18 | Lack of knowledge of warehouse operators in laying materials | 288  | 4%  | 70%  |
| 11   | A19 | Irregularity in material placement             | 288  | 4%  | 74%  |
| 12   | A20 | Material grouping information is not listed    | 288  | 4%  | 78%  |
| 13   | A28 | The operator is negligent in carrying out Work Instructions | 243  | 3%  | 81%  |

3.4. Ranking of Risk Mitigation Strategies
The cause of the selected risk is then determined by its mitigation strategy then the risk mitigation strategy is ranked in terms of the criteria that the company considers to determining the risk mitigation strategy using the AHP method. The criteria that companies consider to determining risk mitigation strategies are obtained from interviews, namely preventing the recurrence of problems, increasing company efficiency, improving the quality of human resources, easy to do and not creating new problems. The initial step taken to rank the risk mitigation strategy is to arrange a hierarchy. In this study, the application of the AHP method was used with the help of Super Decision software. Figure 1. presents the AHP hierarchical structure modelling in the Super Decision software.
Figure 1. AHP hierarchy structure in Super Decision software.

Figure 2. Presents ranking of risk mitigation strategies using the Super Decisions software. Ranking based on total, normal and ideal values. So that, the recommendation for this company is to implement alternatives which is resulted from this study such as to conduct briefings and evaluations every day, coordinate with suppliers continuously, create sign boards in warehouses, tighten the implementation of Standard Operating Procedures (SOP), provide ongoing training, evaluate supplier performance, monitoring more frequently, controlling inventory taking into account safety stock and service levels, and having supplier reserves.

| Alternative Rankings |
|----------------------|
| Graphic | Alternatives | Total | Normal | Ideal | Ranking |
| 1 | Mencari alternatif supplier lain | 0.0181 | 0.0362 | 0.1931 | 9 |
| 2 | Melakukan koordinasi kepada supplier | 0.0792 | 0.1584 | 0.8451 | 2 |
| 3 | Evaluasi kinerja supplier | 0.0462 | 0.0923 | 0.4923 | 6 |
| 4 | Briefing dan Evaluasi setiap hari | 0.0937 | 0.1875 | 1.0009 | 1 |
| 5 | Monitoring lebih sering | 0.0328 | 0.0657 | 0.3503 | 7 |
| 6 | Memperketat pelaksanaan SOP | 0.0699 | 0.1399 | 0.7461 | 4 |
| 7 | Defenisisi strategi pengadaan | 0.0216 | 0.0432 | 0.2304 | 8 |
| 8 | Memberi pelatihan berdasarkan | 0.0639 | 0.1278 | 0.6815 | 5 |
| 9 | Membuat mandatory signboard pada gudang | 0.0746 | 0.1491 | 0.7956 | 3 |

Figure 2. Result of mitigation risk strategy rank

4. Conclusion

The conclusion of this study are as follows:
1. House of Risk phase 1 is carried out to map business processes, identify risk events, risk causes, and risk assess. There are 21 risk events and 34 risk causes that potentially occur in the supply chain flow at PT NFI.
2. There are 13 priority risk causes selected to determine the mitigation strategy based on the ARP value that falls into the 80:20 principle of the Pareto diagram.
3. Based on the Analytical Hierarchy Process (AHP) method, the ranking of risk mitigation strategies in sequence is to conduct briefings and evaluations every day, coordinate with suppliers continuously, create sign boards in warehouses, tighten the implementation of Standard Operating Procedures (SOP), provide ongoing training, evaluate supplier performance, monitoring more
frequently, controlling inventory taking into account safety stock and service levels, and having supplier reserves. Suggestion for the future research is to use another method to find the relationship between risk events and risk causes for example with ANP (Analytic Network Process) method.

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