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Development of Risk Management in Supply Chain Activities Using FMEA Method and Improvement Program Through Focus Group Discussion

(Case Study PT. XYZ)

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Abstract:- This research analyses the application of the Supply Chain Risk Management (SCRM) model. The aim of this research is to identify risk management at PT. XYZ then analyses the risks that have the potential to cause losses to the company and evaluates the priorities of the company's performance improvement program. This research is a category of business research that uses qualitative research methods. The population in this study is all problems in SCRM that occur with a sample size of risk data for all aspects from January to December 2021. The analysis technique used in this research is the House of Risk (HOR) and Focus Group Discussion (FGD) approaches. to prioritize risk sources with the aim of comparing which decisions should be chosen in order to reduce potential risks from risk sources. This research shows that the risks identified include errors in production planning, delays in delivery of raw materials, and product non-conformity with operational standards. The impact of this risk event is significant on PT. XYZ, such as production delays, increased operational costs, and decreased customer satisfaction. Mitigation strategies implemented include routine scheduling checks, stricter implementation of SOPs, and increased coordination between departments.

Keywords:- *Component; Supply Chain Management, House of Risk, Focus Group Discussion.*

I. INTRODUCTION

In the industrial world today, many companies compete for consumers, both in manufacturing and service industries. This encourages companies to make improvements in meeting consumer desires. In an effort to make various improvements in the areas of product quality, service, inventory and affordable prices for consumers, all related aspects of the company must run optimally. This is done, both in terms of information on the flow of goods, good relations between consumers and producers, relations between producers and suppliers and vice versa. The relationship between consumers, producers and suppliers is managed in a form of management called Supply Chain Management.

According to Indrajit and Djokopranoto (2005), the term supply chain was first used by several logistics consultants around the 1980s, then by academics analyzed further in the 1990s, the concept of supply chain management was born. Supply chain management is a system used by organizations or companies whose function is to distribute production goods or services from suppliers to customers. Product flow in supply chain management can be seen from the following picture:

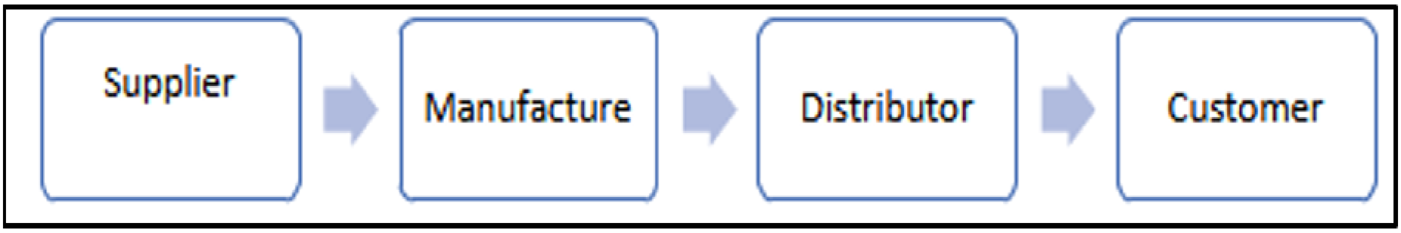

Fig 1 Supply Chain Management Product Flow

In the picture above, it can be concluded that the flow of the product, starting from supplying raw materials to manufacturers to converting the raw materials into ready-to-consume materials, is then distributed to distributors until it reaches the final consumer. According to Hertz (2007), the higher the supply chain management practices in a company, the higher the company's performance and competitive capabilities, so this has a positive impact and is very profitable for the company. Performance is the result of output and something that results from product and service processes that can be evaluated and compared relative to standard objectives, past results, and other organizations.

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Supply Chain Management (SCM) is something that is very important to pay attention to because it involves all elements that participate in a business movement, starting from suppliers, manufacturing companies, to customers. In general, all activities related to material flow, information flow, and financial flow along the supply chain are activities within the scope of SCM. Some of the main activities included in the SCM classification are: product design activities (product development), procurement activities, production and inventory planning activities (planning & control), production activities, and distribution activities.). The classification of activities is usually reflected in the form of division into departments or divisions in a manufacturing company (Pujawan, 2005). In every supply chain activity carried out, of course, there is uncertainty which can cause risks, where this risk can cause delays in supply chain activities, so companies need to identify risks in each of their supply chain activities.

The pharmaceutical industry is known as one of the strongest research and development industries that pays little attention to the development of supply chain technology. The high margins obtained from selling original products allow the industry to have high supply chain costs (Kearney, 2014). The expiration of patents and, as a result, a large increase in the number of generic drug production companies, which are focused on developing efficient, effective and cheaper supply chains, requires the pharmaceutical industry to turn its attention to the existing challenges. in forecasting future supply demand and inventory management, thereby confirming the importance of supply chain effectiveness for further industrial development.

PT.XYZ was established to support the growth of the pharmaceutical business in Indonesia, by providing production, development and marketing capabilities. Within four years since it was founded, PT. PT.XYZ collaborates with partners throughout the world and utilizes an extensive network of active drug ingredient sources. By utilizing a wide network of active ingredient sources, PT. The company exported products to England in 2008 or seven years after the factory was founded. And since then, it has begun to strengthen its existence in Europe by exporting products to markets in England, the Netherlands and Poland.

The pharmaceutical product supply chain at PT.XYZ has high complexity, and supply and delivery channels to customers are limited and highly regulated. This complexity is considered to be one of the main obstacles to improving supply chain performance and efficiency at PT. XYZ. Companies use IT digitalization to assist supply chain operations and control systems as part of their supply chain management strategy (Hayati, 2014). Timely management of raw materials, automatic ordering to vendors, transportation of raw materials from vendors to warehouses, and distribution of finished goods to distributor channels and end users are supply chain components that can be integrated with this technical solution (Anatan and Ellitan, 2008). Orders can be issued immediately, reducing waiting time, and supplier vendors as suppliers of goods through the digitalization system can quickly obtain the quantities and items of raw materials needed by the organization (Chopra and Meindl, 2001). As an organizational requirement to be able to create quickly, achieve high productivity economies of scale, and in a short time, all partner organizations that are members of ABC group subsidiaries have this IT system automatically in the process.

However, problems still often occur in the implementation of supply chain performance at XYZ company, causing financial losses and causing stock disruptions. Generally, in 2022, companies will experience various problems in supply chain practices as in the table below. The operating time of companies affected by this problem requires a review of their risk management.

In the table below, specific problems in the company's supply chain are identified and assessed using a specific scale. Delay in Delivery of Raw Materials by 15%) on a very long scale (>2x estimated). There were significant delays in the delivery of raw materials, exceeding twice the estimates. Errors in Inventory Information are 11.5% on a High scale (>10% of the total). The error rate in inventory information reaches a high level, exceeding 10% of the total inventory information that should be accurate. Poor Raw Material Quality is 5% on a High scale (>5% of the total). There is a problem with the quality of raw materials, where 5% of the total raw materials are considered bad or do not meet quality standards. Failure to deliver final products was 18.9% on a very high scale (>15%). Failure to deliver final products reached very high levels, exceeding 15% of the total production that should have been delivered.

Table 1 Supply Chain Problems PT. XYZ

Problems	Scale	Details
Delay in Delivery of Raw Materials	15%	Very long (>2x estimated)
Errors in Inventory Information	11,5%	High (>10% of total)
Poor Quality of Raw Materials	5%	High (>5% of total)
Failure to Deliver Final Product	18,9%	Very High (>15%)
Regulation and Compliance	-	Needs Evaluation
Supply Instability	-	Needs Evaluation
Failure in Vendor Management	-	Needs Evaluation
Logistics and Transportation Issues	-	Needs Evaluation

The Supply Chain Risk Management problem raised in this research is a problem that occurs in a company that produces medicines. Delays in the delivery of pharmaceutical raw materials can cause drug production to be hampered, which can have a negative impact on product availability on the market. Errors in inventory calculations can lead to problems with insufficient or excess stock. This may result in additional costs or losses due to wasted inventory or an

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inability to meet customer demand. Using low-quality or contaminated raw materials can result in pharmaceutical products not meeting quality and safety standards, potentially having a negative impact on the company's reputation and consumer health. Errors in the pharmaceutical product delivery process can result in the product not arriving at its destination on time. This could disrupt supplies to customers and potentially harm business relationships. Pharmaceutical companies must comply with strict regulations relating to the production and distribution of medicines. Failure to comply with these regulations may result in legal sanctions and financial losses. External factors such as natural disasters, climate change, or political disturbances in supplier countries can disrupt the supply of raw materials. Dependence on suppliers who are unreliable or do not meet quality standards can result in instability in supply. Damage or delays in the transportation process of pharmaceutical products can result in financial losses and poor product availability.

Judging from these problems, it is necessary to carry out evaluation and analysis so that the right solution is obtained for the company to reduce and overcome existing Supply Chain Risk Management problems. One method used to evaluate Supply Chain Risk Management is using the Supply Chain Risk Identification System (SCRIS) and House of Risk (HOR) approaches. The SCRIS approach is a development of the Supply Chain Operation reference which is grouped based on plan, source, make, deliver and return to identify risk sources and risk relationships in the supply chain (Karningsih, 2011). The principle of this HOR is to prioritize which risk sources are first selected in order to take the most effective action in order to reduce potential risks from the risk sources. By using the House of Risk (HOR) approach, it is hoped that it will provide a better solution to the company, namely being able to know the risks that can arise in the company's supply chain flow and being able to know the handling strategies that can be used to deal with the risks that occur.

II. LITERATURE REVIEW

A. Supply Chain Management

A supply chain is a network of companies that work together to create and deliver a product to the end user. These companies are generally suppliers, factories, distributors, wholesalers, retailers and other supporting companies (Pujawan and Mahendrawathi, 2017). There are 3 types of flows in the supply chain that must be managed. First, the flow of goods from upstream to downstream. Second, the flow of money flows from downstream to upstream. Third is the flow of information which can occur from downstream to upstream or vice versa.

Meanwhile, according to Russell and Taylor in Creaton, C. A., & Wullur, M. (2017), Supply chain management focuses on integrating and managing the flow of goods and services and information through the supply chain to make it responsive to customer needs while reducing total costs. According to Lamber and Cooper in Asnawati (2019), the discussion of chains and networks is divided into management components and the behavior of supply chain members.

According to Pujawan in Hariyati (2018), Supply Chain Management is a network of agencies that work together to create and deliver a product to the end user. Based on the statement above, it is explained that Supply Chain Management not only focuses on the company's internal affairs, but also on the company's external affairs. The company's external activities are described as maintaining cooperative relationships between other related companies.

According to Ruslim in Hariyati (2018), supply chain management is the process of unifying business from end users through original suppliers who provide products, services and information to add customer value. According to Hariyati (2018), Supply chain management does not only focus on the internal company, but also focuses on the external company and is interconnected with other companies. Collaboration between companies is very necessary, in order to achieve customer satisfaction.

According to Nugrahanti et al, in Hariyati (2018), the two functions of supply chain management are:

- Supply Chain Management physically changes raw materials into finished goods, before then delivering them to final consumers. Things related to this function include physical costs (material costs, production costs, transportation costs and other costs).
- Supply Chain Management as a market medium to ensure that what is supplied by the Supply Chain is in accordance with consumer demand.

Strategy is a collection of strategic activities and actions carried out by an organization or several organizations together. According to Chopra and Meindl in Hariyati (2017) there are 2 strategies in the Supply Chain. First, Lean Supply Chain (Efficient Supply Chain) which focuses on efforts to meet consumer demand by minimizing total costs and reducing production costs, material costs and storage costs. Second, Agile Supply Chain (Responsive Supply Chain) which focuses on the Supply Chain's ability to respond to market changes.

In Supply Chain Management there are several issues or problems that usually make it difficult to develop a supply chain to make it more effective and efficient. According to Heizer and Render (2015:507), these issues are:

- Local optimization
- Sales incentives, quantity discounts, quotas and promotions
- Big lot
- Whip Effect (bullwhip effect)

Local optimization means that each chain member in the supply chain tends to maximize local profits and minimize direct costs based on their lack of knowledge. If you respond excessively to a request, for example, a slight increase in demand will trigger the company to supply goods to the warehouse without realizing that the warehouse or storage area is not enough to accommodate everything. Therefore,

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fluctuations are exaggerated. This complicates the implementation of effective and efficient distribution.

Sales incentives, quantity discounts, quotas and promotions. This will push goods down the chain for sales that have not yet occurred. This causes fluctuations that will increase costs on all members of the chain. Meanwhile, there is often a bias towards large lots because large lots tend to reduce the cost per unit. But you still have to pay attention to the quantity of goods. Because more goods are produced, storage costs will increase. So, whether it's local optimization, incentives, and large lots, everything must have good information and communication. Meanwhile, the Whip Effect occurs when orders are conveyed from retail traders, to wholesalers, to manufacturing companies, with increasing fluctuations at each level (Heizer and Render, 2015).

B. Failure Mode and Effect Analysis (FMEA)

According to Ramdhani in Tessa (2017), FMEA is a technique for identifying and eliminating potential failures, errors and known problems from the system, before the failure reaches consumers. The risk assessment will then be continued with an RPN (Risk Priority Number) assessment which must pay attention to three factors. These factors are the possibility of risk (occurrence), frequency of impact (severity), and detection (detection). Occurrence is an estimate of the probability or chance of failure causing certain consequences, Severity is an estimate of how bad the end user will feel as a result of failure, and Detection is an estimate of the effectiveness and method of preventing a risk.

C. House OF Risk (HOR)

House of Risk is a modification of Failure Modes and Effect of Analysis (FMEA) and House of Quality (HOQ) to prioritize risk sources. This aims to compare which decisions should be chosen in order to reduce potential risks from risk sources (Ulfa et al. in Senja, 2018).

According to Geraldine and Pujawan in Senja (2018), the HOR method is divided into 2 phases. These parts are the risk identification and risk mitigation phases. The development of this method aims to prevent risks that may occur in the supply chain. If the causes of risk are minimized, the company's risk level is also reduced. According to Pelita (2017), there are 7 stages in determining HOR in phase 1, namely:

- Recognize risk events that are likely to occur in each business operational activity. At this stage, identifying risks can be done using SCOR (plan, source, make, deliver and return).
- Recognize risk events (Ei). These risks are all events that may occur in the Supply Chain.
- Calculate the impact (Si) of risk events on the company's business processes
- Recognize risk-causing agents (Ai)
- Calculate the level of opportunity for risk occurrence (Oj)
- Calculate the correlation between activities with correlation values (0,1,3,9). 0 means there is no correlation, 1 means there is a small correlation, 3 means there is a moderate correlation, and 9 indicates that there is a large correlation.
- Lastly, calculate the Aggregate Risk Potential (ARP) using the following formula:

$$ARP_j = O_j \sum S_i R_{ij}$$

Where;

ARPj = ARP Value

Oj = Occurence / Chance

Si = Severity / Level of Risk Impact

Rij = Risk Correlation Level

To make it clearer, the following is a table from the House of Risk Framework phase 1 according to Pujawan and Geraldine in Pelita (2017),

Table 2 HOR Phase 1 Example

Business Process	**E_i**	***Risk Agent* (A_j)**					**S_i**
		A1	**A2**	**A3**	**A4**	**A5**	
Plan	E1	R11	R12	R13			S1
Source	E2	R21	R22				S2
Make	E3	R31					S3
Deliver	E4	R41					
Return	E5	R51					
Occurence of Agen j		O1	O2	O3	O4		
Aggregate Risk Potential j		ARP 1	ARP 2				
Priority Rank of Agent							

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Meanwhile, according to Senja (2018), the phase 2 HOR model is used to explain which steps must be carried out first. This determination is based on the level of effectiveness of the steps, as well as based on the level of difficulty in carrying them out. In general, companies will prefer steps that are not difficult to take, but still pay attention to a good level of effectiveness, as well as small risks. The steps in HOR phase 2 are as follows:

- Select a number of risk causes based on Pareto analysis (ARPj)
- Determine the most likely steps to be taken to prevent the causes of risk from occurring
- Explain the relationship between prevention efforts and risk causes (Ejk) with values 0, 1, 3, 9, where a value of 0 indicates there is no correlation and a value of 9 indicates the highest correlation.
- Calculate total effectiveness (TE), using the following formula:

$TE_k = \sum ARP_j E_{jk}$

Where;

Te_k= Total Effectiveness

ARP_j = Aggregate Risk Potential Value

E_{jk} = Correlation of Acttion and Risk Source

- Determine the level of difficulty in implementing preventive actions
- Calculate the ETD (Difficulty of Ratio) value, using the formula:

$ETD_k = TE_k / D_k$

Where;

ETD_k = Effectiveness of Action Implementation

TE_k = Total Effectiveness

D_k = Level of difficulty of preventive action

According to Senja (2018), after these steps have been carried out, the HOR phase 2 results will then be calculated in the following table:

Table 3 HOR Phase 2 Example

A_j	Prevention action					ARP_j
	PA1	PA2	PA3	PA4	PA5	ARP1
A1	E11					ARP2
A2						ARP3
A3						ARP4
A4						ARP5
Total effectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2	D3	D4	D5	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of priority	R1	R2	R3	R4	R5	

III. METHODS

This research uses a descriptive qualitative analysis approach. Qualitative research can present detailed information in an effort to present social situations and perspectives, both in terms of concepts, perspectives, behavior and basic research problems. Qualitative research can help assess a case and provide insight into individual experiences, both for evaluating regulations and introducing unknown values (Ghozali, 2021). The basis of the qualitative research approach is generally to use the meaning of social phenomena that occur in the community. In the qualitative approach, the object shown is the meaning of social and cultural phenomena using the culture of the society concerned to obtain a depiction using a certain categorization method (Ghozali, 2021).

The population in this research is internal parties from PT. XYZ is the Manager, Head of Administration and Finance, as well as employees at the company PT. XYZ. Based on limited time, energy and costs, several samples were taken including the Manager, Head of Administration and Finance, and 2 employees of PT. XYZ. The sample taken is an expert or has competence regarding the research topic.

➢ *The Data Collection Techniques used in this Research are as follows:*

- Interviews were used to dig up information related to how these medicines were managed by the company before they were marketed to many places. The tools used include stationery, notebooks and smartphones to record objects.

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- Literature studies are used to complete data from various sources that strengthen research data.

A. Preparation of HOR Phase 1

House of risk phase 1 consists of several stages. These stages include the activity mapping stage, risk identification stage, and risk analysis stage. These stages are then described as follows:

➢ *Activity Mapping*

At this stage, mapping of the activities of drug supply chain actors is carried out. The mapping was obtained based on discussions with the factory head of PT. XYZ. Based on the discussion, the activities that occurred at PT. XYZ is the procurement of raw materials for medicines, packaging, storage and distribution.

➢ *Risk Identification*

At this stage, possible risks that occur in the supply chain flow of medicinal products are identified through interviews with the risk actors involved. At this stage the Failure Mode and Effect Analysis (FMEA) method is used. This method aims to find sources of risk, things that constitute risk, and the impact of risk on each activity. Risk identification is obtained not only from the results of interviews. Risk identification also comes from previous research related to supply chain risk management. This research discusses risk analysis of the supply chain for consumer medicines using the House of Risk (HOR) approach, and risk management in the drug supply chain using the HOR method at PT. XYZ. The collected list of risk events and risk causes is then validated. Validation is carried out to assess whether the risk events and risk causes obtained reflect actual conditions. This validation was carried out by experts, namely Mr. XYZ is an expert in the field of medicine (knows all activities at PT. XYZ), and Mrs. Y is a Risk Management Expert.

➢ *Risk Analysis*

At this stage, a risk analysis is carried out on the impact of the risk (saverity) and the possibility of the risk occurring (occurrence) to determine risk priorities. At the risk analysis stage, the first step that must be taken is to create a questionnaire and validate the questionnaire. After validation, questionnaires were distributed to all willing respondents. Respondents will fill out severity and occurrence assessments based on the FMEA scale. So that the correlation value can be determined based on the saverity and occurrence that have been obtained. The next stage is determining the Aggregate Risk Potential (ARP) value based on severity, occurrence and correlation values. All of this data is combined in the House Of Risk Phase 1 model.

B. Preparation of HOR Phase 2

This phase is a continuation stage of HOR Phase 1. Where HOR Phase 2 has 2 stages, namely:

➢ *Risk Evaluation*

This stage is useful for determining treatment for the selected risk causes. Create a list of proposed preventive actions to anticipate the causes of selected risks. All preventive measures will be adjusted to the conditions of supply chain actors.

➢ *Response to Risk*

This stage is carried out to consider the level of effectiveness of the actions taken. The risk response stage begins by proposing a design for selected risk prevention measures for drug supply chain actors. The proposed action has 2 things that will be assessed, namely effectiveness and level of difficulty. Effectiveness is assessed by the owner of PT. XYZ itself, and the level of difficulty was assessed by several respondents as well as PT supply chain actors. XYZ on a scale from very easy to very difficult to implement. A comparison of the effectiveness value and the level of difficulty will produce a total effectiveness value for the level of difficulty or Effectiveness to Difficulty Ratio (EDTk).

C. Analysis

The analysis aims to evaluate the research that has been carried out. This analysis is carried out for each stage in risk management. These stages are risk identification, severity stage, occurrence stage, correlation stage, ARP assessment stage, risk analysis stage, and risk response analysis.

D. Focus Group Discussion

The Focus Group Discussion (FGD) that will be carried out consists of a dialogue between 6-10 people guided by a facilitator. The aim of these dialogues is to obtain in-depth information regarding participants' perceptions or experiences of a particular topic/range of topics. Discussion of risk management topics through FGDs is recommended because this is a great opportunity to gather various groups of people to listen to the voices and opinions of experts at PT. XYZ in solving supply chain problems that often occur. What will be discussed are topics such as historical events, program plans and evaluation.

IV. DISCUSSION AND RESULTS

A. Business Process at PT. XYZ

A business process (business cycle) is a collection of structured activities or work that are interrelated to solve a particular problem or produce a product or service (in order to achieve a particular goal). PT. XYZ is a pharmaceutical manufacturing company. The Factory Department is divided into several sections, namely Logistics, Production, Engineering, Production and Inventory Control (PPIC), Sourcing, and Regulated Market.

The PPIC Department at PT. XYZ has a very important role in managing a company's supply chain. PPIC is responsible for planning production activities based on customer demand, sales projections, and available production capacity and arranging production schedules to suit needs and ensuring the availability of raw materials and machine capacity. This department is responsible for controlling the inventory of raw materials, semi-finished goods, and finished products. PPIC monitors inventory levels so that they are not too high (reducing unnecessary storage costs) or too low (avoiding shortages in meeting customer demand). PPIC interacts with suppliers to arrange timely delivery of raw

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materials and in quantities that are in accordance with production needs and can also carry out long-term raw material requirements planning to ensure optimal availability.

Risk management at PT. XYZ involves a series of structured steps to identify, analyze, assess, and control various risks that can affect the company's operations. This process begins with weekly planning, which involves annual, monthly, and weekly work meetings. The annual work meeting sets the company's long-term goals and key strategies, while the monthly meeting reviews progress and makes adjustments to the plan. Weekly meetings focus on daily operations, identifying issues that require immediate action, and identifying new risks based on changing situations and weekly evaluation results. In the procurement of raw materials, PT. XYZ identified the risk of delays in raw material deliveries by suppliers. This risk analysis involved reviewing delivery history, assessing supplier reliability, and identifying factors that could cause delays. To address this risk, PT. XYZ implemented mitigation strategies such as diversifying supplier sources, using information systems to monitor delivery status, and establishing clear contracts regarding delivery schedules.

B. Risk Identification Analysis

After identifying the risks of the activities that occur at PT. XYZ, the next stage is to identify the risks of risk events that can occur based on activities at PT. XYZ. Risk identification is carried out by conducting interviews with experts who will then carry out an impact assessment related to risk events using questionnaires distributed to experts. Based on the questionnaire filled out by respondents, 18 risk events were obtained from 8 production activities that occurred at PT. XYZ. The following are the results of interviews and filling out questionnaires related to risk events at PT. XYZ:

Table 4 Risk Event Identification

Procesa	Activity	*Risk Event*	Code	*Severity*
Plan	Production Plan	Scheduling plan error	A1	3
		Changes in production system plans.	A2	3
		Customer orders at the same time	A3	4
		Unpreparedness of production facilities	A4	4
	Order Forecasting	Unable to meet the number of requests.	A5	3
Source	Raw Material Procurement	Raw material planning errors	A6	4
	Receiving Raw Materials from Suppliers	Raw materials arrive late	A7	4
Make	Production Scheduling	Raw materials arrive late	A8	3
	Production Process	Production process does not comply with SOP	A9	4
		Raw materials are not enough for production	A10	4
		Production results do not match consumer orders.	A11	3
		Delays in the production process.	A12	3
		Workplace accidents occur.	A13	3
Deliver	Product Delivery	Delays in product delivery	A14	3
		Lack of transportation services for product delivery	A15	3
		Product pickup does not match the promised time	A16	3
Return	Product Returns	Product performance capacity does not match customer desires.	A17	3
		Customer complaints	A18	3

From the identified risk events, there are risk sources (risk agents) that will also be identified through an assessment of the level of potential for the risk source to occur. This assessment is carried out by interviewing and distributing questionnaires to be filled out by PT. XYZ experts. The following are the results of the identification of risk agents that occurred at PT. XYZ:

Table 5 Risk Agent Identification

Code	*Risk Agent*	*Occurrence*
E1	Raw material shortage	3
E2	Worker negligence	2
E3	Production machines are broken/not functioning	4
E4	Incorrect scheduling/planning	3
E5	Incorrect raw material scheduling/planning	3
E6	Lack of human resources	3
E7	Power outages	3
E8	Undisciplined human resources	3
E9	Lack of transportation	3
A10	Lack of raw materials	4
E11	Production equipment maintenance is not carried out routinely	4
E12	No written SOP	4
E13	Worker fatigue	3
E14	Delay in production process	3
E15	Finished products do not match orders.	3
E16	There are no raw materials in the warehouse.	4
E17	Lack of coordination between the production department and the administration department.	3

C. House of Risk Phase 1

In the House of Risk phase 1, the aggregate risk potential calculation is carried out with the aim of determining the priority of which risks will be given handling or mitigation. The formula for determining the aggregate risk potential (ARP) value is described previously.

In this house of risk phase 1, there is a table containing the ARP calculation which is the final stage in identifying risks. In this table there is a severity value of the risk event, the occurrence value of the risk agent and the correlation between the risk agent and the risk event obtained from the results of interviews with respondents. In addition, there is a ranking of risk agents that will be prioritized to be given a mitigation strategy for the risk. The following is the house of risk phase 1 table:

Table 6 HOR Phase 1

Risk Agent	*Risk Event*																	Si
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	
A1	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	1	3
A2	1	0	3	3	0	1	0	0	0	3	0	0	0	3	0	1	0	3
A3	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	4
A4	0	0	3	0	0	0	3	0	0	0	3	0	0	0	0	0	0	4
A5	0	0	1	0	0	3	0	0	0	0	0	0	1	0	0	0	0	3
A6	0	1	0	0	9	0	0	0	0	0	0	0	0	0	0	3	0	4
A7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
A8	0	1	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	3
A9	0	3	0	0	0	0	0	3	0	0	0	9	0	0	0	0	0	4
A10	9	0	0	0	3	0	0	0	0	9	0	0	0	0	0	9	3	4
A11	0	1	0	0	0	0	0	1	0	0	9	0	0	0	0	0	0	3
A12	3	1	9	3	3	3	3	0	0	0	0	0	3	9	0	0	3	3
A13	0	9	0	0	0	0	0	9	0	0	0	3	0	0	0	0	9	3
A14	0	1	0	3	0	1	0	0	9	0	0	0	0	3	0	0	3	3
A15	0	0	0	0	0	0	0	0	9	0	0	0	0	0	3	0	0	3
A16	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3
A17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	3	3
A18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	3
Oi	3	2	4	4	3	3	3	3	3	4	4	4	3	3	3	4	3	
ARP	144	110	204	324	171	84	63	126	189	180	75	180	36	147	189	204	207	

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Based on the table above House of Risk phase 1 above, the result of the risk agent with the highest aggregate risk potential value is risk agent A4, namely wrong scheduling/planning. While for the risk agent with the lowest aggregate risk potential value is risk agent A13, namely worker fatigue. After obtaining the dominant risk agent, the next step is to conduct a risk evaluation.

D. Focus Group Discussion

In this Focus Group Discussion (FGD), this study discusses the strategy for compiling risk management in PT. XYZ's supply chain activities using the Failure Mode and Effect Analysis (FMEA) Method and identifies improvement programs through group discussions. This FGD aims to identify key risks, prioritize risks, evaluate existing mitigation strategies, identify constraints and challenges, and propose solutions and recommendations for improvement. In PT. XYZ's supply chain, key activities include production planning, raw material procurement, production scheduling, production processes, product delivery, and product returns. The key risks identified include delays in raw material delivery, product quality failure, material price fluctuations, supply instability, and operational disruptions due to natural disasters or other unforeseen events. In the FGD, this study discusses the criteria used to prioritize the identified risks. These criteria include an assessment of the potential impact of risks on the company's operations and performance, as well as the frequency or likelihood of the risk occurring. These risks are grouped based on their level of importance to the company.

Risk mitigation strategies implemented by PT. XYZ include supply diversification, investment in information technology for real-time monitoring, and close collaboration with suppliers. Evaluation of the effectiveness of these strategies in reducing the impact and likelihood of risk occurrence, as well as the obstacles faced in their implementation, were also discussed in the FGD. Evaluation of the effectiveness of the risk mitigation strategies implemented by PT. XYZ was conducted in the FGD. The discussion included an evaluation of the effectiveness of these strategies and the potential for further improvement. By involving various stakeholders, the FGD identified areas where mitigation strategies could be improved to enhance the security and resilience of the supply chain.

Obstacles faced in implementing risk mitigation strategies, both internal and external, were identified in the FGD. Steps to overcome these obstacles, such as employee training, adoption of new technologies, and socialization to raise awareness of the importance of risk management, were discussed in depth. Strategies or solutions that can be adopted to overcome conditional obstacles that are not easily overcome, especially those that are external and beyond the company's direct control, were also discussed in the FGD. This includes building strategic partnerships with suppliers, improving communication between departments, and investing in employee training and development. The development of technology to improve risk management in the supply chain, such as the implementation of more sophisticated information systems such as ERP and analytical tools for risk prediction, were considered in the FGD. By utilizing the latest technology, PT. XYZ can improve visibility and control over risks in the supply chain.

E. Risk Assessment Analysis

This risk evaluation aims to determine the dominant risk agent that will be handled based on the aggregate risk potential value that has been processed previously, which can be seen in the table above. The risk evaluation will use a Pareto diagram. In a Pareto diagram, a data classification will be sorted from left to right based on the highest to lowest order. Pareto diagrams help in finding a problem that will be prioritized for handling. Pareto diagrams have an 80:20 concept, where by improving 20% of dominant risk sources, it is expected to minimize 80% of other risk sources. The following is a Pareto diagram showing the most dominant risk agents:

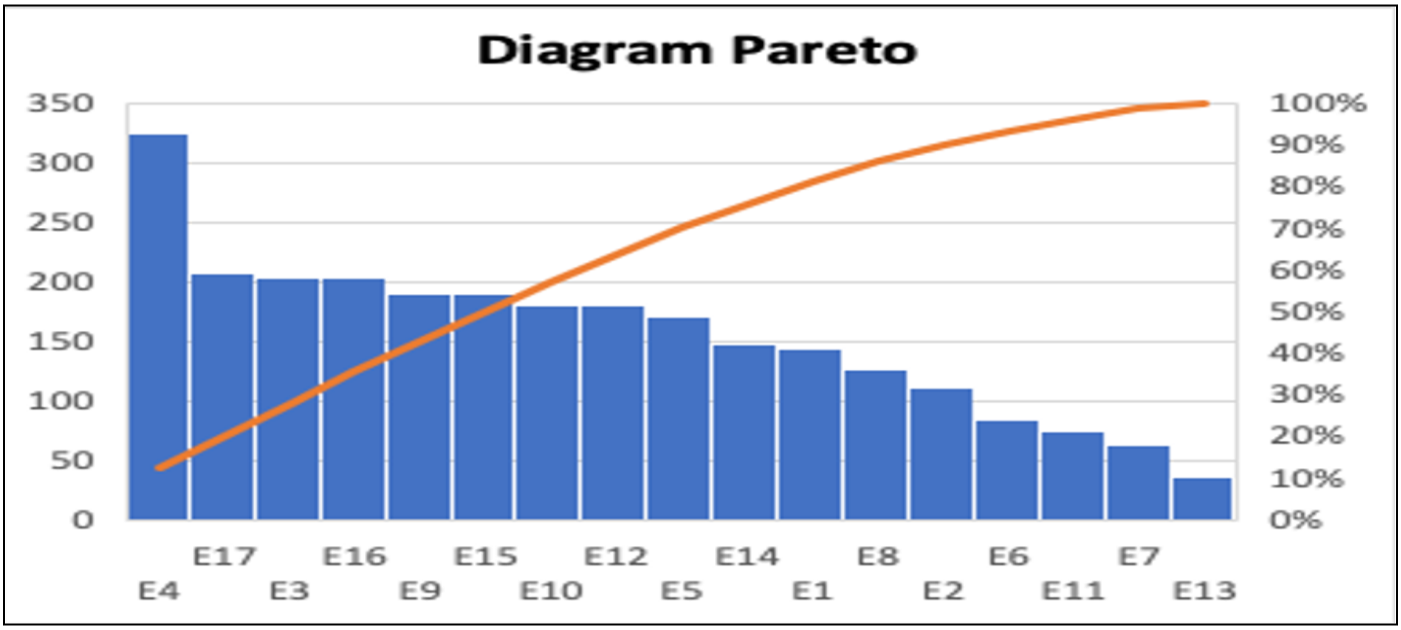

Fig 2 Pareto Diagram 1

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Based on the image above, there are several most dominant risk agents that can be handled. There are two dominant risk agents based on the Pareto diagram above that can be resolved by designing a risk mitigation strategy according to the risk agent. Based on the Pareto concept, 20.2% of the main causal risk agents are obtained which are expected to reduce 79.8% of other risk agents. The two dominant risk agents are E4 and E17. After obtaining the two dominant risk agents, the next step is to design a risk mitigation strategy using the house of risk model phase 2. Before handling, risk mapping will be carried out first to determine the condition of the dominant risk agents. The following is the initial risk mapping of the dominant risk agents:

Table 7 Risk Analysis Mapping

Risk Analysis Matrix	Impact Level				
	Very Low	Low	Intermediate	High	Very High
Very Low					
Low					
Intermediate		A17	A4		
High					
Very High					

➢ *Risk Mapping is done based on the following Levels:*

Table 8 Determining the Risk Map Level

Level	*Severity*	*Occurrence*
Very Low	1	1
Low	2	2
Intermediate	3	3
High	4	4
Very High	5	5

Based on the risk map in the table above, A4 is in the orange zone with a significant risk level, which means that immediate corrective action must be taken, and then A17 is in the yellow zone with a medium risk level, which means that corrective action must be taken routinely and appropriately.

F. House of Risk Phase 2

The next stage after obtaining priority risk agents is the house of risk phase 2. This HOR phase 2 is used to determine the most effective risk mitigation to minimize the possibility of risk events based on risk agents. Several mitigation actions were obtained through references from various sources and direct interviews with experts by considering the level of difficulty and effectiveness when implemented. In the previous stage based on Figure 4.1 Pareto diagram above, there were two dominant risk agents that would be handled. Based on the two risk agents, 11 mitigation actions were designed. The following is a table of the proposed risk mitigation strategies:

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Table 9 Risk Mitigation Strategy Design

Code	Mitigation	Dk
PA1	Maintain good communication between departments/work teams/individuals	3
PA2	Create a relaxed work environment	3
PA3	Maintain good cooperation between teams/sections/individuals	3
PA4	Conduct evaluations of each section/individual	4
PA5	Select employees who have good abilities	3
PA6	Provide training for workers/employees	4
PA7	Raw Material Inventory Management	4
PA8	Implementation of Information Systems	3
PA9	Conduct regular checks on raw material scheduling/planning	4
PA10	Create other schedules to avoid scheduling/planning errors	4
PA11	Add more Raw Material stock than usual	5

After obtaining the mitigation design and degree of difficulty, the next step is to weight the value of the correlation between the mitigation strategy and the dominant risk agent obtained from interviews with experts. From the weighting of the correlation value, the effectiveness value of the mitigation strategy will be calculated by using formula mentioned above.

After obtaining the total effectiveness value, the next step is to determine the Effectiveness to Difficulty ratio value to determine the effectiveness and difficulty ratio in implementing each mitigation action. The formula used to determine the difficulty ratio value is as mentioned in previous chapter.

In this HOR phase 2 table, there is a combination of various variables such as strategic planning data, dominant risk agent data, aggregate risk potential calculations from dominant risk agents, degree of difficulty data and calculations of total effectiveness and effectiveness to difficulty to determine the priority order of risk mitigation. Here is the HOR phase 2 table:

Table 10 HOR Phase 2

Risk Agent	Strategi Penanganan (*Prevention Action*)											ARP
	PA 1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA1 1	
A4	0	0	0	0	1	0	1	3	9	9	3	324
A17	3	3	9	3	0	1	1	1	0	0	0	207
Total Effectiveness of Action	621	621	1863	621	324	207	531	1179	2916	2916	972	
Degree of Difficulty Performing Action	3	3	3	4	3	4	4	3	4	4	5	
Effectiveness to Difficulty Ratio	207	207	621	155,25	108	51,75	132,75	393	729	729	194,4	
Rank Priority	6	5	3	8	10	11	9	4	1	2	7	

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Based on the HOR phase 2 table above, the order of mitigation strategies is obtained based on the highest ETDk value. The following is a table of priority ranks of mitigation strategies based on the HOR phase 2 calculation:

Table 11 Risk Mitigation Priority List

Code	Mitigation	Priority
PA9	Conduct regular checks on raw material scheduling/planning	1
PA10	Create other schedules to avoid scheduling/planning errors	2
PA3	Maintain good cooperation between teams/sections/individuals	3
PA8	Implementation of Information Systems	4
PA2	Create a relaxed work environment	5
PA1	Maintain good communication between departments/work teams/individuals	6
PA11	Add more Raw Material stock than usual	7
PA4	Conduct evaluations of each section/individual	8
PA7	Raw Material Inventory Management	9
PA5	Select employees who have good abilities	10
PA6	Provide training for workers/employees	11

Based on the results obtained, the priority order of 11 mitigation actions will be made the main priority where based on the ETDk value or effectiveness value of the mitigation action, the higher the ETD value, the more effective the mitigation action is to be implemented. The following is the ETD value expressed in the form of a Pareto diagram:

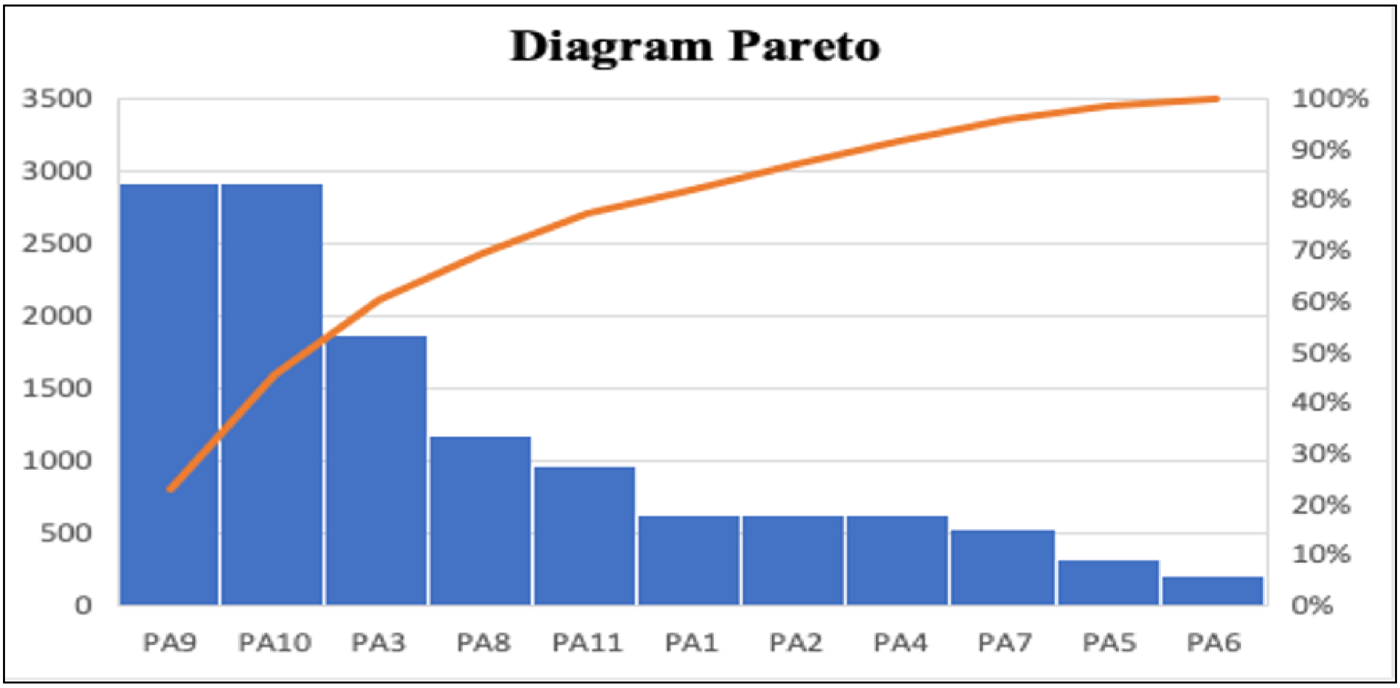

Fig 3 Pareto Diagram 2

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Based on the image above, by considering the effectiveness of the mitigation strategy in its implementation, the prioritized mitigation strategies are 2 mitigation strategies which produce an effectiveness of 45.7% of the total cumulative ETD value. The first strategy with an ETD value of 2916 is to Conduct Routine Checks on Raw Material Scheduling/Planning (PA9) to avoid errors in storing raw material stock in the storage warehouse due to frequent shortages of raw materials during production. The second strategy with an ETD value of 2916 is to Create Another Schedule to Avoid Scheduling/Planning Errors (PA10). This can be done because the production process at PT. XYZ rarely pays attention to factors that can affect production scheduling/planning, so one suitable strategy is to always prepare another schedule.

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

This study aims to identify, analyze, and provide risk mitigation solutions in the supply chain of PT. XYZ using the SCOR model. The results of the study indicate that the main activities in the supply chain of PT. XYZ include production planning, raw material procurement, production scheduling, production process, product delivery, and product returns. Risk identification analysis shows that the production process and raw material procurement are the activities most vulnerable to risk. The risks identified include errors in production planning, delays in raw material delivery, and product non-conformity with operational standards. The impact of these risk events is significant to PT. XYZ's operations, such as production delays, increased operational costs, and decreased customer satisfaction. Determination of risk priorities for mitigation is based on the potential impact and frequency of risk events. Risks with high impact and high frequency, such as errors in production scheduling and lack of coordination between departments, are prioritized to be handled. The mitigation strategies implemented include routine scheduling checks, stricter implementation of SOPs, and increased coordination between departments. The effectiveness of the current mitigation strategy is quite good but still needs improvement, especially in terms of human resources and information technology. PT. XYZ has taken several steps to address the constraints, such as providing training, adopting new technologies, and increasing risk management awareness.

Conditional constraints that are not easily solved, such as market fluctuations, dependence on a single supplier, and natural disasters, require a flexible and adaptive approach. PT. XYZ needs to consider implementing more sophisticated information systems for supply chain management, such as ERP and analytical tools for risk prediction. This technology can help in real-time risk monitoring and management, as well as provide more accurate data for decision making. Overall, PT. XYZ has identified key risks in the supply chain and implemented various mitigation strategies to reduce the impact and likelihood of risk events. However, continuous improvement in risk management and adoption of advanced technologies are still needed to deal with risks that are conditional and difficult to predict.

B. Recommendation

The suggestions put forward by the researcher are as follows:

➢ *Improving Information Technology Capabilities*

PT. XYZ needs to adopt a more sophisticated information system such as Enterprise Resource Planning (ERP) and analytical tools for risk prediction. The use of this technology can help in monitoring and managing risks in real-time, as well as providing more accurate data for decision making.

➢ *Improving Inter-Departmental Coordination*

Improving coordination and communication between departments, especially between production and administration, is very important. This can be done through regular meetings, the use of digital collaboration tools, and the development of more detailed and easy-to-follow SOPs.

➢ *Supplier Diversification*

Reducing dependence on one supplier by diversifying raw material suppliers can help reduce the risk of delays and supply disruptions. PT. XYZ needs to build relationships with several reliable suppliers to ensure smooth procurement of raw materials.

➢ *Improving Planning and Scheduling Systems*

Using more sophisticated planning and scheduling tools to reduce errors in production scheduling and raw material planning. Implementation of predictive algorithms and data analysis can improve planning accuracy and reduce the risk of errors.

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