Analysis of Measurement and Supply Chain Risk Management Control Using House of Risk Method

Sambudi Hamali, Diana Vita Marina, Yaya Jakaria, Kezia Stefana.
Management Department, BINUS Business School Undergraduate Program, Bina Nusantara University, Jl. K.H. Syahdan No. 9, Palmerah, Jakarta 11480, Indonesia
sambudi_hamali@binus.ac.id, diana.marina141014@binus.ac.id, yayajakaria@binus.ac.id, kezia_stefana@yahoo.com

Abstract

This study aimed to identify, calculate, and design risk mitigation that occurs in Supply Chain Risk Management activities using the House of Risk method. The research method uses the mixed method with descriptive research type. The analysis tools used are the SCOR (Supply Chain Operation Reference) and House of Risk method uses data through observation, interviews, and questionnaires. The results of the SCOR identified 19 risk activities and 14 risk factors, and the House of Risk identified 3 causes of the problem and 3 preventive measures. Therefore, the company must identify risks regularly to avoid problems in the supply chain.

Keywords
House of Risk, SCOR, Supply Chain Risk Management

1. Introduction
The rapidly increasing era of globalization is intensifying competition in Indonesia. Indonesia's economic growth is supported by domestic demand as consumption and investment growth and is supported by improved revenues, the development of infrastructure projects, and the maintenance of purchasing power in line with low inflationary pressures.

This research was conducted on companies engaged in the metalware industry that has been in existence since 2015 and produces household appliances, namely wire grids shelves with nail wire raw materials with a location in North Jakarta. The problem faced by the company is; first, the raw material does not conform to the standard because the nail wire material is hard or too soft, and excess oil components. Non-standardized raw materials complicate the production process, which leads to longer production times, as the machine still uses human labor. Too much oil leads to a defect in the finished product, i.e., black spots appear on the product. To cover this, a repainting process must be carried out, leading to higher capital prices. Second, Limited raw materials, since raw materials are needed to produce the shelves, namely nail wire. The Indonesian government limits the number of imports to Indonesia affects every domestic company that normally purchases imported wire. Switch to the local nail wire, which means that not much wire is in stock (limited), and unstable every month prices affect.

Based on previous research conducted by Ahmad & Susanty (2019) that has problems with raw materials that do not meet standards and limited raw materials, this study uses the House of Risk (HOR) method to overcome these problems. The results of this study show that there are 23 priority risks and 17 priority risk causes based on Pareto diagrams, in which the three main risks are selected, namely the risks of project processes that are not in line with the supply of raw materials. limited transportation and the unavailability of raw materials at suppliers as production increases, resulting in 3 risk mitigation plans based on 3 risk factors.

Based on previous research by Alitosah & Kusumah (2019) where there are problems with non-standard raw materials and with limited raw materials, these problems are overcome using the house of risk method. The results of this study show that there are 19 priority risks and 5 priority risk factors and select 5 main risks, namely operators who are not working as they should, sudden requests from buyers, improper machine repair plans, increased production from suppliers, and Raw materials that do not meet the standard of the supplier who creates 10 risk mitigation plans that are the result of mitigating the 5 risk causes.

According to Aggrahini, Karningsih & Sulistiyono (2015), House of Risk is a risk analysis method based on the idea that supply chain risk management should try to focus on preventive measures, namely reducing the possibility of risk occurrence.

Based on the description above, the study formulates the problem of which risks affect the supply chain, what causes the most influential risk, and which risk prevention strategies can minimize the risk.

1.1. Objectives

The purpose of this study is:

1. To identify the risks that affect the supply chain,
2. To identify the causes of the influential risks
3. To implement risk mitigation measures to prevent the occurrence of risks.

2. Methods

The research method used in this study is a mixed method, namely quantitative and qualitative, with the type of descriptive research. The type of data used is qualitative and quantitative data, while the data source used is primary data from interviews, observations, and questionnaires, while secondary data are the results of literature studies. The first phase of this research consists of mapping the activities using the SCOR (Supply Chain Operation Reference) method and then performing risk analysis using the house-of-risk (HOR) method, which is divided into two phases. The first phase of the HOR is the process from risk identification to risk assessment, while the second phase of the HOR is used to develop preventive measures based on the results of HOR 1.

2.1. House of Risk (HOR) Method

The HOR approach aims to identify risks and design treatment strategies to reduce the probability of occurrence of risk agents by providing preventive measures (Pertiwi & Susanty, 2017). The risk agent or the cause of the risk is the causative factor that drives the risk. There are 2 phases used in the HOR approach, namely:

1. HOR phase 1

HOR phase 1 determines the priority level of risk agents as a preventive measure (Ulfah et al., 2017). HOR phase 1 is the initial stage of the House of Risk method, where HOR phase 1 is a risk identification phase for preventive action. The steps in HOR phase 1 are risk identification and risk assessment which includes three evaluations of the level of impact:

1. Severity

Severity value states how much disruption is caused by a risk event to the company's business processes. Assessment of the severity of each risk event by distributing questionnaires to the person in charge of the company. The score scale in determining the severity level is based on a value of 1 – 10 (Firdaus & Widiyanti, 2015), where the scores are 1: no effect, 2: very small effect, 3: small effect, 4: very low effect, 5: low effect, 6: medium effect, 7: high effect, 8: very high effect, 9: harmful effect with mitigation and 10: harmful effect without warning, then recalculated using the formula:

$$S_i = \sqrt[k]{S_{i1} \times S_{i2} \times \ldots \times S_{ik}} \; \forall i \qquad (1)$$

where:
Si = Severity each of risk event
i = Risk event no 1, 2, …. n
k = number of respondents

Source: Helmi & Masri (2017)

2. Occurrence

Occurrence states the probability level of the frequency of a risk cause resulting in the emergence of one or more risk events. Occurrence value scale by giving a value of 1 – 10 (Firdaus & Widiyanti, 2015),, where the value of 1 no effect with almost no failure, 2-3 low failures, 4 - 6 failures are rare, 7 - 8 repeated failures, 9 - 10 very high failures i.e., often occurs, then recalculated using the formula:

$$O_j = \sqrt[k]{O_{j1} \times O_{j2} \times \ldots \times O_{jk}} \; \forall j \quad (2)$$

where:
Oj = occurrence risk causes
j = risk causes no 1, 2, … n
k = number of respondents

Source: Helmi & Masri (2017)

3. Correlation
Correlation determines the relationship between risk agents and risk sources. Weighting the correlation value between risk events and risk agents with a correlation value scale of 0.1, 3, and 9, namely by explaining the value of 0, there is no relationship, 1 weak relationship, 3 moderate relationships, and 9 strong relationships (Rakadithya, Hartono & Laurence, 2019).

The identification of risk levels results is mapped into the House of Risk model phase 1 to determine the correlation with the result value, aggregate risk priority (ARP). The ARP value to determine the importance of the risks that need to be addressed uses the formula:

$$ARP_j = O_j \sum S_i R_{ij} \quad (3)$$

where:
ARP: Aggregate Potential Risk Value
Oj : Occurrence Risk Agent Value
Si : Severity Risk Event Value
Rij : Correlation Risk Agent and Risk Events

Source: Rakadithya, Hartono & Laurence (2019)

2. HOR phase 2
HOR phase 2 is a priority in taking considered adequate actions (Ulfah et al., 2017). In HOR 2, several treatment strategies are considered effective in reducing the probability of impact caused by risk agents. The steps taken in this phase are:

1. Calculating Total Effectiveness (TEk) using the formula:

$$TE_k = \sum_j ARP_j E_{jk} \quad (4)$$

where:
TEk : Effectiveness Preventive Action Value
Ejk : Correlation Preventive Action and Risk Agent

Source: Rakadithya, Hartono, & Laurence (2019)

2. Calculating the Total Effectiveness Ratio (TEk) to Difficulty Level (Dk). The difficulty value scale is divided into three numerical weights; namely, 3 is easy to apply, 4 is rather difficult to apply, and 5 is difficult to apply; then calculate the ratio value using the formula:

$$ETD_k = \frac{TEk}{Dk} \quad (4)$$

where:
TEk: overall effectiveness
Dk: level of difficulty

Source: Rakadithya, Hartono, & Laurence (2019)

The results of the HOR phase 1 and phase 2 to perform data analysis with descriptive elaboration and mitigation results are expected to be helpful for the company.

3. Results and Discussion

3.1 Activity Assignment Phase

The following are the results of mapping supply chain activities at company using SCOR (Table 1)

Table 1. SCOR

Supply Chain Process	Activity
Plan	1. Forecast distributor requests
	2. Determination of the required raw materials
	3. Production planning
Source	1. Receipt of raw materials
	2. Raw material checking
Make	1. Production implementation
	2. Implementation of Quality Control (QC)
	3. Product packaging
Deliver	1. Delivery of goods to distributors
	2. Checking item that have arrived
	3. Billing to distributors
Return	1. Return of rejected products (defective / over ordered)
	2. Re-checking the product to be returned

3.2. Risk Analysis Phase

After mapping, the researcher runs a risk identification process to determine the risks (risk events) and the causes of the risks (risk agents). The risk identification process is done by interviewing the company's director, recording the supply chain process and the company's literature review, or based on existing references. Each risk and risk agent is rated on a scale of 1 to 10 based on the severity of the risk (severity) and the probability of the occurrence of a risk agent (occurrence).

The results of the degrees of severity are shown in Table 2.

Table 2. Risk Events

Supply Chain Process	Activity	Risiko (E)	Code	Severity
Plan	1. Forecast distributor requests	1. Excess or lack of stock	E1	7
		2. Uncertainty of orders from distributors	E2	6
	2. Determination of the required raw materials	1. Raw material calculation error	E3	7
		2. Rising raw material prices from suppliers	E4	7
	3. Production planning	1. Production planning is not on target	E5	6
		2.Error in the production process	E6	6
Source	1. Receipt of raw materials	1. Raw material delay	E7	6
		2. Error in the Order process	E8	5
	2. Raw material checking	1. Raw materials are not up to standard	E9	6

Make	1. Production implementation	1. The machine is not working properly	E10	7
	2. Implementation of Quality Control (QC)	1. Defective products	E11	7
	3. Product packaging	1. Defective products due to errors in product handling	E12	7
Deliver	1. Delivery of goods to distributors	1. Natural disasters	E13	5
		2. Delivery schedule hampered due to damage to the shipping fleet	E14	6
	2. Checking item that have arrived	1. Employee error when checking (Human Error)	E15	5
	3. Billing to distributors	1.Distributor is late to pay invoice	E16	6
Return	1. Return of rejected products (defective / over ordered)	1. The items are damaged	E17	5
		2. Delay in the process of returning the product to the company	E18	5
	2. Re-checking the product to be returned	1. Distributors do not re-check the cause of damaged products	E19	5

The full results of the risk agent identification are shown in Table 3:

Table 3. Risk Agent Scale

Risk Agent (A)	**Code**	**Occurrence**
Error on Forecast	A1	5
Only have 1 supplier	A2	7
The number of orders from distributors and customers is uncertain	A3	7
Inaccuracy in production planning process	A4	5
The communication system within the company and with distributors is not going well	A5	6
The declining quality of raw materials from suppliers	A6	8
Product manufacture is not according with SOP	A7	7
H*uman error*	A8	6
Error in maintenance planning on production equipment	A9	5
Engine limitations	A10	3
Changes to regulatory regulations, such as Import Restriction Regulations. The issuance of Regulation of the Minister of Trade of the Republic of Indonesia number 06 of 2018	A11	6
Natural disasters	A12	3
Limited shipping fleet	A13	4
Capital flow is not smooth	A14	4

The results of the risk identification and the risk agents are taken over into the calculation phase of the aggregate agent potential (ARP). ARP calculations are carried out to measure the level of risk takers.

After the ARP results have been calculated, they can be described into House of Risk phase 1, which is shown in Table 4

Table 4. House of Risk 1

Risk Event	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	Severity of Risk Event (Si)
E1	3	0	0	0	3	0	0	0	0	0	0	0	0	0	7
E2	0	0	1	0	3	0	0	0	0	0	0	0	0	0	6
E3	9	0	0	0	0	0	0	1	0	0	0	0	0	0	7
E4	0	9	0	0	0	0	0	0	0	0	9	0	0	0	7
E5	0	0	0	9	0	0	0	0	3	3	0	0	0	0	6
E6	0	0	0	9	0	0	0	0	3	3	0	0	0	0	6
E7	0	9	0	0	0	0	0	3	0	0	0	1	0	0	6
E8	1	0	0	0	3	0	0	8	0	0	0	0	0	0	5
E9	0	9	0	0	0	9	0	0	0	0	0	0	0	0	6
E10	0	0	0	0	0	0	9	0	3	3	0	0	0	0	7
E11	0	0	0	0	0	9	3	3	0	0	0	0	0	0	7
E12	0	0	0	0	0	0	0	3	0	0	0	0	0	0	7
E13	0	0	0	0	0	0	0	0	0	0	0	9	0	0	5
E14	0	0	0	0	0	0	0	0	0	0	0	1	3	0	6
E15	0	0	0	0	9	0	0	3	0	0	0	0	0	0	5
E16	0	0	0	0	3	0	0	0	0	0	0	0	0	3	6
E17	0	0	0	0	0	0	3	9	0	0	0	0	0	0	5
E18	0	0	0	0	9	0	0	0	0	0	0	0	1	0	5
E19	0	0	0	0	3	0	0	3	0	0	0	0	0	0	5
Occurrence of Agent (Ji)	5	7	7	5	6	8	7	6	5	3	6	3	4	4	
Aggregate Risk Potential	445	1197	42	540	1062	936	693	1092	285	171	378	171	92	72	
Priority Risk of Agent	7	1	14	6	3	4	5	2	9	10	8	11	12	13	

The results of the ARP in table HOR 1 are sorted by the largest number and sorted using the Pareto diagram. The values are listed in Table 5.

Table 5 Risk Agents

Code	Risk Agent	ARP
A2	Only have 1 supplier	1197
A8	*Human error*	1092
A5	The communication system within the company and with distributors is not going well	1062
A6	The declining quality of raw materials from suppliers	936
A7	Product manufacture is not according with SOP	693
A4	Inaccuracy in production planning process	540
A1	Error on Forecast	445
A11	Changes to regulatory regulations, such as Import Restriction Regulations. The issuance of Regulation of the Minister of Trade of the Republic of Indonesia number 06 of 2018	378
A9	Error in maintenance planning on production equipment	285
A10	Engine limitations	171
A12	Natural disasters	171
A13	Limited shipping fleet	92
A14	Capital flow is not smooth	72
A3	The number of orders from distributors and customers is uncertain	42

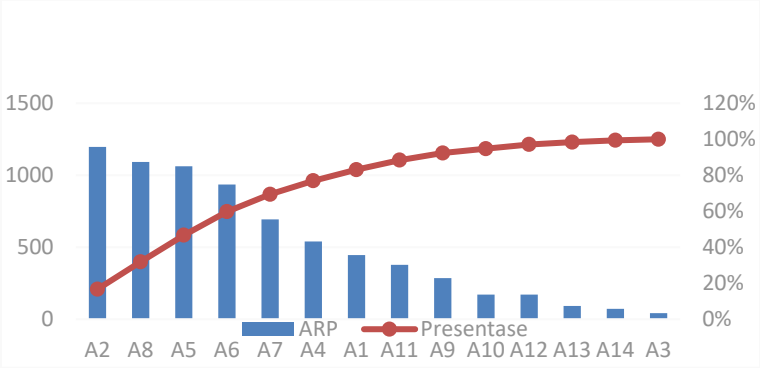

Figure 1. ARP Pareto Diagram

Based on the pareto graph in Figure 1, the results of the pareto graph using the 80:20 calculation, which then selected 3 causes for the highest risk, are included in A2, which has only 1 supplier, A8, there is human error and A5 communication system in the company internally and with less running dealers with good precautions. Various prevention strategy plans are recommended as the cause of the selected risk, which make it possible to eliminate or reduce the occurrence of these risk mediators. The following prevention strategies apply to each selected active ingredient. (Table 6)

Table 6. Preventive Action

Preventive Action	Code
Conduct invoice billing regularly and providing deadlines	PA1
Looking for a route so that the goods can be delivered according to the promised receipt schedule	PA2
Registering a company to insurance	PA3

Coordination with distributors to make more specific requests	PA4
Conduct training for employees	PA5
Provide guidance on how to work for employees	PA6
Perform maintenance before shipping and avoid rush hour	PA7
Looking for other raw material suppliers	PA8
Improve communication to internal companies and distributors	PA9

3.2. Risk Response Phase

The results of HOR phase 1, which is the risk broker with the highest ARP value, and their precautions are used to calculate HOR phase 2. After the correlation between each risk mediator and the preventive measure has been determined, the calculation of the total effectiveness (TEk) is continued.

Then, on a scale of 3, 4 and 5, an assessment of the level of difficulty in the implementation of each preventive measure (Dk) is carried out. Then the ratio of effectiveness to difficulty (ETDk) is calculated with the value of TEk and Dk.

The results of the TEk and Dk values can be described again in the House of Risk phase 2, so that the results of the calculation of House of Risk 2 can be seen in Table 7.

Table 7. House of Risk 2

Risk Agent	Preventive Action									ARP
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	
A2	0	0	0	0	0	0	0	9	0	1197
A8	0	0	0	0	3	1	0	0	0	1092
A5	0	0	0	0	0	0	0	0	9	1062
A6	0	0	0	0	0	0	0	9	0	936
A7	0	0	0	0	3	3	0	0	0	693
A4	0	0	0	0	1	3	0	0	0	540
A1	0	0	0	0	3	3	0	0	0	445
A11	0	0	0	0	0	0	0	1	0	378
A9	0	0	0	0	0	0	9	0	0	285
A12	0	0	0	0	0	0	0	0	0	171
A10	0	0	3	0	0	0	0	0	0	171
A13	0	9	0	0	0	0	0	0	0	92
A14	9	0	0	0	0	0	0	0	1	72
A3	0	0	0	9	0	0	0	0	0	42
Total Effectiveness (Tek)	648	828	513	378	7230	6126	2565	19575	9630	
Degree of Difficulty (Dk)	3	4	3	4	3	3	4	4	4	
Effectiveness to Difficulty (ETD)	216	207	171	94.5	2410	2042	641.25	4893.75	2407.5	
Rank of Priority	6	7	8	9	2	4	5	1	3	

The results of the ETD in table HOR 2 are sorted by the largest number and sorted using the Pareto diagram. The values are listed in Table 8.

Table 8. Levels of Preventive Action Measures

Preventive Action	Code	ETD
Looking for other raw material suppliers	PA8	4893.75
Conduct training for employees	PA5	2410
Improve communication to internal companies and distributors	PA9	2407.5
Provide guidance on how to work for employees	PA6	2042
Perform maintenance before shipping and avoid rush hour	PA7	641.25
Conduct invoice billing regularly and providing deadlines	PA1	216
Looking for a route so that the goods can be delivered according to the promised receipt schedule	PA2	207
Registering a company to insurance	PA3	171
Coordination with distributors to make more specific requests	PA4	94.5

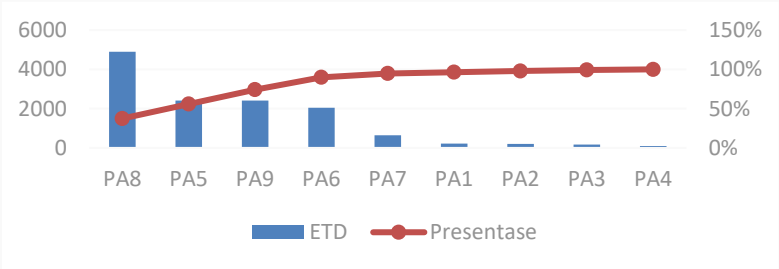

Figure 2. ETD Pareto Diagram

Based on the Pareto chart Figure 2 above, the results of the Pareto chart use the calculation of 80:20, which then selected 3 risk prevention measures with the highest ETD value, namely in PA 8 looking for suppliers of other raw materials for the PA 5 training conducts employees and PA 9 improves communication with the internal company or dealer.

4. Conclusion

The House of Risk method at the company identified 19 risk events and 14 risk causes that could disrupt supply chain activities. Based on House of Risk 1, there are three most influential risk causes when calculating the ARP values (Aggregate Risk Potential); namely, only one supplier, human error, and communication system within the company and with distributors is not going well.

Based on the analysis of the House of Risk 2 data, we can take preventive action by calculating the value of ETD, i.e., Looking for other raw material suppliers, conducting training for employees, and improving communication with internal companies and distributors.

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Biographies

Sambudi Hamali is a lecturer in Management Department at Bina Nusantara University since 2014. He is graduated with Doctoral Degree in Management Science from Padjadjaran University. He has experience in various industries, not only in education but also in the construction and services industry.

Diana Vita Marina is a lecturer from Management Department since 2021 at Bina Nusantara University. She is graduated with a master's degree from master's in management Universitas Gadjah Mada (MM UGM Jakarta Campus). She has experience not only in education but also in ISO Certification Body Company.

Yaya Jakaria is a lecturer in the Statistics Department since 1994 and a lecturer in the management program since 2020 at Binus University. He earned a Doctorate in Strategic Management from Padjadjaran University in 2009. He has experience in various industrial fields, but also has experience in educational research. He has carried out various research results at the national and international levels.

Kezia Stefana is graduated from Management Department, BINUS Business School Undergraduate Program, Bina Nusantara University.