Fuel distribution process risk analysis in East Borneo

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Abstract. Fuel distribution is an important aspect of fulfilling the customer's need. It is risky because it can cause tardiness that can cause fuel scarcity. In the process of distribution, many risks are occurring. House of Risk is a method used for mitigating the risk. It identifies seven risk events and nine risk agents. Matrix occurrence and severity are used for eliminating the minor impact risk. House of Risk 1 is used for determining the Aggregate Risk Potential (ARP). Pareto diagram is applied to prioritize risk that must be mitigated by preventive actions based on ARP. It identifies 4 priority risks, namely A8 (Car trouble), A4 (Human Error), A3 (Error deposit via bank and underpayment), and A6 (traffic accident) which should be mitigated. House of Risk 2 makes for mapping between the preventive action and risk agent. It gets the Effectiveness to Difficulty Ratio (ETD) for mitigating action. Conducting safety talk routine once every three days with ETD 2088 is the primary preventive actions.

1 Introduction

Supply chain management has an important role in every business process in a company because it influences efficiency and effectivity of relation to the supplier, manufacturer, and the customer. "Generally, all activities related to material flow, information flow, and financial flow along the supply chain are the activities within the scope of SCM" [1].

The supply chain is a set of firms that pass materials forward. Normally, several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain. Raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies are all members of a supply chain [2].

Every company's business activity, including supply chain, always has the risk that can disrupt the success of the company and even endanger the safety of worker [3]. Therefore, risk management is needed. British Standard Institute's Guide to project management defines risk management as "processes whereby decisions are made to accept a known or assessed risk or the implementation of action to reduce the consequences or the probability of occurrence of an adverse event" [4]. In the context of supply chain risk management, events are characterized by their probability of occurrence and their related consequences within the supply chain[5].

Supply chain risk management is not only as the cost Saving but rather a value creation activity has given that it can lead to more sustainable supply chains[6, 7].

The fuel distribution is an important process of fuel industry to deliver the fuel to the customer in the right quantity and on time. It is risky activity because if tardiness of delivering happens, it can cause fuel scarcity

that endangers other related business. In the process of distribution, some potential risks can happen especially in filling and delivery process. Identifying risk and preventive action are needed for mitigating and minimizing the risks. Some risk analysis researches have been done in some aspect of oil and gas industries such as in financial [8, 9] and supply chain modeling [10, 11].

Delivery flexibility measures adopted by the firms are largely internal to the firm. Delivery or shipment risk is in not only to the internal process and distribution flexibility related aspects of the firm but also to the poor logistics infrastructure that is external to the firm.[12]

House of risk is a renewable method of risk analysis. It is modification of the Failure Mode and Effects Analysis (FMEA) method for quantification of risk by quantification and the House of Quality (HOQ) model to prioritize which risk agents should be addressed first and to select the most effective action to reduce Potential risks posed by risk agent [13]. Implementation house of risk in supply chain have been done by some researchers. Kusmantini et al. implemented House of Risk in Furniture supply chain risk [14]. Data collection uses a triangular method that combined in depth interview technique with a number of successful exporters and distributing questioners to more than 80 SMEs in DIY. It identifies 23 agents and 43 incidence risks in the supply chain. It is also implemented in the supply chain of shoe company. By using two phases of house of risk, Kristanto [15] identifies 27 risk events and 52 risk agents. It gets 6 mitigation actions.

Thus, the advantages of prevention and mitigation in the distribution process are crucial because if the risk occurs it will cause enormous losses. It encourages researchers to conduct research on the mitigation and preventive actions to overcome the risk. House of risk will

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be implemented to identify and mitigate risks to minimize losses. This study is done in a national oil company in Balikpapan.

2 Research Method

This step is identifying and formulating problems for doing research that uses in identifying the problems that occurred in the process. Data are collected by observation and interview. A deep discussion is done to determine risk rating scale with the company. Firstly, it collects and processes the data. Collecting data consist of primary data and secondary data. Primary data consists of result of observation, result of interview, and a rating scale from the company. The secondary data consist of House of Risk Application. The rating scale of severity can be shown in the Table 1.

Table 1. Severity rank

Rank	Subjective Estimate for Severity	Description
1	No impact	Insignificant
2	Minor impact	Single small impact
3	Medium impact	Cause short-period difficulties
4	Major impact	Causes long-period difficulties
5	Catastrophic impact	Directly affect highest rates

Before interviewing an expert, it should need the occurrence rating scale, the occurrence rating scale shown in Table 2.

Table 2. Occurrence rating scale

Rank	Subjective Estimate of Occurrence	Description	
1	Very unlikely	Very rare event (very rarely)	Occurs 1 times a year
2	Improbable	There is indirect evidence of event (rarely)	Occurs 2-3 times a year
3	Moderate	There is direct evidence of event (sometimes)	Occurs 3-4 times a year
4	Probable	There is strong direct evidence of the event (often)	Occurs 4-5 times a year
5	Very Probable	Event recurs frequently (Very Often)	Occurs > 5 times a year

Data analysis is started by identifying activities based on SCOR-model. SCOR-model is the product of the Supply-Chain Council (SCC), an independent, not-for-profit, global corporation with membership open to all companies and organizations interested in applying and advancing the state-of-the-art in supply-chain management systems and practices. There are three process levels of SCOR, level-1 process is known as SCOR process and are defined for each element such as a producer or wholesaler in the supply chain [16].

Fig. 1. SCOR Process (*sources: supply chain council.inc. copyright 2016*)

Occurrence and severity matrix is needed to eliminate the risk that has the minor impact. The matrix can be shown in Fig 2.

Fig. 2. Occurrence and severity matrix

The secondary data is the application of House of Risk 1, House of risk phase one is trying to relate a set of requirements (what) and a set of responses (how) where each response could address one or more requirements. The degree of correlation is typically classified as none (and given an equivalent value of 0), low (one), moderate (three), and high (nine). Each requirement has a certain gap to fill and each response would require some types of resources and funds. In HOR 1 calculate the Aggregate Risk Potential (ARP). The formula of ARP is below:

$$ARPj = Oj \sum_i Si\, Rij \qquad (1)$$

where:
Oj: Occurrence {1, 2, 3, 4, 5}
Si: Severity {1, 2, 3, 4, 5}
Rij: Relationship between risk agent and risk event {0, 1, 3, 9}

After making the HOR 1, Pareto analysis, based on the ARP, is run to identify risk priority that should be to mitigate. Then, The HOR 2 is used to determine which actions are to be done first, considering their differing effectiveness as well as resources involved and the degree of difficulties in performing. It needs to calculate the total effectiveness of each action. The formula to calculate the effectiveness is:

$$TEk = \sum_j ARPj\, Ek \qquad (\forall k) \qquad (2)$$

where:
ARP   : Aggregate Risk Priority
Ek   : Relationship between risk agent and preventive action {0, 1, 3, 9}

It needs to calculate the total effectiveness to difficulty, the formula is:

$$ETDk = \frac{TEk}{Dk} \qquad (3)$$

where:
ETDk   : Effectiveness to difficulty ratio
TEk   : Total effectiveness of action k
Dk   : Degree of difficulty performing action k

It chooses the high ETD is the first preventive action that should be doing first.

3 Result and Discussion

Based on data analysis, some results are found:

3.1 Risk Event

Risk event is the risk that may be occurring. Risk event and the severity of the distribution process can be shown in Table 3.

Table 3. Risk event

No	Major Processes	Sub-processes	Risk events	Code	Severity
1	Plan	Scheduling	the emptiness stock on fuel station	E1	5
2	Deliver	Filling	There is oil spill and overflow	E2	3
			fire and explosion	E3	4
			The pulling clutch	E4	3
		Deliver process	Tardiness of deliver	E5	2
			Not delivery fuel oil	E6	3
3	Return	Handling return from customer	tardiness of cross ferry	E7	3

Determining the major process is from SCOR-method then divided into three plans, deliver, and return. Each Sub process has risk event. Risk event was given by code with E1 until E7. The severity has number 1 until 5; it means minor impact until catastrophic impact.

3.2 Risk Agent

Risk agent is the cause of the risk event. It can show the risk agent and occurrence in the distribution process in Table 4.

There are nine identified risk agents. The risk agent gives a code with A code (A1 to A9). Each risk agent has occurrence from 1 to 5. The value of occurrence means very unlikely until very probable. The occurrence rating scale is from the expert by interview.

Table 4. Risk agent

No	Code	Risk Agent	Occurrence
1	A1	The failure of delivering schedule	3
2	A2	Fuel station not deliver stock report actually	2
3	A3	Error deposit via bank and underpayment	2
4	A4	Human Error	2
5	A5	Not implement SOP (Standard Operation Process)	1
6	A6	Traffic accident	3
7	A7	Traffic jam	5
8	A8	Car trouble	3
9	A9	Negligence car tank crew	1

3.3 Occurrence and Severity Code

The occurrence and severity code has aims to determine the matrix of occurrence and severity to gets the minor and major impact. The severity code and occurrence code match to get the new code of E and A for put on the matrix of occurrence and severity. It aims to make a new code to determine the risk in what position - minor or major impact. It gets some code of risk agent and risk events (E1A1 until E7A9). The code can be shown in Table 5.

3.4 Occurrence and Severity Matrix

The occurrence and severity matrix show the minor and major impact. It can be shown in the Fig. 3.

Fig. 3. Occurrence and severity matrix

From the matrix of occurrence and severity, it gets the major impact and minor impact of the risks. It is identified that E5A9 has a minor impact. It needs to eliminate the risk because it only focusses on the risk that has the major and medium impact and immediate mitigation is required.

Table 5. Risk event and risk agent

Code	Severity	Code	Occurrence	Code E and A
E1	5	A1	3	E1A1
		A2	2	E1A2
		A3	2	E1A3
E2	3	A4	3	E2A4
		A5	4	E2A5
E3	4	A4	3	E3A4
		A5	3	E3A5
E4	3	A4	4	E4A4
		A5	3	E4A5
E5	2	A1	3	E5A1
		A2	2	E5A2
		A3	2	E5A3
		A4	3	E5A4
		A6	3	E5A6
		A7	5	E5A7
		A8	3	E5A8
		A9	1	E5A9
E6	3	A3	2	E6A3
		A4	3	E6A4
		A6	3	E6A6
		A8	3	E6A8
		A9	1	E6A9
E7	3	A1	3	E7A1
		A2	2	E7A2
		A3	2	E7A3
		A4	3	E7A4
		A6	3	E7A6
		A8	3	E7A8
		A9	1	E7A9

3.5 House of Risk 1

House of Risk is trying to relate a set of requirements (what) and a set of responses (how) where each response could address one or more requirements. It gives degree correlation such as low (one), moderate (three), and high (nine). Result House of Risk 1 can be shown in Table 6.

Table 6. House of risk 1

No	Risk Event	A1	A2	A3	A4	A5	A6	A7	A8	Si
1	E1	3	3	9						5
2	E2				9	9				3
3	E3				9	9			9	4
4	E4				9	3				3
5	E5	9	3	9	3		9	9	9	2
6	E6			9	3		9		3	3
7	E7	3	1	1	9		3	3	9	3
Oj		3	2	2	2	1	3	5	3	
ARPj		126	48	186	264	72	162	135	270	
Pj		6	9	3	2	7	4	5	1	

ARP (Aggregate Risk Potential) is calculated, the result is shown in Table VI. It indicates the importance of each risk agent. It is the result of the likelihood of occurrence of the risk agent j and the aggregate impacts generated by the risk events caused by the risk agent j.

3.6 Pareto Calculation

Pareto Calculation needed to determine the number of risk agents with high-priority rank based on the ARPj, (from HOR 2). The calculation can be shown in Table 7.

Table 7. Pareto Calculation

Risk Agent	Pj	ARPj	Cumulative ARP	% ARP	Cumulative ARP	
A8	1	270	270	21%	21%	Priority
A4	2	264	534	21%	42%	
A3	3	186	720	15%	57%	
A6	4	162	882	13%	70%	
A7	5	135	1017	11%	81%	non-priority
A1	6	126	1143	10%	90%	
A5	7	72	1215	6%	96%	
A2	8	48	1263	4%	100%	

Based on Table VII. It gets the priority and non-priority risk agent from the Pareto calculation. It calculates the ARP percentage and cumulative ARP. The Cumulative ARP above 80% is not a priority and below 80% is a priority.

Diagram Pareto is used for the show between the ARP and cumulative ARP to know what the immediate mitigation is required. By using 80% cut off based on the value of ARP, four risk agents are identified to be "prioritized risk agent", (Table 7). They are A8 (Car trouble), A4 (Human Error), A3 (Error deposit via bank

and underpayment) and A6 (traffic accident). The diagram Pareto can be shown in Fig.4.
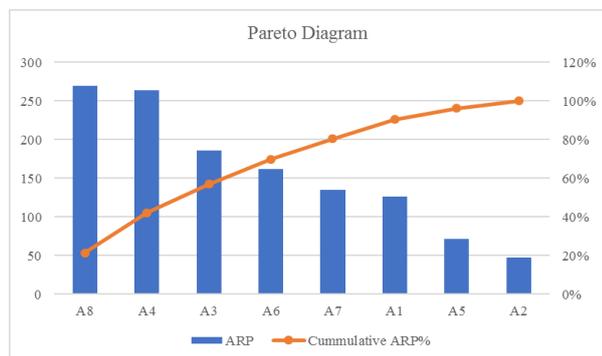

Fig 4. Pareto diagram

From the diagram, it can determine which the risk agent that should be the priority to mitigate. A8, A4, A3, and A6 become the priority that should be needed mitigation. The priority risk can be shown in Table 8.

Table 8. Priority Risk Agent

Risk Agent	ARP	Cumulative	Risk Agent
A8	270	21%	Car trouble
A4	264	21%	Human Error
A3	186	15%	Error deposit via bank and underpayment
A6	162	13%	traffic accident

After Pareto diagram, it has priority risk agent that has the ARP 270, 264, 186, and 162. It becomes the priority to mitigate. Based on risk agent identified, an intensive discussion has been done to identify all possible action to prevent the problem. Nine preventive actions are identified Table 9.

Table 9. Preventive Action

No	Code	Preventive Actions
1	PA1	SOP socialization
2	PA2	Display SOP in the place of activity
3	PA3	Conduct safety talk routine once every three days
4	PA4	Conduct monitoring in the place of activity
5	PA5	Conduct Standard Operating Procedure training
6	PA6	Conduct check car tank routine
7	PA7	Servicing regularly
8	PA8	More communicative to bank and customer
9	PA9	Reexamination of the data existing data

To get effective and efficient action, some important preventive actions will be selected from all possible action. HOR 2 is applied; the result is in Table 10.

Table 10. House of Risk 2

No	Risk Agent	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	ARP
1	A8			9	3	9	9	9			270
2	A4	9	9	9	9	9				1	264
3	A3				1	1			9	9	186
4	A6	9	9	9	1	9	9	9			162
	Total Effectiveness of Action (TEk)	3834	3834	6264	3534	6450	3888	3888	1674	1938	
	Degree of difficulty performing action (DK)	3	3	3	3	4	3	3	3	3	
	Effectiveness to Difficulty Ratio (ETD)	1278	1278	2088	1178	1612,5	1296	1296	558	646	
	Rank priority	5	6	1	7	2	3	4	9	8	

Based on nine preventive actions, a mapping analysis is done by house of risk 2. An expert judgment is applied to give a rating for each relation among risk agent and preventive actions. Based on the calculation of the total effectiveness, degree of the difficulty, effectiveness to difficulty ratio, and rank priority are gained. The priority preventive action to mitigate the selected risk agents can be shown in Table 11.

Table 11. Chosen preventive action

No	Code	Preventive Actions	ETD
1	PA3	Conduct safety talk routine once every three days	2088
2	PA5	Conduct Standard Operating Procedure training	1612,5
3	PA6	Conduct check car tank routine	1296
4	PA7	Servicing regularly	1296
5	PA1	SOP socialization	1278
6	PA2	Display SOP in the place of activity	1278
7	PA4	Conduct monitoring in the place of activity	1178
8	PA9	Examination of the data existing data	646
9	PA8	More communicative to bank and customer	558

The priority preventive action is from Effectiveness to Difficulty (ETD). It gets the preventive action that should

be the priority to mitigate the risk agent. The first priority preventive action is conducting safety talk routine once every three days and followed by conducting Standard Operating Procedure training.

4 Conclusion

Based on the result, the conclusion from this research is:
1. The distribution process of fuel gets 7 risks events and 9 risk agent identifications.
2. From the mapping of house risk 1 gets 5 risk agents that should be used to determine the mitigation. The risk agents are trouble car tank (A8) with ARP 270, human error (A4) with ARP 264, error deposit via bank and underpayment (A3) with ARP 186, and traffic accident (A6) with ARP 162.
3. Based on house of risk 2, two most significant preventive action are conducting safety talk routine once every three days (PA3) with ETD 2088 and conducting Standard Operating Procedure training (PA5) with ETD 1612,5

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