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Building Supply Chain Resilience by Quality Function Deployment Approach

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Abstract

Internet of things (IoT) becomes the backbone of the advanced countries and it has a real contribute to exchange the traditional style or way of practical life, even personal life into smart style, with (IoT) technology the life become more and more easy and professional. internet of things achieves various applications coordinate with sensors and standard protocols to apply what is called machine -to- machine connection (M2M), in this paper we will talk more about the concept of (M2M), the main component of internet of things and finally the common protocols that is used in network, in addition to that this work present an IOT operation with processing system using camera for capturing image and Xilinx system generator(XSG)models for designing image processing algorithms and the result of the processing is an image with black and white for edge detection and Thresholding models and gray color image for gray enhancement model.

Introduction

In the current industrial world, especially in the increasingly competitive business sector, the supply chain plays an important role in the sustainability and competitiveness of the company. Therefore, supply chain management is needed. Supply chain management is one of the efforts to meet consumer needs, because the concept of supply chain management shows how the process of goods circulates from producers to the hands of end consumers by showing the quality of the goods. The services provided in supply chain management must also be of quality such as responsiveness and labor efficiency to meet consumer needs (Heikkilä, 2002; Gunasekaran et al., 2008). Not only does it cover all components such as producers, suppliers, distributors, and consumers directly or indirectly, the supply chain also includes distributors, warehouses, retailers, retail traders, and even customers themselves (Djama et al., 2023; Hugos, 2024; Rushton et al., 2022).

However, the supply chain often has risks that can hinder or cause losses to the company. PT XYZ is one of the largest and leading agri-food companies in Indonesia which already has many company units. PT XYZ already has a very good position in the industrial world, but this company still has several problems in its supply chain such as frequent sudden increases in customer demand at certain times such as during Eid which causes the process of releasing goods to take longer and there are still product returns from customers around 4-9 times in one month due to several factors, one of which is that there are still errors in loading feeds which indicate serious problems. This not only harms the company in terms of costs, but can also affect the image and trust of customers in the quality of the products offered. Therefore,

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it is necessary to evaluate and improve the supply chain system to ensure smooth operations and maintain customer satisfaction.

The supply chain must be reliable or dependable in order to withstand all possible risks (Piprani et al., 2022; Rashid et al., 2024). To create an integrated supply chain, cooperation is needed between all related parties so that supply chain resilience can be realized. Supply chain resilience is the ability of a supply chain to face, adapt, and recover from disruptions. Companies need to design strategies so that there is no failure in the supply chain. In addition, companies are also required to be able to meet customer needs so that customers do not switch to other companies and reorder from the company so that the company can continue to compete with other companies. To overcome this, it is necessary to take corrective action by designing effective supply chain resilience in the company. The method that can be used as an approach to customer needs is Quality Function Deployment (QFD) (Akao, 2024; Bahia et al., 2023). Quality Function Deployment is a structured process or mechanism to determine customer needs and translate those needs into relevant technical needs, where each functional area and organizational level can understand and act (Lestari et al., 2020).

The steps in making HOQ are:

Identifying Customer Requirements

The first step is to identify customer needs. This is done by studying literature and brainstorming with the company.

Prioritizing CR (Customer Requirements)

Making an assessment of Customer Requirements (CR) that have been identified with an assessment scale. Through this assessment, the priority ranking of customer needs will be determined. Then the weight calculation is carried out for each customer needs attribute using the formula below:

$$W_i = \frac{I_i}{\sum_{i=1}^{n} I_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2.1)$$

Identifying Design Requirements (DR)

Identifying the risks that can occur in the company's supply chain. This is done by studying literature and brainstorming with the company.

Determining Relationship Matrix

Determining the correlation or evaluation of the relationship between customer needs (left side) and the risks at the top of the HOQ.

Technical Matrix

This section is located at the bottom of the HOQ to determine the relationship between CR and DR, then the AI and Relative Importance (RI) calculations are carried out. AIj to calculate the total relationship of each company attribute with customer needs. While RIj refers to the risk attribute.

$$AI_j = \sum_{i=1}^{n} W_i R_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2.2)$$

$$RI_j = \frac{AI_j}{\sum_{j=1}^{m} AI_j} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2.3)$$

Design Requirements are usually ranked based on RI, not AI. Therefore, the calculation will be done using the RI value (Isti'anah et al., 2021).

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Methods

Identification and Operational of Variables

Operational definition is used to explain the meaning of each independent variable and dependent variable. The dependent variable is a variable that is explained or influenced by the independent variable. The dependent variable in this study is the company value. The independent variable is a variable that explains or influences other variables (Wulandari & Efendi, 2022). The dependent variable in this study is the resilience measure or measure of resilience and the independent variable in this study is the customer needs attribute that will be included in the Quality Function Deployment (QFD).

Data Collection Methods

The data used in this study are primary data and secondary data. Primary data is data taken through direct observation. Primary data is used in this study by conducting interviews and filling out questionnaires by PT XYZ. Interviews were chosen as the data collection method because they allow researchers to gain in-depth contextual information from individuals who have a direct understanding of customer needs, and provide an opportunity to explore nuances and details that may not be revealed through other methods. Meanwhile, questionnaires are used to collect data from a large number of respondents efficiently, allowing for a more systematic and representative quantitative analysis of various departments within the company. The combination of these two methods is expected to provide a comprehensive picture of customer needs and potential risks faced by the company. While secondary data is obtained from other references such as journals and previous research. This study also uses previous research as a reference and to support this study. This study also uses previous research as a reference and to support this study. In selecting secondary data sources, we emphasize journals and studies that are relevant to the research issue and the industry it is closely related to. This strategy ensures that the insights and conclusions derived from these sources are relevant and can significantly enhance our analysis. By concentrating on literature that addresses comparable challenges and contexts, we strengthen the credibility and relevance of our research framework, allowing us to leverage existing knowledge and best practices in the industry. This careful selection process not only strengthens our methodological foundation but also ensures that our findings are based on a comprehensive understanding of the scope and current trends affecting the industry.

The data collected are in the form of customer needs assessment data, frequency of potential risks, assessment of the level of impact of risk causes on potential risks, and assessment of the effectiveness of resilience actions. Through a literature study, 29 customer needs attributes were obtained from various sources. After that, an interview was conducted with the company that had an understanding of the needs that were usually requested by customers. In this interview, confirmation was also carried out regarding the references that had been obtained previously. After brainstorming with the marketing team, from the 29 customer needs attributes, 19 attributes were determined to be used in this study based on adjustments to the company's conditions. In addition, for potential risks, 20 attributes were obtained, 27 risk causes, and 27 resilience measures. After identifying the required attributes, an assessment was carried out by the company. This assessment was carried out to determine the absolute importance value, weight, and obtain the relative importance value of these attributes. The questionnaires made in this study were 4 questionnaires, namely a questionnaire assessing the level of importance of customer needs, a questionnaire assessing the level of frequency of potential risks, a questionnaire assessing the level of impact of risk causes on potential risks, and a questionnaire assessing the level of effectiveness of resilience measures. The customer needs assessment questionnaire was carried out by the company's marketing department and the person who filled out the other 3 questionnaires was one representative from 6 departments

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including the purchasing, marketing, ppic, production, quality control, and warehouse departments.

Results and Discussion

Data Collection

Customer needs attributes are obtained through literature studies from research conducted by Wicaksono (2021), Istianah et al. (2021), Ernawati et al. (2023), and adjusted to company conditions by brainstorming with the company. In the following table, 19 attributes were obtained based on brainstorming with the company's marketing team who have an understanding of customer needs and agree on the given need attributes.

Table 1. Identification of Customer Needs

Variable	Attribute
P1	Competitive price
P2	Fast transaction
P3	Fast in providing service
P4	The company always provides the best solutions
P5	There are no invoice errors
P6	Company is responsive to questions/complaints about goods
P7	Warranty guarantee against damage to goods
P8	Availability of facilities to obtain information and convery criticism/suggestions
P9	The price corresponds to the quality
P10	Strong texture
P11	Price stability
P12	Bright and attractive colors
P13	Contamination free
P14	Appropriate product particle shape/size
P15	Fresh smell
P16	Providing a period of time for payment
P17	Market protection guarantee
P18	Easy of making order
P19	Compliance with the quantity and type of products oredered

Source: Wicaksono (2021), Istianah, et al. (2021), Ernawati, et al. (2023), and PT XYZ.

Potential risk attributes are determined based on literature studies from research conducted by Yazdani et al. (2019), Kumar & Singh (2021), Hsu et al. (2021), Jianying et al. (2021), Baig et al. (2022), Ernawati et al. (2023), Marchello et al., (2023), Novitasari et al. (2024), and adjusted to company conditions by brainstorming with the company. In the following table, 20 attributes were obtained based on literature studies and brainstorming with companies that have an understanding of supply chain risk.

Table 2. Identification of Potential Risk

Variable	Attribute
R1	Rare raw materials
R2	Import disruption
R3	Uncertainty of supply & distribution
R4	Natural disasters
R5	Estimated errors in planning

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R6	Stacking of raw materials
R7	Disturbances in information systems
R8	Inappropriate raw material procurement prices that affect suppliers
R9	High material production costs
R10	The quality of production materials is poor
R11	Bad relationship with dealer/agent
R12	Demand fluctuations
R13	The quality of the incoming raw materials does not meet standards
R14	Inappropriate product pricing affects the consumer market
R15	Return product
R16	Error when loading feed products
R17	Mismatch between product stock in the warehouse and in the system
R18	IT system down
R19	Product price instability
R20	Downtime during production

Source: Yazdani et al. (2019), Kumar & Singh (2021), Hsu et al. (2021), Jianying et al. (2021), Baig et al. (2022), Ernawati et al. (2023), Marchello et al., (2023), Novitasari et al. (2024), PT XYZ.

The attributes of potential risk causes are obtained through literature studies from research by Hsu et al. (2021), Qisthani & Hidayatuloh (2021), Baig et al. (2022), Marchello et al. (2023), and adjusted to the identified risk potential and also the company's condition through brainstorming with the company parties related to the supply chain. In the following table, 27 attributes were obtained based on literature studies and brainstorming with company parties who have an understanding of the causes of risk.

Table 3. Identification of Risk Causes

Variable	**Attribute**
CR1	Climate Change and natural factors
CR2	There are transportation restrictions
CR3	Changes in government policy
CR4	Pandemic
CR5	Inadequate risk management mechanisms
CR6	Suppliers prioritize other buyers' orders
CR7	Depends on the particular supplier
CR8	Bad weather
CR9	Improved product costs, logistics and quality
CR10	Inappropriate production planning
CR11	Lack of maintenance of communication equipment
CR12	The company's pricing strategy is not good
CR13	Fluctuations in raw material prices
CR14	Poor supplier quality control
CR15	Not communicating well before work
CR16	Changes in prices and distributor warehouse availability
CR17	Mistake in choosing a supplier
CR18	Poor overall product cost control
CR19	Falling of products from forklift during transfer/arrangement of feed products
CR20	Moldy feed
CR21	Damage to feed products
CR22	Operational negligence

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CR23	Improrer handling by staff
CR24	Lack of employee training and supervision
CR25	Hacker attack
CR26	Price changes from marketing and economic policies
CR27	Damage to production machine

Source: Hsu et al. (2021), Qisthani & Hidayatuloh (2021), Baik et al. (2022), Marchello et al. (2023), Saraswati (2017), and PT XYZ.

The resilience measure attribute or resilience measure was obtained through a literature study from Shingh et al. (2019), Kenanga & Ardi (2022), and adjusted to the company's conditions. In the following table, 26 attributes were obtained based on literature studies and brainstorming with company parties who have an understanding of resilience measures.

Table 4. Resilience Measure Identification

Variable	Indicators	Sub-Indicators
RM1	Security	Cyber Security
RM2		Access Security
RM3		Redundancy in IT systems
RM4	Visibility	Real time strategy decisions
RM5		Knowledge of operating assets
RM6		Supply chain visibility
RM7	Collaboration	Inventory holding costs
RM8		Demand forecasting
RM9		Risk sharing
RM10		Production planning
RM11		Supplier delivery efficiency
RM12	Agility	The Security and accuracy of delivery
RM13		Product quality
RM14		Stock availability level
RM15		Fast marketing response
RM16	Flexibility	Delivery of goods on time
RM17	Efficiency	Preventive maintenance and repairs
RM18	Redundancy	Changes to production plans
RM19	Financial Strenght	Insurance
RM20		Price margins
RM21	Market position	Customer relations
RM22	Risk Management	Monitoring
RM23		Effective communication
RM24	Knowledge Management	Training
RM25		Teamwork
RM26		Caring culture

Source: Shingh et al. (2019), Kenanga & Ardi (2022), and adjusted to the company's conditions

Data Processing

Based on the customer needs data that has been identified in table 4.1, an assessment is carried out using an importance scale by the company's marketing team. Customer needs are rated by comparing and ranking them based on their importance. Importance Weight (Ii) or importance value is determined using a Likert scale from 1 to 5 starting from very unimportant, not

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important, quite important, important and very important. The following table is the result of the customer needs attribute assessment.

Table 5. Value of The Customer Needs

Variable	Attribute	Important Scale
P1	Competitive price	4
P2	Fast transaction	3
P3	Fast in providing service	4
P4	The company always provides the best solutions	5
P5	There are no invoice errors	5
P6	Company is responsive to questions/complaints about goods	5
P7	Warranty guarantee against damage to goods	3
P8	Availability of facilities to obtain information and convery criticism/suggestions	4
P9	The price corresponds to the quality	3
P10	Strong texture	4
P11	Price stability	4
P12	Bright and attractive colors	4
P13	Contamination free	4
P14	Appropriate product particle shape/size	4
P15	Fresh smell	4
P16	Providing a period of time for payment	4
P17	Market protection guarantee	4
P18	Easy of making order	5
P19	Compliance with the quantity and type of products oredered	3

In the table, it can be seen that the customer needs that get the lowest importance value are fast transactions, the company is easy to contact, there are no invoice errors and the appropriateness of the number and type of products ordered with an importance value of 3. Next, the weight calculation for each customer needs attribute is carried out using formula 2.1.

HOQ 1 Calculation

The initial stage of HOQ 1 is to determine customer needs into Customer Needs (What's) and calculate their weight.

Table 6. Weight of Customer Needs

Attribute	I_i	W_i
Competitive price	4	0,053
Fast transaction	3	0,039
Fast in providing service	4	0,053
The company always provides the best solutions	5	0,066
There are no invoice errors	5	0,066
Company is responsive to questions/complaints about goods	5	0,066
Warranty guarantee against damage to goods	3	0,039
Availability of facilities to obtain information and convery criticism/suggestions	4	0,053
The price corresponds to the quality	4	0,053
Strong texture	3	0,039

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Price stability	4	0,053
Bright and attractive colors	4	0,053
Contamination free	4	0,053
Appropriate product particle shape/size	4	0,053
Fresh smell	4	0,053
Providing a period of time for payment	4	0,053
Market protection guarantee	4	0,053
Easy of making order	5	0,066
Compliance with the quantity and type of products oredered	3	0,039

From the weight calculation above, it is found that customer needs have an importance value of 5, namely 4 attributes with a weight of 0.066, a value of 4 is 11 attributes with a weight of 0.053, and a value of 3 is 4 attributes with a weight of 0.039. The results show that customers want companies to be responsive to questions/damaged goods, provide a guarantee for damaged goods, the company always provides the best solutions, and ease in placing orders. The next step is to identify potential risks and assign a probability value, which is obtained through brainstorming with the company.

Table 7. Average Value of The Risk Potential

Variable	Attribute	Likelihood Scale
R1	Rare raw materials	1,17
R2	Import disruption	1,17
R3	Uncertainty of supply & distribution	1,67
R4	Natural disasters	1,00
R5	Estimated errors in planning	1,50
R6	Stacking of raw materials	2,17
R7	Disturbances in information systems	1,83
R8	Inappropriate raw material procurement prices that affect suppliers	1,67
R9	High material production costs	1,67
R10	The quality of production materials is poor	1,83
R11	Bad relationship with dealer/agent	1,00
R12	Demand fluctuations	1,83
R13	The quality of the incoming raw materials does not meet standards	2,00
R14	Inappropriate product pricing affects the consumer market	1,83
R15	Return product	2,00
R16	Error when loading feed products	2,00
R17	Mismatch between product stock in the warehouse and in the system	2,00
R18	IT system down	1,50
R19	Product price instability	1,50
R20	Downtime during production	1,67

From the table above, it can be seen that the potential that has a value of 2.17 is 1 potential risk; a value of 2 is 4; a value of 1.83 is 4; a value of 1.67 is 4; a value of 1.5 is 3; a value of 1.17 is 2; a value of 1 is 2 attributes.

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Table 8. Ranking Results Based on HOQ 1 Calculations

Variable	Risk Potential	AI_j	RI_j	*Ranking*
R1	Rare raw materials	0,386	0,022	14
R2	Import disruption	0,262	0,015	18
R3	Uncertainty of supply & distribution	0,264	0,015	17
R4	Natural disasters	0,172	0,01	20
R5	Estimated errors in planning	0,174	0,041	7
R6	Stacking of raw materials	0,258	0,015	19
R7	Disturbances in information systems	1,707	0,097	3
R8	Inappropriate raw material procurement prices that affect suppliers	1,525	0,087	4
R9	High material production costs	0,354	0,02	15
R10	The quality of production materials is poor	0,651	0,037	9
R11	Bad relationship with dealer/agent	0,356	0,02	16
R12	Demand fluctuations	1,449	0,082	5
R13	The quality of the incoming raw materials does not meet standards	0,766	0,044	6
R14	Inappropriate product pricing affects the consumer market	0,507	0,029	11
R15	Return product	3,58	0,204	1
R16	Error when loading feed products	2,38	0,135	2
R17	Mismatch between product stock in the warehouse and in the system	0,502	0,029	12
R18	IT system down	0,588	0,033	10
R19	Product price instability	0,716	0,041	8
R20	Downtime during production	0,438	0,025	13

Based on data processing on HOQ 1, 5 potential risks were obtained with the highest AIj and RIj values, namely the risk of product returns, disruption to the information system, inappropriate raw material procurement prices that affect suppliers, errors when loading feed products, and demand fluctuations.

HOQ 2 Calculation

Based on the identified risk causes, an assessment is carried out for each risk attribute cause by the company by considering the potential risks that arise.

Table 9. Average Value of Cause of Risk

Variable	Risk Code	Causes of Risk	*Impact Scale*
CR1	R1	Climate Change and natural factors	2,67
CR2	R2	There are transportation restrictions	3,17
CR3		Changes in government policy	3,83
CR4		Pandemic	3,83
CR5	R3	Inadequate risk management mechanisms	3,50
CR6		Suppliers prioritize other buyers' orders	3,00
CR7		Depends on the particular supplier	3,33
CR8	R4	Bad weather	2,50
CR9	R5	Improved product costs, logistics and quality	3,17
CR10	R6	Inappropriate production planning	3,50
CR11	R7	Lack of maintenance of communication equipment	3,17
CR12	R8	The company's pricing strategy is not good	3,67

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CR13	R9	Fluctuations in raw material prices	3,83
CR14	R10	Poor supplier quality control	3,33
CR15	R11	Not communicating well before work	3,33
CR16	R12	Changes in prices and distributor warehouse availability	3,17
CR17	R13	Mistake in choosing a supplier	3,00
CR18	R14	Poor overall product cost control	3,50
CR19	R15	Falling of products from forklift during transfer/arrangement of feed products	3,17
CR20		Moldy feed	4,33
CR21		Damage to feed products	4,33
CR22	R16	Operational negligence	4,17
CR23		Improrer handling by staff	3,50
CR24	R17	Lack of employee training and supervision	3,33
CR25	R18	Hacker attack	3,83
CR26	R19	Price changes from marketing and economic policies	4,17
CR27	R20	Damage to production machine	3,83

In the table, it can be seen that there are 2 risk causes that have an impact scale value of 4.33; 2 risk causes with a value of 4.17; 5 risk causes with a value of 3.83; 1 risk cause with a value of 3.67; 4 risk causes with a value of 3.50; 4 risk causes with a value of 3.33; 5 risk causes with a value of 3.17; 2 risk causes with a value of 3; 1 risk cause with a value of 2.67; and 1 risk cause with a value of 2.5.

Table 10. Ranking Results Based on HOQ 2 Calculations

Variabel	**Causes of risk**	**AI_k**	**RI_k**	**Ranking**
CR1	Climate Change and natural factors	2,080	0,014	23
CR2	There are transportation restrictions	1,125	0,008	26
CR3	Changes in government policy	3,022	0,021	14
CR4	Pandemic	2,390	0,016	20
CR5	Inadequate risk management mechanisms	3,269	0,023	13
CR6	Suppliers prioritize other buyers' orders	0,879	0,006	27
CR7	Depends on the particular supplier	2,737	0,019	18
CR8	Bad weather	3,113	0,021	15
CR9	Improved product costs, logistics and quality	2,209	0,015	22
CR10	Inappropriate production planning	0,868	0,075	6
CR11	Lack of maintenance of communication equipment	3,005	0,021	16
CR12	The company's pricing strategy is not good	3,776	0,026	10
CR13	Fluctuations in raw material prices	6,691	0,046	8
CR14	Poor supplier quality control	19,677	0,136	1
CR15	Not communicating well before work	3,566	0,025	11
CR16	Changes in prices and distributor warehouse availability	5,284	0,036	9
CR17	Mistake in choosing a supplier	19,125	0,132	2
CR18	Poor overall product cost control	2,842	0,020	17

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CR19	Falling of products from forklift during transfer/arrangement of feed products	2,577	0,018	19
CR20	Moldy feed	8,534	0,059	7
CR21	Damage to feed products	12,280	0,085	4
CR22	Operational negligence	11,968	0,083	5
CR23	Improrer handling by staff	14,718	0,102	3
CR24	Lack of employee training and supervision	1,948	0,013	24
CR25	Hacker attack	1,444	0,010	25
CR26	Price changes from marketing and economic policies	3,478	0,024	12
CR27	Damage to production machine	2,367	0,016	21

Based on data processing on HOQ 2, the 5 highest risk causes were obtained, It can be seen that the one with the highest RIl value is poor supplier quality control, wrong supplier selection, improper handling by staff, improper production planning, and damage to feed products.

HOQ 3 Calculation

Based on the resilience measures that have been identified, an assessment of each resilience measure attribute is carried out by the company using an effectiveness scale.

Table 11. Average Value of Resilience Measure

Variable	Indicators	Sub-Indicators	Effectiveness Scale
RM1	Security	Cyber Security	4,7
RM2		Access Security	4,3
RM3		Redundancy in IT systems	4,0
RM4	Visibility	Real time strategy decisions	4,5
RM5		Knowledge of operating assets	4,2
RM6		Supply chain visibility	4,0
RM7	Collaboration	Inventory holding costs	3,3
RM8		Demand forecasting	3,5
RM9		Risk sharing	3,7
RM10		Production planning	4,2
RM11		Supplier delivery efficiency	4,0
RM12	Agility	The Security and accuracy of delivery	4,2
RM13		Product quality	4,7
RM14		Stock availability level	4,5
RM15		Fast marketing response	4,7
RM16	Flexibility	Delivery of goods on time	4,7
RM17	Efficiency	Preventive maintenance and repairs	3,8
RM18	Redundancy	Changes to production plans	3,5
RM19	Financial Strenght	Insurance	4,0
RM20		Price margins	4,3
RM21	Market position	Customer relations	4,2
RM22	Risk Management	Monitoring	4,3
RM23		Effective communication	4,3
RM24		Training	4,3

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RM25	Knowledge Management	Teamwork	4,3
RM26		Caring culture	4,2

From the table above, it can be seen that the potential that has a value of 2.17 is 1 potential risk; a value of 2 is 4; a value of 1.83 is 4; a value of 1.67 is 4; a value of 1.5 is 3; a value of 1.17 is 2; a value of 1 is 2.

Table 12. Ranking Results Based on HOQ 3 Calculations

Variable	**Indicators**	**Sub-Indicators**	**AI_l**	**RI_l**	**Ranking**
RM1	Security	Cyber Security	1,349	0,013	19
RM2		Access Security	1,273	0,012	20
RM3		Redundancy in IT systems	0,860	0,008	25
RM4	Visibility	Real time strategy decisions	3,938	0,039	10
RM5		Knowledge of operating assets	7,153	0,070	6
RM6		Supply chain visibility	1,116	0,011	24
RM7	Collaboration	Inventory holding costs	1,185	0,012	21
RM8		Demand forecasting	1,187	0,012	22
RM9		Risk sharing	1,850	0,018	17
RM10		Production planning	2,789	0,048	9
RM11		Supplier delivery efficiency	2,416	0,024	14
RM12	Agility	The Security and accuracy of delivery	0,701	0,007	26
RM13		Product quality	1,184	0,012	23
RM14		Stock availability level	10,647	0,104	2
RM15		Fast marketing response	2,350	0,023	16
RM16	Flexibility	Delivery of goods on time	2,797	0,027	13
RM17	Efficiency	Preventive maintenance and repairs	7,786	0,076	5
RM18	Redundancy	Changes to production plans	2,853	0,028	12
RM19	Financial Strenght	Insurance	10,616	0,104	3
RM20		Price margins	5,517	0,054	7
RM21	Market position	Customer relations	5,099	0,050	8
RM22	Risk Management	Monitoring	8,978	0,088	4
RM23		Effective communication	3,492	0,034	11
RM24	Knowledge Management	Training	11,116	0,109	1
RM25		Teamwork	2,417	0,024	15
RM26		Caring culture	1,432	0,014	18

Based on the table, It can be seen that the one with the highest RIl value is training, which shows that by carrying out the mitigation, it can provide the greatest impact on reducing the impact of previously identified risk causes. For the lowest value, namely security and accuracy of delivery, which shows that the mitigation has the smallest impact on reducing the occurrence of the impact of the identified risk causes.

Training resilience measures

Employee training is important to improve their skills and knowledge in dealing with change. With the right training, employees will be better prepared to deal with problems that arise,

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both in the production process and in interactions with customers. This also includes developing skills in the use of new technologies and risk management

Resilience measure stock availability level

Ensuring adequate stock availability is essential to meet customer demand. Companies need to conduct demand analysis to determine optimal stock levels, so that they can avoid product shortages that can harm sales and customers.

Insurance resilience measure

Taking appropriate insurance can protect the company from financial losses due to product damage or disasters. Insurance acts as a safety net, maintaining customer trust and providing peace of mind for management to focus on business development.

Monitoring resilience measure

Effective monitoring allows companies to analyze risks and respond to changes in demand in real time. With the right information system, companies can collect relevant data to identify potential problems and make better decisions. In addition, monitoring resilience steps can be taken to reduce the risk of poor supplier quality control so that the quality of the final product can be maintained and reduce product returns from customers.

Resilience measure preventive maintenance and repair

Performing preventive maintenance and repair on information systems and production equipment is important to reduce the risk of operational disruptions. With routine maintenance, companies can ensure product quality and smooth operations before delivery.

Conclusion

Based on the results of data processing, a supply chain resilience design has been made with the QFD (Quality Function Deployment) method approach at PT JCI Sidoarjo unit through the preparation of HOQ 1 with the results of the 5 highest potential risks, namely product returns, disruptions to the information system, inappropriate raw material procurement prices that affect suppliers, errors when loading feed products, and fluctuations in demand. Furthermore, the preparation of HOQ 2 with the results of the 5 highest causes of risk, namely errors in choosing suppliers, poor supplier quality control, improper handling by staff, improper production planning, and damage to feed products. Then the preparation of HOQ 3 was carried out with the results of the 5 highest resilience measures, namely insurance resilience measure errors, training, stock availability levels, monitoring, and preventive maintenance & repairs.

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