Supply Chain Risk Mitigation with Supply Risk Management Approach

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Abstract

Risk is often described as an event, a change in circumstances or a consequence. Risk can be addressed and can even be eliminated through risk management. In this study will be done identification of the cause of delay in raw materials until on time in the manufacturing company. During these 2 years the company faced the problem of providing raw materials that are often late, which is a barrier for companies to produce in a timely manner to meet consumer demand, because this problem the company suffered losses, so it is necessary to know the factors that cause delays in the supply of raw materials. The method used in this study is HOR (HOR I, HOR II) by identifying risk events and risk agents. After identification with HOR I risk agent that causes the onset of insulation due to late transportation, delays in procurement of raw materials, dependence on the parent company. To mitigate the risk agent is prepared mitigation strategy (HOR II) that is, making a work contract with the supplier who comes from the parent company to communicate directly with the supplier, procure raw materials 2 weeks - 2 months before needed.

Keywords –
Risk, Delay, Raw Material, Supplier, Mitigation, Hor

1. Introduction

Seeing the number of requests for superior products or also called platinum type products that are high delays in shipping raw materials that occur are very dangerous for the timeliness of the provision of products that consumers expect and result in scheduling the production process is not carried out properly resulting in delays in finished

products reaching consumers. And this problem will pose risks that will harm the company and customers. And the problem faced is solved ad-hoc is considered able to solve the problem, so that the problem faced is only solved when it is not solved continuously.

The parent company, called the headquarters, serves a branch company. The head office supplies 80% of raw materials, while 20% of raw materials are obtained through suppliers from outside the company. Procurement of raw materials branch offices from outside suppliers is carried out in a centralized manner, by opening product orders (PO) to suppliers and sending raw materials to branches, while for suppliers from abroad, for example from Japan, Germany and China directly send raw materials to branch offices, while for local suppliers, namely from Jakarta, Bogor raw materials are sent to head office, Then the parent company continues to the branch office (Goerlandt and Montewka, 2015).

Branch offices only calculate the needs of raw materials based on consumer demand and for stock needs, then schedule the use of raw materials in accordance with production, then make PO to the head office (Ntwali et al.,2020). Except for local suppliers, branch offices are allowed to directly open PO for ordering raw materials such as wood, cloth, and Dacron. Based on the initial interview, it can be concluded the flow of Supply Chain Ordering raw materials from upstream to downstream can be seen in The Picture. Here:

Complexity of the flow of raw materials, causing disruptions such as: (1). Delays in raw materials, this is caused by the procedure of ordering raw materials from the head office, then forwarded to suppliers and head offices that open PO to suppliers, thus posing a risk of delays in raw materials arriving at the factory when needed. (2.) The occurrence of raw material delivery errors, due to the number of branch companies that must be served by the head office. (3) Lack of communication between the center and branch, as well as communication in each company line, such as logistics that does not regulate and maintain the availability of raw materials while the production part does not actively inform the number of raw materials needed, this often leads to a shortage of raw materials when the product will be produced (Leiss and Krewski, 2019).

To ensure the smooth supply chain of production raw materials, there must be efforts to anticipate or reduce these disruptions, which can hamper activities and risks in the supply chain (Birungi and Muthoni, 2021). This research is focused on the main product (platinum product) because this product is the highest level of demand, but raw materials are often not met due to supply chain problems that are not on time, it is necessary to do the design of supply chain risk mitigation to reduce losses caused by poor supply chain management systems.

Based on the background of the problems described above, the problem that will be solved in this study is the delay in the operation of the Supply Chain of raw materials, which resulted in the failure of normal fulfillment of raw materials, in connection with which it takes efforts to overcome it by finding:

(1) What factors cause delays, inaccuracies in the amount of raw material supply. (2) How to minimize delays, inaccuracies in the amount of raw material supply. (3) How the design of mitigation delays, inaccuracies in the amount of raw material supply (Larkin et all., 2019)

2. Literature Review

2.1. Definition of Supply Chain Management

Supply chain management is one of the concepts to respond to supply chain problems. Supply chain management emphasizes an integrated pattern regarding the process of product flow from suppliers, manufacturers, retailers to the end consumer. In the concept of supply chain management wants to be shown that the series of activities between suppliers to the end consumer in one unit without a large bulkhead. The mechanism of information between these various components takes place transparently. Supply chain management is a concept that concerns product distribution patterns that can replace traditional product distribution patterns. This new pattern concerns distribution activities, production schedules, and logistics (Duramany-Lakkoh, 2021). There are also those who say that supply chain management is a method of product creation to be delivered to the end user, in which it is covered by various components, namely: "the supplier of raw materials, the manufacturing units, warehouses, transporters, retailers, and finally selling". (Simchi-levi at all, 2003) From the definition it can be concluded that the focus of SCM is the synchronization of processes for customer satisfaction. All supply chains essentially compete with customers of the products or services offered. All parties in one supply chain must cooperate with each other as much as possible to improve services at low prices, quality, and precisely delivery. Competition in the context of SCM is competition between chains, not between individual companies.

The downside of traditional adversarial practice is the focus of measures of success and activity on small parts of the supply chain that are often opposite to the goal of improving customer or end-customer service. Supply chain management is a series of approaches applied to integrate suppliers, entrepreneurs, warehouses, and other storage sites efficiently so that products are produced and distributed with the right quantity, right location and timely to minimize costs and satisfy customer needs[7]. 7Leiss, 2019 Designing and implementing an optimal supply chain globally is quite difficult due to its dynamism and conflict of objectives between facilities and partners. The supply chain concept is a new concept in looking at logistics issues. The old concept is more looking at logistics as an internal problem of each company and the solution is focused on solving internally in their respective companies. In this new concept, logistics problems are seen as broader problems that stretch very long from basic materials to finished goods used by the end consumer, which is the link of supplying goods (Aven, 2016).

In the supply chain there are usually 3 types of streams that must be managed. The first is the flow of goods that flow from upstream to downstream. Both streams of money flow from downstream to upstream. Third is the flow of information that occurs from upstream to downstream or vice versa (Larkin et all, 2019). Supply chain management is not only oriented to the internal affairs of the company, but also external affairs that concern relationships with partner companies.

2.2. Supply Chain Risk Management.

Supply chain risk management (SCRM) or supply chain risk management can be defined as a reflection of the discipline of a professional in which they are in the supply chain. In the information technology space, the National Institute for Standards and Technology defines supply chain risk management as a multidisciplinary practice with several interconnected enterprise processes that, when done correctly, will help departments and agencies manage risk using information technology products and services. MITRE, a company that provides engineering and technical services to the federal government, defines SCRM as a discipline that addresses the threats and vulnerabilities of commercially obtained information and communications technologies within and used by government information and weapons systems (Larkin et all., 2019). Through SCRM, system engineers can minimize risks to systems and components obtained from sources that are not trusted or identified as low materials and components.

Supply Chain Risk Management (SCRM) is the implementation of strategies to manage outstanding risks along the supply chain through continuous risk assessment with the aim of reducing vulnerability and ensuring sustainability. One way to look at supply chain risk management is to think of it as a junction between supply chain management and risk management. One thing we know about SCRM is that there is no standardized definition. This is one indicator that SCRM is a still-evolving discipline (Schlegel and Trent, 2015).

2.3. Basic Principles of Risk Management.

Risk management began to be introduced in the field of occupational safety and health in the 1980s after the development of accident model theory and the increasingly rampant environmental and health issues. Risk management aims to minimize losses and increase opportunities or opportunities. When viewed the occurrence of losses with the accident model theory, then risk management can cut the chain of events of the loss, so that the domino effect will not occur. Basically, risk management is preventive against loss or 'accident'. Something is meant by risk, especially since this concept can be defined in a variety of ways (Larkin et all., 2019). One common perspective simply says that risk is a situation that involves exposure to danger or loss.

Another perspective takes it a step further by adding that risk is the probability or threat of damage, injury, liability, loss, or other negative events caused by external or internal vulnerabilities and which can be avoided through preventive measures. Another view holds that risk is the effect of uncertainty on goals. Risk can also be seen, at least in part, as an inability to seize the opportunity. For our purposes, we define risk as the possible realization of unintended or unintended consequences that lead to undesirable outcomes such as loss, injury, damage, or missed opportunity (Schlegel and Trent, 2015). Most risk watchers believe that when risk comes true, something bad usually happens. Not surprisingly, supply chain managers almost always see risk as something to avoid. Instead, employers see risk through a different lens. They see risk in terms of upside-down opportunities and missed opportunities when they fail to act. For people, creative risk taking is important for any goal that has high stakes on the company. An officially defined risk event is a special event that negatively affects a decision, plan, company or organization.

2.3.1. Scope of risk management process

The scope of the risk management process consists of: a. Determination of the context of the activities to be managed risk b. Identify risks, c. Risk analysis d. Risk evaluation, e. Risk control, f. Monitoring and review, g. Coordination and communication. The implementation of risk management must be an integral part of the implementation of the company / organization system. This risk management process is one of the steps that can be done to create continuous improvement. The risk management process is also often associated with the decision-making process within an organization. Risk management is a method that is logically and systematically organized from a series of activities: context determination, identification, analysis, evaluation, control, and risk communication. This process can be applied at all levels of activities, positions, projects, products, or assets[10]. Risk management can provide optimal benefits if applied from the beginning of the activity. However, risk management is often carried out at the stage of implementation or operational activities.

There are four main prerequisites of risk management, namely:

a. Executive Risk Management Policy, the organization must be able to define and prove the truth of its risk management policies, including its objectives for what, and its commitments. Risk management policies should be relevant to the context of the organization's strategy and objectives, objective and in accordance with the nature of the business (organization). Management will ensure that the policy is understandable, implementable at every level of the organization.

b. Planning and Managing Results:

1) Management commitment the organization must be able to ensure that:

- The risk management system has been implemented, and is in accordance with the standards
- The results/performance of the risk management system are reported to the organization's management, so that they can be used in review and as a basis for decision making.

2) Responsibility and authority; Responsibilities, powers and relationships between members that can demonstrate and distinguish work functions in risk management must be documented for the following:

- Preventive measures or reduction of the effects of risk.
- Controls that will be carried out so that risk factors remain at acceptable limits.
- Recording of factors related to risk management activities.
- Solution recommendations in a predetermined manner.
- Check the validity of the implementation of existing solutions.
- Communication and consultation internally and externally.

3) Human Resources; The organization must be able to identify the necessary human resource (HR) competency requirements. Therefore, to improve HR qualifications it is necessary to follow trainings relevant to his job such as managerial training, and so on.

c. Program Implementation. A number of steps need to be taken so that the implementation of a risk management system can run effectively in an organization. The steps to be taken depend on the philosophy, culture and structure of the organization.

d. Management Review. A review of the risk management system at a specific stage, should be able to ensure the conformity of risk management activities that are being carried out with the standards used and with the following stages. Risk management is an integral part of process management. Risk management is part of the process of activities in the organization and its implementation consists of scientific discipline and background, risk management is a process that runs continuously.

Key elements of the risk management process, as seen in the image include:

1) Setting goals; Establish the strategy, policy of the organization and the scope of risk management to be carried out.

2) Identify risks; Identify what, why and how factors influence the occurrence of risk for further analysis.

3) Risk analysis; This is done by determining the level of probability and consequences that will occur. Then determine the level of risk that exists by multiplying the two variables (probability X consequences).

4) Risk evaluation; Compare the level of risk with standard criteria. After that the level of risk that exists for some hazards is made the level of management priority. If the level of risk is set low, then the risk falls into an acceptable category and may only require monitoring without having to exercise control.

5) Risk control; Decrease the degree of probability and consequences that exist by using various alternative methods, can be by risk transfer, and others.

6) Monitor and Review; Monitor and review the results of the risk management system and identify changes that need to be made.

7) Communication and consultation; Communication and consultation with internal and external decision makers for follow-up of risk management results undertaken.

8) Risk management can be applied at any level of the organization. Risk management can be applied at strategic and operational levels. Risk management can also be applied to specific projects, to assist the decision-making process or to the management of areas with specific risks.

Some important terms in risk management, following:

a. Consequences, namely a result of events expressed qualitatively or quantitatively, in the form of loss, illness, injury, adverse or favorable circumstances. It can also be a range of consequences that may occur and relate to an event.
b. Cost, i.e. an activity, both direct and indirect, includes a variety of negative impacts, including money, time, labor, disruption, good name, politics and other losses that are not clearly stated.
c. An event, is an event (incident) or situation, that occurs at a particular place during a certain time interval
d. Analysis of Sequence of Events, a technique that describes the range of possibilities and the series of consequences that can arise from the process of an event.
e. Error Sequence Analysis, a method of system engineering to show logical combinations of various system states and possible causes that could contribute to a particular event (called a peak event).
f. Frequency is a measure of the number of events of an event that is expressed as the number of events of an event in each time. It also looks like a possibility and an opportunity.
g. Hazard is an intrinsic factor that is attached to something and has the potential to cause harm.
h. Monitoring is the critical checking, monitoring, observation, or recording of the progress of an activity, action, or system to identify changes that may occur.
i. Probability, used as a qualitative picture of chance or frequency. The probability of a specific event or outcome, measured by the ratio of a specific event or outcome to the number of possible events or outcomes. Probability is denoted by numbers from 0 and 1, with 0 signifying an unlikely event or outcome and 1 signifying a definite event or outcome.
j. Risk Follow-up, the level of risk that still exists after risk management is done.
k. Risk is the opportunity for something to happen that will have an impact on the target. This is measured by the law of causation. The variables measured are usually probabilities, consequences and problem solving.
l. Acceptable risk, the decision to accept certain consequences and possible risks.
m. Risk analysis, a systematic that uses the information obtained to determine how often certain events can occur and the magnitude of those consequences.
n. Risk assessment, risk analysis process and overall risk evaluation.
o. Risk aversion: Informed decisions do not become involved in risk situations.
p. Risk control, the part of risk management that involves implementing policies, standards, physical change procedures to eliminate or mitigate risks.
q. Risk evaluation. A commonly used process for determining risk management by comparing the level of risk against predefined standards, risk level targets and other criteria.
r. Risk Identification, the process of determining what can happen, why and how.
s. Risk reduction is the selective use of management principles and techniques to reduce the likelihood of an event or its consequences, or both.
t. Risk transfer, Delegate or transfer a loss burden to another group / section through legal channels, agreements / contracts, insurance, and others. Risk transfer refers to the transfer of physical risk and its parts to another place.

Some companies will use the term risk mitigation to describe almost everything done in the name of risk management, including precautions. By the most basic definition risk mitigation is to reduce the impact of something." Something" could be the effect of a risk event such as a fire on a supplier or a supply chain quality issue. In a broader sense, mitigation can also be defined because of actions taken either to reduce the likelihood of risks occurring or minimize the extent of the impact.

2.4. Model SCOR (Supply Chain Operations Reference)

The SCOR model is a way for a company to communicate a framework that describes the supply chain in detail, defines, and categorizes the processes that build a supply chain. In addition, the SCOR model also builds the measurement metrics needed in the measurement of supply chain quality (Klapper and Vivar, 1999). The application of the SCOR method to supply chain management provides thorough observation and measurement of supply chain

processes. Supply Chain Operations Reference (SCOR) is a model designed by the Supply Chain Council (SCC). In this case there are several versions in SCOR. Currently SCC has issued SCOR model version 10.0 . The SCOR model is one of the models of supply chain operations, which is essentially a process-based model. This model integrates three main elements in management, namely business process reengineering (BPR), benchmarking, and best practice analysis (BPA) into the cross-supply chain framework. SCOR divides supply chain processes into five core processes: plan, source, make, deliver, return. SCOR has three levels of process from common to detailed. SCC was founded in 1996 and was initiated by organizations such as Bayer, Compaq, Procter & Gamble, Lockheed Martin, Nortel, Rockwell Semiconductor, Texas Instruments, 3M, Cargill, Pittglio, Rabin, Todd &McGrath (PRTM), and AMR (Advanced Manufacturing Research) consisting of 69 volunteers consisting of industry practitioners and researchers (Bolstorff, 2003). The advantage of the SCOR model as a Process Reference Model (PRM) is its ability to integrate Business Process Reengineering (BPR), benchmarking and Best Practice Analyze (BPA) into the supply chain framework.

According to the Supply Chain Council (2010), there are 4 levels of SCOR version 10.0 mapping stages, namely:

a. Level 1 defines the scope and content of the SCOR model.
b. Level 2 is the configuration stage.
c. Level 3 is the decomposition stage of processes that exist in the supply chain into elements that define a company's ability to compete.
d. Level 4 is an implementation phase that maps specific implementation programs and defines behaviors to achieve competitive advantages and adapt to changing business conditions.

SCOR is a reference model of supply chain operations. As with the framework described in the previous section, SCOR is essentially also a process-based model. This model integrates three main elements in management, namely business process reengineering, benchmarking, and measurement process into a cross-functional framework in the supply chain (Pujawan, 2005). These three elements have the following functions:

1) Business process reengineering essentially captures the complex processes that are happening today (as is) and defines the desired process (to be).
2) Benchmarking is an activity to obtain operational performance data from similar companies. Internal targets are then determined based on the best-in-class performance obtained.
3) Process measurement serves to measure, control, and improve supply chain processes.

2.4.1. Process in SCOR

As shown in the figure, SCOR divides the supply chain process into 5 core processes namely plan, source, make, deliver, and return. The five processes work as described, namely:

a. Plan is a process that balances demand and supply to determine the best course of action in meeting procurement, production, and delivery needs. The plan includes the process of assessing distribution needs, planning, and controlling inventory, production planning, material planning, capacity planning, and adjusting supply chain plan with the financial plan.
b. Source, which is the process of procuring goods and services to meet demand. The processes covered include scheduling shipments from suppliers, receiving, checking, and authorizing payments for goods shipped by suppliers, selecting suppliers, evaluating supplier performance, and so on. The type of process can differ depending on whether the item purchased includes stocked, make to order, or engineer to order products.
c. Make, which are processes related to the process of transforming raw materials into semi-finished products to meet existing demand.
d. Deliver, which are processes related to the supply of finished goods, including transportation management, warehouses that are all to meet consumer demand
e. Return, which is the processes related to the process of returning products for certain reasons, for example because the product does not match consumer demand, and so forth. In SCOR the model is divided into levels to perform its quality. In level one score model appears every aspect that will be measured, such as reliability, responsiveness, flexibility, cost and assets. From each of these aspects, there are measurement matrices to be measured. The examples of matrices in the SCOR model method are as follows:

1) Aspects of Reliability

- Delivery performance, which is the number of products received on time
- Inventory Inaccuracy, which is the amount of storage between the physical amount of inventory in the warehouse and existing records / documentation

- Defect Rate, which is the rate of return of defective material returned to the supplier.

2) Aspects of Responsiveness

- Planning Cycle Time, which is the time it takes to compile a production schedule
- Source Item Responsiveness, which is the time it takes the supplier to meet the needs of the company in the event of an increase in the number of certain types of materials from the initial demand of an order.

3) Aspects of Flexibility

- Minimum order quantity, which is the minimum number of units that can be fulfilled by the supplier in each order.
- Make Volume Flexibility, which is the percentage increase that can be met by production within a certain period.

4) Aspects of Cost

- Defect cost, which is the cost used to replace defective products.
- Machine Maintenance Cost, which is the cost of maintenance of industrial machinery.

5). Aspects of Assets:

The form of the supply chain described by the SCOR model is:

a. Payment Term, which is the average time difference between material requests and payment time to suppliers.
b. Cash-To-Cash Cycle Time, which is the time from the company spends money on material purchases until the company receives payment money from consumers. Level two of SCOR, illustrated about the company's Mapping Supply Chain to be measured in quality. As for level three, each component will be in Mapping level two in Breakdown to get a detail of these components. At level three, the parameters of each matrix and component have begun.

2.5. Model House of Risk

This model is based on the idea that proactive supply chain risk management should strive to focus on preventive measures, i.e., reducing the likelihood of risk agents occurring. Reducing the occurrence of risk agents will usually prevent some risk events from occurring. In such cases, it is necessary to identify the risk events and associated risk agents. Typically, one risk agent can cause more than one risk event. For example, problems in a supplier's production system can result in material shortages and increased rejects where the latter is due to switching to other suppliers.

In the FMEA model, risk assessment is done through calculations of the Risk Priority Number (RPN) as a product of three factors, namely probability of occurrence (occurrence), severity of impact (severity), and detection (detection). Unlike in the FMEA model where the probability of an event (occurrence) and severity (severity) is related to the risk event (risk event), in this model the probability of occurrence (occurrence) for the risk agent (risk agent) and the severity (severity) for the risk event (Pujawan and Geraldine, 2009).

Because one risk agent can induce several risk events, it is necessary to quantity the aggregate risk potential (Agregate Risk Potential) of the risk agent. If Oj is the probability of the occurrence of risk agent j, Si is the severity of the impact if the risk event i occurs, and Rij is the correlation between risk agent j and risk event i (which is interpreted as how likely risk agent j will drive risk event i) then ARPj (potential aggregate risk agent risk j) can be calculated as follows: Adjustment of the House of Quality (HOQ) model to determine the risk agent should be given priority for preventive action. Rank A is assigned to each risk agent based on the magnitude of the ARPj value for each j. Therefore, if there are many risk agents, the company can choose one of several risk agents that have great potential to induce a risk event. For that there are two models called House of Risk (HOR) which are based on modified HOQ, namely:

a. Hor1 is used to determine which risk agents should be given priority for preventive measures.
b. HOR2 to give priority to actions that are considered effective but with reasonable financial and resource commitment.

2.5.1. House of Risk I

In a risk model (HOR), we relate to a set of requirements (what) and a set of responses (how) in which each response can address one or more requirements. Relationship levels are usually classified as non-existent (and are rated equivalent to 0), low (one), medium (three), and high (nine). Each requirement has certain gaps to fill and each response will require some type of resources and funds. Adopting the above procedure, HOR I was developed through the following steps (Pujawan and Geraldine 2009):

a. Identify the risk events that can occur in any business process. This can be done through the process of mapping the supply chain (plan, source, make, deliver, and return) and then identifying "what can go wrong" in each of those processes.

b. Assess the severity of a risk event (if it occurs) on a scale of 1-10 where 10 represents very severe. The severity of each risk event is entered into the right column and indicated as Si.

c. Identify risk agents and assess the likelihood of each risk agent happening. Here, a scale of 1-10 is also applied where 1 means it almost never happens and a value of 10 means it almost certainly happens. The risk agents (Aj) are placed on the top row of the table and the associated occurrence is in the bottom row, notated as Oj.

d. Develops a relationship matrix, i.e., the relationship between each risk agent and each risk event, Rij {0, 1, 3, 9} where 0 represents no correlation and 1, 3, and 9 represent, respectively, low, medium, and high correlation.

e. Calculate the aggregate risk potential of agent j (ARPj) specified as the product of the possible occurrence of j risk agent and the aggregate impact generated by the risk event caused by j risk agent as in the equation described.

f. Rank risk agents according to their aggregate risk potential in descending order (from large to low value). Hor I images can be seen in this image:

2.5.2. House of Risk II

HORII is used to determine the actions to be taken first, given their different effectiveness as well as the resources involved and the level of difficulty in performing. Companies ideally choose a series of actions that are not so difficult to do but can effectively reduce the likelihood of risk agents occurring. The steps are as follows (Pujawan and Geraldine, 2009):

a. Select several risk agents with high priority ratings, perhaps using Pareto analysis or ARP j values, which will be discussed in the second HOR. The selected risk agent will be placed as "what" on the left side of hor2 as depicted in the image. Place the corresponding ARP j values in the right column.

b. Identify actions deemed relevant to prevent risk agents. Note that one risk agent can be handled with more than one action and one action simultaneously can reduce the likelihood of more than one risk agent happening. The action is put on the top row as a "how" for this HOR.

c. Determine the relationship between each precaution and each risk agent, Ejk. Values can be {0, 1, 3, 9} representing each, nothing, low, medium, and high relationship between action k and agent j. This relationship (Ejk) can be considered as the level of effectiveness of action k in reducing the likelihood of agent risk.

d. Calculate the total effectiveness of each action as follows: TTEk= ∑iARPJ. EJK ∀k

e. Value the degree of difficulty in performing each action, Dk, and place successive values below overall effectiveness. The level of difficulty, which can be represented by a scale (such as a Likert or another scale), should reflect the funds and other resources needed in performing its action.

Calculate the total effectiveness against difficulty, namely ETDk = TEk /Dk. g. Set a priority rating for each action (Rk) where rank 1 is given to the action with the highest ETDk. Hor II images can be seen in the image.

3. Methodology

Data Collection, including

a. Mapping the Company's Supply Chain Activities. The first thing which should be done was the risk mapping of supply chain activities based on the SCOR (Supply Chain Operation Reference) model, mapping this activity was done by interview in the Company. Here is an image mapping supply chain activity, and a description of supply chain activity.

Here is a description of activities that contain risks in the supply chain in branch offices:

1. Plan, the process of estimating distribution needs, material planning, capacity planning, inventory control, and production planning. Activities included in the plan are: 1) Demand forecasting, 2) Production planning, 3) Shipping planning

2. Source, source activities are scheduling shipments from suppliers, selecting suppliers, evaluating supplier work, which includes source activities are: 1) Procurement of materials, 2) Receipt of materials, 3) Storage of materials

3. Make, is the process of transforming raw materials into products, activities that include make are: 1) Production process, 2) Checking / quality control, 3) Packaging products

4. Deliver, is a process related to the supply of finished goods, which includes deliver activities are: 1) Warehouse, 2) Delivery of products

5. Return, is the process of returning products for a reason, which includes return activities are: 1) Return of products from consumers, 2) Return of materials to suppliers

b. Risk identification is a stage that aims to find out the occurrence of risk events that interfere with the company's supply chain activities and to find out the risk agent (risk agent) that causes the risk event to occur. Identification is done through interviews at the company to factory heads and employees.

4. Result And Discussion

A risk event is an event that interferes with the company's supply chain activities. Data about risk events is coded with the letter E, to make it easier to read. The risk event that occurs and its severity (severity) in the company can be seen in the table 1.

Table 1. Risk Event and Severity

Process	Sub Process	Risk Event (*Ej*)		*Severity*
Plan	Demand Forecasting	Forecasting error	E1	5
		Distortion of request information	E2	2
	Planning	Sudden change of production schedule	E3	5
	Production	Production schedule delayed	E4	6
	Inventory control material	Error in stock count	E5	3
		Insufficient stock of raw materials	E6	3
		Delay in issuing PO	E7	7
	Purchasing process	Delay in receiving goods from suppliers	E8	6
		Material does not meet specifications	E9	7
Source		The amount of material does not match the order	E10	8
		Poor communication system with center	E11	5
	Supplier			
		The supplier cannot fulfill the order	E12	6
Make	Production process	Machine breakdown	E13	3
		Worker fatigue	E14	5
		Material can't be used anymore	E15	3
		Stacking of elements on the workstation	E16	2
	Packaging process	Packaging is not up to standard/damaged	E17	5
Deliver	Election shipping	Boat capacity is reduced due to high season	E18	4
		Ship documents not accepted	E19	6
		The ship is late in arriving at the port	E20	8
	warehouse	Material stuck in port	E21	8
	Delivery of products to customers		E22	7

Return	Defective product returns	Late delivery	E23	6
		The product does not meet the standard/defect	E24	3

This severity value states how much disruption is caused by an event risk to the company's business processes. Severity is measured based on the impact that occurs, this impact is a definite value that is usually converted in financial losses. The severity of the severity of the severity can be seen in the table 2.

Table 2. Severity Score

Level	*Severity*	Information
1	*No*	Does not cause disturbance
2	*Very Slight*	Risk of causing very little disturbance
3	*Slight*	Risk of causing less disruption
4	*Minor*	Risk of causing minor disturbance
5	*Moderate*	Moderate risk of causing disturbance
6	*Significant*	The risk of causing a big disturbance
7	*Major*	The risk of causing a huge disturbance
8	*Extreme*	Risk of causing very severe disturbance
9	*Serious*	Risk of causing serious disturbance
10	*Hazardous*	Risk of causing harmful interference

b. Risk Analysis

The action after identifying the risk event is to identify the cause of the onset of the risk and provide an assessment of the cause of the occurrence of the risk, which is done through a questionnaire filled by the factory manager.
Here's the table 3 is the table of meaning of occurrence levels in questionnaires, and occurrence tables / frequency levels of emergence of risk agents to cause a risk event .in table 4.

Table 3. Occurrence Risk Agent Score

level	***Occurance***	**Information**
1	*Almost never*	The emergence of risk causes is almost non-existent
2	*Remote*	The occurrence of risk causes is very rare
3	*Very slight*	The occurrence of risk causes is very few
4	*Slight*	Occurrence of the cause of the risk is little
5	*Low*	Occurrence of low-risk causes
6	*Medium*	The emergence of moderate risk causes
7	*Moderately*	The occurrence of risk causes is quite high
8	*High*	The emergence of high-risk causes
9	*Very High*	The occurrence of causes of very high risk
10	*Almost certain*	The occurrence of risk causes almost always occurs

Table 4. Identification of Risk Causes and Occurrence Value

Code	***risk agent***	***occurrence***

A1	Forecasting that is much different from reality	7
A2	A sudden request	5
A3	Material needs in large quantities	5
A4	Delay in procurement of goods	7
A5	There is no clear long-term plan	7
A6	Error sending the amount of material by the supplier	7
A7	Poor internal/external communication system	8
A8	Dependence on the center (headquarter offices)	8
A9	Insufficient Human Resources	7
A10	Error in machine setup/human error	6
A11	There is no great sense of responsibility from each employee towards his work	8
A12	Poor coordination system	7
A13	PO changes that are not properly monitored	5
A14	Changing port regulations	6
A15	Arrival of the ship that is not on time	7
A16	The complexity of the port bureaucracy	6

Risk Assessment Analysis

Through data collection and data processing that has been done, in getting the 6 largest values of risk agents / risk causes that can be seen in the following table 5.

Table 5. The Highest Risk Agent

Level	Risk Agent	Risk Agent	ARP
1	A15	Arrival of the ship that is not on time	1.272
2	A4	Delay in procurement of goods	1.029
3	A16	The complexity of the port bureaucracy	900
4	A8	Dependence on parent company	720
5	A6	Error sending the amount of material by the supplier	714
6	A11	The low sense of responsibility for each employee towards his work	648

Source: Data processing

At the stage of mitigation design / design for the strategic level, what is meant here is a mitigation design designed to reduce the impact of a risk agent that can be done before risk occurs. This mitigation design is in the form of readiness of a plan for the preparation of preventing and risk reduction actions in the long term. The type of mitigation strategy design used is proactive strategy, which is a strategy for risk mitigation caused by risk agents A15, A4, A16, A8, A6, and A11. The mitigation design strategy table can be seen in table 6 below:

Table 6 Mitigation Design Strategy Based on HOR II

Handling Risk	Risk Mitigation Design	*Risk Agent*	ETD*k*	Priority Rank

PA2	Ordering raw materials long before raw materials are needed (2 months before materials are needed)	A4	6.903	1
PA1	Multiple routes, looking for alternative routes for material delivery modes	A15	2.829	2
PA4	Make work contracts with suppliers from the parent company to communicate directly with suppliers.	A8	2.581	3
PA5	Request firm action from the center for supplier negligence (make an MOU), ask the center to check before sending to the branch	A6	2.146	4
PA3	Strengthening relationships with port people, preparing complete documents	A16	2.025	5
PA6	Provide rewards, punishments for employees	A11	1.944	6
PA7	Provide work motivation to employees	A11	1.458	7
PA8	Recruitment of HR that is more qualified and has a good socialist mentality	A11	1.166,4	8

Source: Data processing

Based on the data processing that has been done before, namely the results of data processing using HOR II, the mitigation design analysis that will be carried out on the company is:

1. Order raw materials long before raw materials are needed (2 months before materials are needed).

During this time the company is often late to receive raw materials from suppliers, resulting in a production schedule retreat and unable to meet customer demand appropriately, and this is very detrimental. To overcome this, the way to order raw materials is 2 weeks - 2 months before the proper booking schedule. To be able to realize this mitigation action, it takes the coordinator to bear the procedures for implementing this mitigation action, namely the head of logistics / logistics manager in the company.

2. *Multiple route*

The company's main raw material supplier is the existing holding company in Bogor and the company supplies almost 80% of the raw materials from the parent company by sea, and this adds to the long time raw materials arrive at the company, especially for chemical raw materials for the manufacture of foams that are compressed by the center from abroad (Germany, Japan) for it is needed a more efficient and fast alternative path, Such as relying on air lines that are expected to be able to reduce the waiting time of raw materials to arrive at the company. Create a work contract with the supplier who comes from the parent company in order to communicate directly with the supplier.

5. Conclusion

Experiencing several problems in running its business, one of these problems is the provision of raw materials that are experiencing delays, this problem experienced by the company for the last 2 years and becomes a barrier for the company to produce products in a timely manner to meet consumer demand. Based on the results shown data processing and analysis of discussions that have been done before providing some conclusions as follows:

1. By using the SCOR model in mapping supply chain activities there are 24 risk events and 16 causes of risk (risk agent) identified during the company's business activities, as well as causing losses.
2. The results of calculations using the House of Risk found 6 risk factors (risk agents) that resulted in late reaching the factory, which are meant by these factors are:
   a. The arrival of the ship is not on time.
   b. Delay in raw material order schedule
   c. The complexity of port bureaucracy
   d. Dependence on the parent company
   e. Error of delivery of the amount of material by the supplier
   f. Low sense of responsibility in employees towards their work

Based on the results of data processing with HOR II, the actions needed for correction action (mitigation design) to avoid the onset of the risk of delay in raw materials, and errors in the number of raw materials are:

a. Multiple routes, looking for alternative routes of material delivery modes
b. Ordering raw materials long before raw materials are needed
c. Strengthening relations with the port, preparing complete documents to facilitate loading, and unloading activities at the port.
d. Create a contract of employment with the supplier who comes from the parent company to communicate directly with the supplier.
e. Request firmness to the parent company for supplier negligence
f. Reward, punishment for employees
g. Conduct continuous briefings every morning before starting operations at the company
h. Recruitment of quality HUMAN RESOURCES

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References

Aven, T., 2016. "Risk assessment and risk management: Review of recent advances on their foundation," *Eur. J. Oper. Res.*, vol. 253, no. 1, pp. 1–13, 2016, doi: 10.1016/j.ejor.2015.12.023.

Birungi, C., L. Muthoni, 2021. "Analysis of Risk Measures in Portfolio Optimization for the Uganda Securities Exchange," *J. Financ. Risk Manag.*, vol. 10, no. 02, pp. 135–152, doi: 10.4236/jfrm.2021.102008.

Duramany-Lakkoh, E.K., 2021. "Measuring Financial Performance for the Sustainability of Microfinance Institutions in Sierra Leone before the Ebola Outbreak," *J. Financ. Risk Manag.*, vol. 10, no. 03, pp. 274–297, doi: 10.4236/jfrm.2021.103016.

Goerlandt, F., J. Montewka, 2015. "Maritime transportation risk analysis: Review and analysis in light of some foundational issues," *Reliab. Eng. Syst. Saf.*, vol. 138, pp. 115–134, doi: 10.1016/j.ress.2015.01.025.

Klapper, L.S, Vivar, J., 1999. Supply Chain Management: A Recommended Performance Measurement Scorecard, LG803R1. McLean, Virginia: Logistic Management Institute.

Larkin, P. *et al.*, 2019. "An integrated risk assessment and management framework for carbon capture and storage: A Canadian perspective," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 464–508, doi: 10.1504/IJRAM.2019.103336.

Larkin, P., *et al.*, 2019. "Risk management in carbon capture and geological storage: Insights from a structured expert elicitation," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 404–428, doi: 10.1504/IJRAM.2019.103334.

Larkin, P., *et al.*, 2019. "Uncertainty in risk issues for carbon capture and geological storage: Findings from a structured expert elicitation," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 429–463, doi: 10.1504/IJRAM.2019.103335

Larkin, P., W. Leiss, and D. Krewski, 2019. "Risk assessment and management frameworks for carbon capture and geological storage: A global perspective," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 254–285, doi: 10.1504/IJRAM.2019.103332.

Leiss, W., D. Krewski, 2019. "Environmental scan and issue awareness: Risk management challenges for CCS," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 234–253, doi: 10.1504/IJRAM.2019.103340.

Leiss, W., P. Larkin, 2019. "Risk communication and public engagement in CCS projects: The foundations of public acceptability," *Int. J. Risk Assess. Manag.*, vol. 22, no. 3–4, pp. 384–403, doi: 10.1504/IJRAM.2019.103339.

Ntwali, A., A. Kituyi, A. O. Kengere, 2020. "Claims Management and Financial Performance of Insurance Companies in Rwanda: A Case of SONARWA General Insurance Company Ltd.," *J. Financ. Risk Manag.*, vol. 09, no. 03, pp. 190–210, doi: 10.4236/jfrm.2020.93011.

Pujawan, I Nyoman dan Laudine H. Geraldine. 2009. House of Risk: a Model for Proactive Supply Chain Risk Management. Business Process Management Journal, Vol 15, No. 6, pp. 953-967. Emerald Group Publishing Limited.

Pujawan, I Nyoman. 2005.Supply Chain Management. Surabaya, Indonesia. Guna Widya.

Schlegel, G.L., Trent, R.J., 2015. Supply Chain Risk Management: An Emerging Discipline. CRC Press. New York, DOI:10.1201/b17531

Simchi-levi, D., J.K. Ryan, Chen, F, 2003. The bullwhip effect: Managerial insights on the impact of forecasting on variability in a supply chain management. Kluwer Academic Publishers Group.

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