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Risk Mitigation Strategy in the Packaging Box Industry Supply Chain in Batam

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Abstract

Risk is a factor that hinders supply chain operations that cannot be avoided but can be minimized or eliminated by carrying out appropriate risk management. This paper was conducted at a packaging box factory with a make-to-order business system. The purpose of this research is to identify the various risks that occur, analyze the sources of risk and create mitigation strategies. The method used in this research is the House of Risk Model to identify and determine the priority of the handling strategy. There are seven risks that become a priority for mitigation, namely sudden demand, increased demand, dependence on one supplier, supplier lead time too long, delays in delivery schedules, inappropriate alternative supplier selection, and delays in the purchasing process. In this case, the planning and sourcing processes must be improved.

Keyword*: packaging box, mitigation, house of risk, risk*

I. Introduction

Currently supply chain management is no longer considered a new thing for companies. Various companies have implemented supply chain management in their business to improve process efficiency. Supply Chain Management is a pattern that involves distribution activities, production schedules, and delivery.

Various risks that occur in the packaging box factory supply chain are delays in the arrival of the main raw goods, namely paper rolls or printing sheets from suppliers, failures in the production process and delays in delivery of finished goods to consumers. To reduce and overcome the potential emergence of risks in the supply chain, an effort to improve supply chain performance is needed gradually and carried out continuously by overcoming and preventing various risks that have the potential to arise/occur. In connection with the existence of risk in supply chain management, risk management plays an important role to keep the supply chain system from being disrupted. In the supply chain system, risk management plays a very important role because you never know what will happen in the future.

In general, the supply chain risk management process consists of risk identification, risk analysis, risk evaluation and risk mitigation. Risk identification is suggested as a fundamental step in the risk management process [1], [2]. Most of the potential risks not only within the organization, but also between members of the supply network as well as between the supply network and its environment must be identified [3]. Unidentified risks can lead to misdirection in the supply chain risk management process (eg: creation of risk mitigation plans), lead to inappropriate or inappropriate strategies to control these risks and this can lead to greater losses. Supply chain risk can be defined as: the possible damage caused by an event within a company in the supply chain or its environment that causes a negative impact on business processes in more than one company in the supply chain [4]

In this study, a risk analysis was carried out at a packaging box factory with a make to order system. In 1817 the first cardboard boxes were made in England 200 years after the Chinese invented paper, and turned into a revolutionary development in the late nineteenth century. Cardboard packaging was commercially produced in 1839. The principle of lithography was discovered by Alois Senefelder in 1798, was a significant point in the history of packaging design, and progressed further with the development of mass production. Since all packaging from cardboard boxes, crates, bottles, and cans to paper labels, the printed label lithography process was one of the most noteworthy developments of that era. Furthermore, each label or wrapper is printed by hand using a wood press machine on handmade paper.

There are also several names for places/containers:

- Shipping containers made of corrugated fiberboard are sometimes called “carton boxes”, “cartons”, or “boxes”. There are many options for corrugated box designs.
- Folding cardboard made of cardboard is sometimes called a "cardboard box."
- Set-up boxes are made of non-bent cardboard and are sometimes called "cardboard boxes".
- Drink boxes made of laminated cardboard, sometimes called "carton boxes", "cardboard" or "box".

Based on data from the Indonesia Packaging

Federation (2020), the performance of the packaging industry in the country is projected to grow at around 6% in 2020 from last year's realized value of Rp 98.8 trillion. Judging from the material, 44% of the packaging circulating in the form of flexible packaging, 14% rigid plastic packaging, and 28% paperboard packaging.

The purpose of this study is to identify risks and causes of risks that may occur in supply chain activities and determine priority mitigation actions in packaging box factories. Identification of risk and risk sources based on the Supply Chain Operations Reference (SCOR) model consists of five dimensions, namely plan, source, make, deliver and return [5], [2]. The method used in this study is the House of Risk (HOR) with 2 calculation stages. HOR 1 is used for the risk identification, analysis, and evaluation process while HOR 2 is used for risk handling or risk mitigation [6].

The house of risk (HOR) model is a framework which is the development of the FMEA (Failure Mode and Effect Analysis) method and the QFD (Quality Function Deployment) method [7]. Broadly speaking, the stages in this framework are divided into two phases, namely the risk identification phase and the risk treatment phase. The HOR model is based on supply chain risk management, which focuses on preventive measures and reducing the likelihood that risk agents will reoccur. Reducing the occurrence of a risk agent has an effect on several risk events. In such cases, it is necessary to act to identify risk events and the associated risk agents. Usually, one risk agent can cause more than one risk event.

II. Method

This study is an explanatory research, which aims to explain the relationship between risk events, risk agents, and mitigation strategies. This study uses primary data collected and obtained by conducting field studies with the process of collecting data and information directly on the object of research by means of observation, namely studies conducted to obtain data and information related to conditions, strategies, plans, processes and measures and business targets, and in-depth interviews.

House of Risk

Mapping supply chain activities using the Supply Chain Operation Reference (SCOR) model, namely plan, source, make, deliver, and return, then proceed to calculate the value of Aggregate Risk Priority (ARP), determine risk priorities using the House of Risk model phase 1, determine risk mitigation using the House of Risk model phase 2. The stages of House of Risk 1 (HOR 1) are as follows:

1. Identification of the company's business process/supply chain activities based on the SCOR model, namely plan, source, make, deliver, and return. It aims to find out where the risk can arise.
2. Identification of risk events and risk agents for each identified supply chain activity. This risk is an event that may arise during supply chain activities is expressed as Ei (Risk Event)
3. Estimating the impact that will arise if a failure occurs, in this case using a scale of 1 – 10 where 10 indicates an extreme impact. The severity of the risk event is expressed as the Severity of Risk,
4. Identification of risk agents/risk sources that can cause the identified risk events to occur.
5. Calculation of potential risk with the Aggregate Risk Potential of agent which is determined as a result of possible events from the risk source and the collection of impact causes of each risk event caused by the risk source.
6. Ranking the order of risk sources based on the value of the highest Aggregate Risk Potential (ARP);

$$ARP = O_j \sum S.\ R_j \quad (1)$$

Table 1 House of Risk Fase 1

Business Processes	*Risk Event* (Ei)	*Risk Agents* (Aj)							*Severity of Risk Event* i (Si)
		A_1	A_2	A_3	A_4	A_5	A_6	A_7	
Plan	E_1	R11	R12	R13	R14				S1
	E_2								S2
Source	E_3	R21	R22	R23					S3
	E_4								S4
Make	E_5	R31	R32						S5
	E_6								S6
Deliver	E_7	R41							S7
	E_8								S8
Return	E_9								S9
Occurrence of Agent j		O1	O2	O3	O4	O5	O6	O7	
Aggregate Risk Potential j		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority Risk of Agent j									

Source: [8]

House of Risk 2 is used to determine risk management from identified risk sources at the highest level based on the highest ARP value in the House of Risk 1 process. The identified risks are used as input to the House of Risk 2. The stages of HOR phase 2 are as follows: following:

1. Selecting a number of risk sources with high priority rankings that may use the Pareto analysis of ARPj expressed in HOR 2.
2. Identify relevant action considerations for prevention of risk sources. This action is to put in the top row as PAk on HOR 2.
3. Determine the relationship between each preventive action and each risk source, E_{jk}. The values (0, 1, 3, 9) which show no correlation, respectively, are low, medium, and high correlation between measures k and source j. The E_{jk} relationship can be considered as the level of effectiveness of the k action in reducing the likelihood of the occurrence of the risk source.
4. Calculate the total effectiveness of each action as follows:

$$TE_k = \sum_j ARP_j E_{jk} \quad (2)$$

5. Estimate the degree of difficulty in performing each action, Dk and place the values respectively on the bottom row of the effective total. The formula for calculating the total effectiveness on the difficulty ratio.

$$ETD_k = TE_k / D_k \quad (3)$$

6. Ranking the priority of each action (R) where rank 1 gives the meaning of the action with the highest ETD_k.

Table 2 House of Risk Fase 2

Selected risk agent (Aj)	*Preventive Action* (PAk)					ARP_j
	PA_1	PA_2	PA_3	PA_4	PA_5	
A_1	E_{11}					ARP_1
A_2						ARP_2
A_3						ARP_3
A_4						ARP_4
Total effectiveness of actions (*k*)	TE_1	TE_2	TE_3	TE_4	TE_5	
Action difficulty (*k*)	D_1	D_2	D_3	D_4	D_5	
Ratio of total effectiveness to level of difficulty	ETD_1	ETD_2	ETD_3	ETD_4	ETD_5	
Priority ranking	R_1	R_2	R_3	R_4	R_5	

Source: [7]

III. Results and Discussion

3.1. Supply Chain Mapping

The mapping of the company's supply chain activities is required to get a better view of the Supply chain. The supply chain flow within the company begins with an order from the customer, followed by negotiations with the customer. The type of order will be identified whether the order is new or repeated order. If it is new, then the engineer will design the product and PPIC will plan purchasing and ordering raw materials from suppliers. If repeated orders, orders will be identified again whether the product is the same or there is a design change. If there is a design change, then the flow is almost similar to a new order, where the engineer will redesign the product. For old orders, PPIC will carry out purchasing planning and purchasing will make orders for raw materials until the raw materials are delivered to the company. Raw materials will be inspected by incoming QC. If the raw materials received are of poor quality and cannot be repaired, the raw materials will be returned to the supplier. Good quality raw materials will go to the warehouse. Furthermore, the production process will be carried out to produce finished goods. If the resulting product does not meet specifications, the product will be discarded or repaired. If the finished goods are of good quality, then the

product will be stored in the warehouse and will be delivered to the customer. If the goods received by the consumer are defective, the product will be returned to the company and then discarded or repaired. If the quality of the goods is very bad, the company will make the product back and deliver it to the consumer.

3.2. House of Risk Phase 1

3.2.1. Identification of Risk Events

Identification of risk events is carried out using the SCOR method, where activities in the company's supply chain are divided into several sub-activities, namely plan, source, make, deliver, and return. This grouping is done to facilitate the division of activities. The incidence of risk and the weighting of severity values were obtained from interviews / questionnaires conducted. Risk events and severity levels can be seen in table3.

3.2.2 Identification of Risk Agents

Risk agents are things that can cause risk events to occur. One risk agent can cause more than one risk event and one risk event can be caused by more than one risk agent. Identification of risk agents (risk agents) for supply chain packaging box products at the Company is carried out using 4 ME, which are: man (human) which is a risk agent originating from humans, machine & equipment (machinery and equipment) namely risk agent originating from machine or equipment used in the production process, method (method) is a risk agent originating from the implementation method or procedure, material (material or raw material), environment or environment, and demand. The risk agent is assessed for occurrence or the level of chance of occurrence. This assessment is carried out by the fields of PPIC, corrugator, converting, offset, purchasing, and delivery-warehouse. This measurement uses a scale of 1-10 where the higher the number, the risk agent has a greater chance of emergence. The Company's risk agent can be seen in table 4.

Table 3. Supply chain Risk Event

Process	Subprocess	Code	Risk Agent	Severity (Si)
Plan	Production Planning	E1	Error in calculating raw material purchases	10
		E2	Error planning delivery of raw materials	9
		E3	Production scheduling plan error	9
	Inventory Control	E4	Insufficient raw materials required	9
		E5	Expired ink	6
		E6	Insufficient quantity of raw materials with certain specifications (eg ink color A, raffia color B)	8
Source	Receipt of raw materials from suppliers	E7	Late delivery of raw materials from suppliers	8
		E8	Raw materials from supplier do not pass QC	8
		E9	The amount of raw materials received is not as requested	7
		E10	Short Lead time	8
	Return of raw materials to suppliers	E11	The number of defects in raw materials so that they are returned to the supplier	7
		E12	Violation of the contract agreement by the supplier	7
	Supplier Selection	E13	There is no travel letter from the supplier/company	3
		E14	No invoice from supplier/ Company	3
		E15	Late payments to suppliers	2
Make	Production Scheduling	E16	Sudden change in production schedule	1
		E31	Sudden change in production schedule	3
	Production processes	E17	Delays in the production process (BM)	5

		E18	Product size does not match the order	7
		E19	The print on the product does not match the design and color on the model	7
		E20	The stitch machine used is not in accordance with the consumer's wishes (manual/auto)	5
		E21	Production process is hampered	8
		E22	Operator error in machine settings	4
		E23	Engine not operating	9
		E24	There are workers who eat during working hours	5
		E25	The occurrence of work accidents	8
		E26	The stages of the process carried out by workers are not appropriate	2
		E27	Production quantity not according to order	2
		E28	Obstacles binding the product with white rope	2
		E29	The production process is not in accordance with the SOP	4
		E30	Goods fall from forklift	4
		E31	Many product defects so that it becomes baller trash	4
	Finish good Storage	E32	Errors in product storage that cause defects	7
	Delivery process	E33	The number of products sent does not match	8
		E34	The product sent does not match the specifications ordered	8
		E35	Product damage during shipping	7
		E36	Delay in the delivery process	6
		E37	Work accident during delivery	9
		E38	Limited number of trucks in delivery	7
		E39	Product delivery schedule error to customers	8
Return	Returns from customer	E40	Complaints from customers	7
		E41	Product returned by customer	7

Table 4. Supply chain Risk Agent

Code	Risk Agent	Occurrence
Demand		
A1	Sudden demand by consumers	9
A2	Sudden change in demand volume	8
A3	Sudden change in product design	6
A4	Sudden change of delivery request	7
A5	Fluctuating demand	8
A6	The product does not match consumer demand	3
A7	The product does not meet consumer specifications	3
A8	Discontinued request from customer	2
Man		

A9	Operator misread WO	2
A10	Error printing the new WO	1
A11	The wrong worker took the printing die	4
A12	Workers violate company regulations	3
A13	Human error	2
A14	Workers come late	6
A15	Workers don't come during overtime	2
A16	Driver violates traffic rules	5
A17	Workers are indifferent	3
A18	Human resources are not careful	3
Machine & Equipment		
A19	Broken machine (including spare parts)	4
A20	Machine is old	3
A21	Machine productivity varies	3
A22	Machine limitations (inevitable)	3
A23	Problem generator	2
Method		
A24	Lack of worker monitoring	4
A25	Lack of communication and information between departments or between workers	6
A26	Error data from other departments	5
A27	The existing SOPs are less relevant	3
A28	Lack of rolling workers	4
Material		
A29	Scarcity of raw materials	5
A30	Increase in raw material prices	7
A31	Material quality is not good	6
A32	Material quality changed	4
A33	The supplier cannot fulfill the company's request	4
A34	Limited suppliers	3
Environment		
A35	Power outage	3
A36	Natural disaster factor	1
A37	Weather and climate factors	6
A38	Ineffective layout	8
A39	Space limitations	8
A40	Traffic jam	6
A41	A lot of damage to the land route traversed	4
A42	Hazardous events caused by humans (example: demo)	4

I.1. House of Risk Fase 2

I.1.1. Aggregate Risk Potentials (ARP)

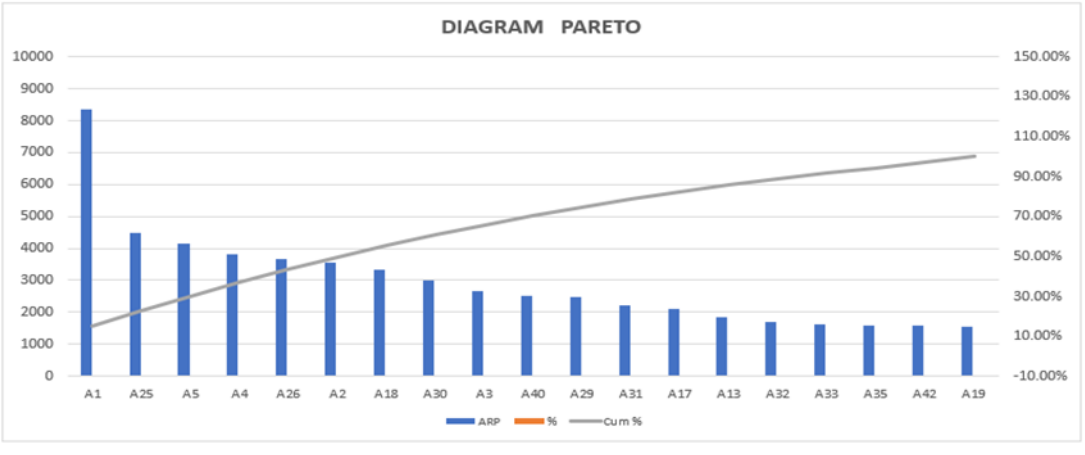
The calculation of the value of the risk priority index (ARP) is used as a consideration for determining the priority of risk management which will later be included in the HOR phase 2. The calculation of the ARP is then prioritized with the highest score. As per below table of the top 20 highest value.

Table 5. Risk Agent Ranking Based on ARP

Rank	Code	Risk Agent	ARP
1	A1	Sudden demand by consumers	8361
2	A25	Lack of communication and information between departments or between workers	4476
3	A5	Fluctuating demand	4160
4	A4	Sudden change of delivery request	3829
5	A26	Error data (such as schedule) from other departments	3665
6	A2	Sudden change in demand volume	3568
7	A18	Human resources are not careful	3330
8	A30	Increase in raw material prices	2989
9	A3	Sudden change in product design	2682
10	A40	Traffic jam	2514
11	A29	Scarcity of raw materials	2475
12	A31	Material quality is not good	2232
13	A17	Workers are indifferent	2094
15	A13	Human error	1858
16	A32	Material quality changed	1680
17	A33	The supplier cannot fulfill the company's request	1636
18	A35	Power outage	1596
19	A42	Hazardous events due to humans (example: demo)	1576
20	A19	Machines are easily damaged (including spare parts)	1564

3.3.2 Identification of Relevant Mitigation Actions (PA_k)

Furthermore, identification of relevant mitigation actions (PA_k) against emerging risk agents is carried out. This stage aims to identify what will be the handling strategies to deal with emerging risk agents.



Gambar 1. Pareto Diagram

Table 6. Risk Mitigation

Code	Risk Mitigation
PA1	Build commitment and communicate effectively with related customers Request
PA2	Evaluation and rescheduling on demand
PA3	Implement a reward and punishment system for workers
PA4	Conduct performance evaluations with inter-departmental or workers
PA5	Improve communication both internally and externally

3.3.3. Calculation of Total Effectiveness of Implementation (ETD_k)

The calculation of the total effectiveness of the implementation shows how effectively the mitigation actions are implemented to deal with risk agents [9]. The calculation of the total effectiveness of the implementation $M(ETD_k)$ of mitigation actions can be seen in below table.

Table 7. Total Application Effectiveness

Risk Agent Code	Mitigation Action (PAk)					ARP
	PA1	PA2	PA3	PA4	PA5	
A1	9	3		1	9	8361
A25			9	9	9	4476
A5	3	3		3	3	4160
TE_k	87729	37563	40284	61125	128013	
D_k	3	4	3	3	3	
ETD_k	29243	9390,75	13428	20375	42671	

3.3.4 Ranking of Total Effectiveness of Implementation (ETD_k)

After calculating, it is necessary to rank the total effectiveness of implementation (ETD_k) to show which mitigation actions are effective in dealing with risks.

Table 8. Ranking of Total Effectiveness of Implementation

Code	Risk Mitigation	ETD_k	Rank
PA1	Build commitment and communicate effectively with related customers Request	29243	2
PA2	Evaluation and rescheduling on demand	9390,75	5
PA3	Implement a reward and punishment system for workers	13428	4
PA4	Conduct performance evaluations with inter-departmental or workers	20375	3
PA5	Improve communication both internally and externally	32003,3	1

IV. Conclusion

Some conclusions that can be drawn are explained as follows:

1. Identified 54 risk events in the Packaging/paperboard Company supply chain activities at Batam area. The risk events in the plan process consist of 6 risk events, the source process consists of 9 risks, the make process consists of 30 risks, the deliver process consists of 7 risks, and the return consists of 2 risks. 43 risk agents were identified where the top three ranks as priority risk agents based on the Aggregate Risk Potential (ARP) value, namely sudden requests by consumers (A1), lack of communication and information between departments or between workers (A25), and fluctuating requests (A5).
2. Three mitigation actions that can be implemented are building commitment and effective communication with customers regarding requests, evaluating and rescheduling requests,

and implementing a reward and punishment system for employees.

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