Design the Supply chain risk mitigation with supply chain risk management approach in spring bed factory

SK Parinduri¹, S Sinulingga¹, and MT Sembiring¹

¹Magister in Industrial Engineering, Faculty of Engineering, Universitas Sumatera Utara, Prof. T. Maas Street, Kampus USU

E-mail: sitikhad3101@gmail.com

Abstract. A risk is often described an event, a change in situation, or a consequence. It can be handled or eliminated by using risk management. The objective of the research was to identify some factors which caused the lateness in delivering raw materials until it comes on time at spring bed factory, a company which produces spring beds. Within these 2 years the company has had the problem of providing raw materials which are often delivered late so that the company cannot meet consumers’ demand punctually. In consequence it suffers financial loss. The research used HOR (HOR I and HOR II) by identifying risk event and risk agent. The result of the identification with HOR I risk agent, it was found that the lateness was caused by the lateness of ship arrival, the lateness in supplying raw materials, dependency on parent company. To mitigate risk agent, mitigating strategy (HOR II) was organized such as making work contract with suppliers that came from parent company in order to communicate directly with suppliers, procuring raw materials from 2 weeks to 2 months before they were needed, and doing multiple routes.

1. Introduction

Supply chain management is a concept that concerns the pattern of product distribution that can replace traditional patterns of product distribution. This new pattern involves distribution activities, production schedules, and logistics. There is also a saying that supply chain management is a method of product creation to be delivered to the end user, which includes the various components: “the supplier of raw materials, the manufacturing units, warehouses, transporters, retailers, and finally selling” [6]. Basically risk management is prevention against the occurrence of losses or ‘accident’, the risk is defined in various ways. One common perspective simply says that risk is a situation that involves exposure to harm or loss. Risk can also be defined as the possibility of unintended or unwanted consequences leading to undesirable outcomes such as loss, injury, damage, or loss of opportunity [5].

In the supply chain, there are usually 3 kinds of flow that must be managed. First is the flow of goods flowing from upstream to downstream. Both streams of money flowing from downstream to upstream. The third is the flow of information that occurs from upstream to downstream or vice versa (Pujawan, 2005) [4]. Supply chain management is not only oriented to the company’s internal affairs but also external affairs involving relationships with partner companies.
Geraldin and Pujawan [2], developed a model of supply chain risk management using House of Quality (HOQ) and Failure Modes and Effects Analysis (FMEA) conceptual methods to develop a framework for overcoming supply chain problems with the House of Risk (HOR) approach. The HOR Approach aims to identify risks and design a coping strategy to reduce the likelihood of risk agents by taking precautions for risk agents. Reducing the risk agents reduces the occurrence of some risk events. In making HOR I, the severity of the risk agent is needed, severity is assessing the impact of risk events (if they occur) on a scale of 1-10 where 10 represents very severe, this is needed to determine the value of the risk agent that might occur in the company. There are two phases used in the HOR approach:

1. HOR I is used to determining the priority level of the risk agent be given as a precautionary measure
2. HOR II is a priority in taking action that is considered effective.

Amelia, et al (2017) [1], the research was conducted on the division of PT. Pal Indonesia has a big challenge to make the ship with the appropriate duration of the set date. Therefore, research is needed to analyze the risks that arise in the business process. The method chosen is the House Of Risk method.

Utarı, Baihaqi (2015) [9], conducting research at PT. Atlas Copco Nusantara to identify, analyze risk sequences and risk chain mitigation strategies using House Of Risk.

The central company is the main supplier of the spring bed plant, which is almost 80% raw materials while 20% of raw materials are obtained through the surrounding area. The central company opens Pre Order to the supplier and sends the raw material to the factory, for Supplier from Japan, Germany, and China directly send raw materials to the factory, to Supplier Jakarta, Bogor raw material is sent to the central company then the central company proceeds to the spring bed plant. So the factory only calculates the need of raw materials based on consumer demand and for stock, then scheduling the use of raw materials in accordance with the production, then make (Purchasing Order) to the central company. Only for local suppliers bias company directly open Pre Order for ordering raw materials such as wood, fabric, and dacron.

The method used to solve factory problems is the House of Risk method to manage risk properly and not cause losses. With House of Risk matrix, it can be done to evaluate the cause of raw material delay and characteristics of risk agent, so that it can identify the dominant factors that influence the delay, and formulate the dominant risk mitigation strategy.

2. Research Method

To solve the problem of research method is:

1. Mapping activities of the company with SCOR (Supply Chain Operation Research) to identify the company's business process.
2. House of Risk approach phase I, with the following steps:
   - Assessing severity in the risk event, occurrence of agent, and assessing the relationship between risk event and risk agent
   - Calculating Aggregate Risk Potential (ARP), Making risk agent ranking based on large to small ARP values, and priority risk agent selection using the Pareto approach
3. House of Risk approach phase II, with the following steps:
   - Planning risk mitigation actions, Assessing the level of risk mitigation relationships with risk agents, and Assessing the level of difficulty of mitigation actions
   - Calculating the total effectiveness of each mitigation action (TEk), Calculating the effectiveness and level of difficulty ratio (ETDk), and ranking priority mitigation actions based on large to small ETDk values

3. Results and Discussions

In the mapping of business activity the company found risk event which then determined its severity level as seen in the following table:
### Table 1. Risk Event and Severity

| Process        | Sub Process | Risk event ($E_j$)                  | Severity |
|----------------|-------------|-------------------------------------|----------|
| Plan           | Demand forecasting | Forecasting errors                  | E1 5     |
|                | Production planning | Distortion of demand information    | E2 2     |
|                | Inventory control material | A sudden change of production schedule | E3 5     |
|                |              | Reverse production schedule         | E4 6     |
|                |              | Error in stock calculation          | E5 3     |
|                |              | Less raw material stock             | E6 3     |
|                |              | Delay of PO letter issuance         | E7 7     |
|                | Purchasing  | Late in receipt of raw material from supplier | E8 6     |
|                | Supplier    | Material not according to specification | E9 7     |
|                | Make        | The amount of material is not suitable | E10 8    |
|                | production  | Sistemkomunikasi yang              |          |
|                |            | burukdenganpasatPoor communication system with center company | E11 5    |
|                |            | Supplier cannot afford material needs | E12 6    |
|                | Packaging  | Engine damage                        | E13 3    |
|                | process     | Worker fatigue                       | E14 5    |
|                |            | Material cannot be used anymore      | E15 3    |
|                |            | The accumulation of raw materials in the work station | E16 2    |
|                | Shipping selection | Less ship capacity due to the busy season | E18 4    |
|                | warehouse   | Ship document not accepted           | E19 6    |
|                | Product delivery to costomers | Ship arriving late at the harbor | E20 8    |
|                |            | Material obstructed at port         | E21 8    |
|                |            | Late delivery                        | E22 7    |
|                | Return      | Products are not up to standard/disable | E23 6    |
|                | defective product | No transportation available         | E24 3    |

This severity value states how much of a disruption caused by an event of the risk to a company's business processes. Severity is measured on the basis of the impact, the impact of which is a fixed value that is usually converted into financial losses. The value of severity and risk occurrence was obtained by interview and questionnaire to the manufacturer.

### Table 2. Identify Causes of Occurrence Risks and Value

| Code | Risk agent                                      | occurrence |
|------|------------------------------------------------|-------------|
| A1   | Forcasting is much different from reality       | 7           |
| A2   | Sudden demand                                  | 5           |
| A3   | Material needs in large quantities             | 5           |
| A4   | Late in procurement                            | 7           |
| A5   | There has been no clear long-term planning     | 7           |
| A6   | Incorrectly send quantity of material by supplier | 7           |
| A7   | poor internal/ekternal communication system    | 8           |
| A8   | Depending of the central enterprise             | 8           |
| A9   | Insufficient human resource                     | 7           |
A10 Error in machine set up/human error 6
A11 There is no great sense of responsibility from each employee to his job 8
A12 Poor communication system 7
A13 PO changes that are not closely monitored 5
A14 Changing Port Regulation 6
A15 The arrival of the ship is not on time 7
A16 The complexity of port bureaucracy 6

House of Risk Phase I is used to identify priority risk agents for the planned mitigation action. To make the House of Risk I matrix required ARP formula, Aggregate Risk Potential (ARP) calculation is obtained by using the following formula:

\[ ARP_j = O_j \sum_i S_i R_{ij} \]  (1)

Where:
\( O_j \) : Occurrence
\( S_i \) : Severity
\( R_{ij} \) : Relationship

An example of ARP I calculation is:

\( \begin{align*}
O_1 &= 7 \\
S_1 &= 5 \quad R_1 = 9 \\
S_2 &= 2 \quad R_2 = 3 \\
S_3 &= 5 \quad R_3 = 1
\end{align*} \)

The answer is:

\[ ARP = O_1 \sum_i S_i R_{ij} = 7 \times (5 \times 9) + (2 \times 3) + (5 \times 1) = 392 \]

The ARP value is then entered in the House of Risk matrix of phase 1

| Risk Agent | Bussiness | Process | Event | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | A13 | A14 | A15 | A16 |
|------------|-----------|---------|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| E1         | 9         | 3       | 1     | 1  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E2         | 3         | 3       |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E3         | 1         |         |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E4         | 3         |         |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E5         | 3         |         |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E6         | 1         |         | 3     | 3  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| E7         | 1         |         | 1     |    | 9  | 9  |    |    |    |    |    |    |    |    |    |    |    |    |    |

| Risk Agent | Severity |
|------------|----------|
| E1         | 5        |
| E2         | 2        |
| E3         | 5        |
| E4         | 6        |
| E5         | 3        |
| E6         | 3        |
| E7         | 7        |
Determination of priority risk agent category is done by using Pareto diagram or known as 80:20 law. Pareto law application of risk indicates that 80% of the company's losses are caused by a crucial 20% risk, focusing on risk management on 20% of crucial risk agents, and the impact of corporate risk by 80% can be overcome.

Table 4. Pareto Agent Risk Calculation

| Rank | Risk agent code | ARP   | % ARP  | % accumulative ARP | Category     |
|------|-----------------|-------|--------|--------------------|--------------|
| 1    | A15             | 1.272 | 14.46  | 14.46              | Priority     |
| 2    | A4              | 1.029 | 11.7   | 26.16              |              |
| 3    | A16             | 0.900 | 10.23  | 36.39              |              |
| 4    | A8              | 0.720 | 8.185  | 44.57              |              |
| 5    | A6              | 0.714 | 8.116  | 52.69              |              |
| 6    | A11             | 0.648 | 7.366  | 60.05              |              |
| 7    | A13             | 0.630 | 7.162  | 67.22              |              |
| 8    | A10             | 0.594 | 6.752  | 73.97              | Non - Priority |
| 9    | A1              | 0.392 | 4.456  | 78.42              | Priority     |
| 10   | A12             | 0.378 | 4.297  | 82.72              |              |
The next step is to identify the mitigation design which is then plotted on the phase 2 HOR model together with the selected risk agent. In this second phase, first calculate the total design effectiveness value of mitigation (TEk), the degree of difficulty of mitigation (Dk) and the total effectiveness of degree of difficulty in doing mitigation activities (ETDk). To calculate the value of TEk and ETDk required a relationship value between mitigation design against risk agents to be mitigated. The following table scales the degree of difficulty (Dk), and the meaning of the relationship value between mitigation design and risk agent.

The formula for calculating Total Effectiveness (TEk) and Effectiveness to Difficulty (ETDk) are:

\[ TE_k = \sum A_{R_k} E_{jk} \]  
\[ ETD_k = \frac{TE_k}{D_k} \]

### Table 5. Rank of risk mitigation action

| Rank Management | Design Risk Mitigation | ETDk  | Rank of priority |
|-----------------|------------------------|-------|-----------------|
| PA2             | Accelerate raw material procurement far before needed(2 months before) | 6.903 | 1                |
| PA1             | Multiple route          | 2.829 | 2                |
| PA4             | Organized such as making work contract with suppliers that came from parent company in order to communicate directly with suppliers | 2.581 | 3                |
| PA5             | Ask the central assertiveness of supplier negligence | 2.146 | 4                |
| PA3             | Strengthening working relationship with ports | 2.025 | 5                |
| PA6             | Giving gifts and punishments | 1.944 | 6                |
Table 6. Matrix of Mitigation Strategy (HORII)

| Risk Agent | Risk Management Design |
|------------|------------------------|
|            | PA1 | PA2 | PA3 | PA4 | PA5 | PA6 | PA7 | PA8 | ARPj |
| A15        | 9   | 9   |     |     |     |     |     |     | 1.272 |
| A4         |     |     | 9   |     |     |     |     |     | 1.029 |
| A16        |     |     | 3   | 9   |     |     |     |     | 900   |
| A8         |     |     |     |     |     | 9   | 3   |     | 720   |
| A6         |     |     |     |     |     | 9   | 9   |     | 714   |
| A11        |     |     |     |     |     |     |     | 9   | 9     |

4. Conclusions
After processing and analyzing the data, it can be concluded that:
From the calculation results using House of Risk got 6 top ranking cause of risk (risk agent) causing raw material late to the factory so that business activity is not smoothly is as:
a. The arrival of the ship is not timely
b. Delay in procurement
c. Complicated port bureaucracy
d. Dependency on the center
e. Error shipping material quantity by supplier
To mitigate the risk agents causing such delays it is recommended that the plant perform the following mitigation actions:
1. To mitigate risk agent, mitigating strategy (HOR II) was organized such as making work contract
with suppliers that came from parent company in order to communicate directly with suppliers
2. Ordering raw materials 2 months before needed.
3. Place an objection to the center for the negligence of the supplier in sending the quantity /
specification of raw materials to the company, and requested re-checking the amount of raw
materials to be sent.
4. Provide motivation, briefing before starting work
5. Recruit employees with integrity and quality
6. Add / change the delivery path of raw materials

5. References
[1] Amelia p, Vanany, Iwan, 2017. Analisis Risiko Operasional Pada Divisi Kapal Perang PT.
PAL Indonesia Dengan Metode House Of Risk, Jurnal sistem informasi indonesia (JSII) ISSN:
2460 – 6839 Vol 2 hal 1

[2] Geraldin I h, Pujawan i n, Dewi d s 2007, Manajemen Risiko dan Aksi Mitigasi untuk
Menciptakan Rantai Pasok yang Robust Jurnal Teknologi dan Rekayasa Teknik Sipil TORSI hal
53

[3] Hidayat t, Basuki m, 2017. Penilaian Risiko Faktor Keterlambatan Shipment Loading Pada Divisi
Fatty Acid Departement Oleochemical PT. XYZ Menggunakan Metode House of Risk, Seminar
Nasional IENACO-2017; ISSN:2337-4349, hal 266

[4] Irawan p j. Santosa i, 2017 Model Analisis dan Strategi Mitigasi Risiko Produksi Keripik Tempe,
Jurnal Teknologi dan Manajemen Agroindustri, ISSN 2252-7877 vol 6 hal 2

[5] Mikael, r, 2015. Analisis Risiko Operasional dalam Pemilihan Perangkat Keras (Hardware) Dan
Perangkat Lunak (Software) pada Inustri Perbankan, Pasca Sarjana Magister Management
Universitas Katolik Parahyangan, ISSN 2460-8114

[6] Pujawan, I Nyoman, 2005 Supply Chain Management, Surabaya; Guna Widya Edisi 3

[7] Schegel, Gregory, L and Robert J. Trent. 2005 supply Chain Management and Emerging
Discipline. CRC Press

[8] Simchi-Levi, at all, 2003, Supply Chain Design And Planning-Application of Optimization
Techniques For Sti PT. Atlas Copco Nusantara Dengan Metoda House Of Riskstrategic And
Tactical Models, Hand Book in Operations

[9] Utari, Baihaqi I, Perancangan Strategi Mitigasi Risiko Supply Chain Dengan Metoda House Of
Risk, Prosiding Seminar Nasional Manajemen Teknologi XXII, ISBN: 978-602-70604 vol 1 hal
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