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Risk Analysis and Mitigation in the Coffee Supply Chain (Case Study: XYZ MSME, Klungkung)

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Abstract

XYZ is one of the coffee processing MSMEs located in Klungkung Regency, Bali. In carrying out its operations, this MSME encounters several problems, one of which is the lack of green bean raw materials. This condition has the potential to cause production targets to not be achieved, so that consumer demand cannot be met. This problem can cause losses for MSME, so efforts are needed to anticipate and reduce the risks that occur due to the lack of raw materials. This study aims to identify risk events and risk sources, as well as to design mitigation strategies to minimize the impact of risks on the supply chain at XYZ MSME. The HOR method consists of two phases. Identifying risk events and sources is done in HOR phase 1, and designing mitigation solutions for priority risk agents is done in HOR phase 2. According to the study's findings, there are 56 risk agents and 31 risk events, with 23 risk agents prioritized according to their Aggregate Risk Potential (ARP) value. Furthermore, 17 mitigation strategies were designed to reduce risk, and nine of these strategies were selected as the top priorities in risk management. These priority strategies include setting quality standards for green bean suppliers, implementing a strict penalty or price discount system, providing a buffer stock of raw materials, implementing a safety stock system for raw materials, adding potential suppliers from different locations, improving supplier selection and evaluation, establishing cooperation contracts for a specific period of time, with setting price standards, preparing new suppliers, and forming a Quality Control (QC) team.

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INTRODUCTION

Coffee is one of the agricultural commodities that holds a important position in the Indonesian economy. As an agricultural country, coffee contributes significantly to the export sector and in creating jobs for the community. Based on data from the Badan Pusat Statistik (2023), the area of coffee plantations in Bali reached 33,791 ha. Buleleng and Tabanan regencies are the areas with the largest coffee plantations, namely 13,126 ha and 10,493 ha.

Coffee is a beverage made from brewing coffee beans that have been roasted and ground into powder. There are two main varieties of coffee that are popular, namely Arabica (*Coffea arabica*) and Robusta (*Coffea Canephora*). Coffee processing is a lengthy procedure that begins harvesting and continues through bean processing, roasting, to grinding into coffee powder (Tawakal, 2022).

Micro, Small, and Medium Businesses (MSMEs) are one industry that contributes to the processing of coffee. MSMEs are subject to both internal and external influences and are dynamic. Every firm, regardless of size, that expands has the potential to encounter risks in the form of unforeseen circumstances that might result in losses for the organization, according to Sarjana et al. (2022). Risk management is very important for small businesses to reduce and minimize potential losses, given that the risks faced by small and medium industries are quite diverse (Sari et al., 2017)

XYZ MSME is a coffee processing business in Bali that sources its raw materials from farmers in Pupuan District, Tabanan Regency. The supply chain at XYZ MSME faces several problems. One of the problems is the lack of green bean raw materials, while demand continues to increase. This MSME does not use formal contracts with supplier farmers, but instead makes advance payments before the harvest period. This has the potential to create risks, such as uncertainty in the availability of raw materials for MSMEs. Another supply chain risk that may have an impact on this MSME's sustainability is pricing volatility and production cost instability. As a result, efficient risk management is necessary to reduce the possibility of risks in the supply chain.

The method used to analyze risks in the XYZ MSME supply chain is the House of Risk (HOR) method. According to Pujawan and Geraldin (2009), this approach combines the Failure Mode and Effects Analysis (FMEA) for determining the degree of risk with the House of Quality (HOQ) model for prioritizing risk agents according to their Aggregate Risk Potential (ARP) value and creating mitigation plans to lessen the impact. This approach

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reduces the **probability** of risk agents appearing in the supply chain by emphasizing proactive risk management. Furthermore, the Supply Chain Operations Reference (SCOR) served as the basis for risk detection in this research model that describes supply chain activities and flows by including five primary processes: plan, source, make, deliver, and return. This method makes it easier to find possible risks in any supply chain operation. The HOR approach has been used in a number of earlier research to identify supply chain risk reduction tactics (Purnomo et al., 2021; Suryaningrat & Paramudita, 2022; Ulfaturrahmi & Nugrahani, 2024). These studies' findings demonstrate the efficacy of the HOR technique in determining risk occurrences and their agents as well as in developing risk management plans. As stated above, this research is to identify and analyze potential risks within the coffee supply chain of XYZ MSME using House of Risk (HOR) method, as well as to design appropriate mitigation strategies.

LITERATURE REVIEW

Suppy Chain Management

A logistics network, the supply chain is made up of chains that deliver commodities from raw materials to completed items. According to Gunawan and Wahyuni (2024), the parties engaged include manufacturers, suppliers, warehouses, retailers, and the consumers themselves.

Supply chain management is a series of integrated processes that include planning, implementation, control, and monitoring of the flow of goods, services, and information from start to finish. The main components of supply chain management include procurement (procurement of raw materials and production resources), manufacturing (the process of converting raw materials into finished products), distribution (distribution of products to retailers or end consumers), inventory management (management of inventory to maintain product availability in accordance with demand), and transportation and logics (arranging transportation and logistics management to make product delivery more efficient) (Syamil et al., 2023).

Risk Management

Risk management is a systematic process of initial identification, analysis, planning, and control of risks within an organization with the aim of minimizing adverse effects and events and maximizing the possibility and impact of positive events, which are referred to as opportunities (Kristiana et al., 2022). Important steps that can be applied in risk

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management include risk identification, risk analysis, risk evaluation, risk treatment, and risk monitoring and review (Sarjana et al., 2022).

Supply Chain Operation Reference (SCOR)

Supply Chain Operation Reference (SCOR) is a process-based reference model commonly used to measure supply chain performance (Liputra et al., 2018). According to Warella et al. (2021), the SCOR model consists of five main processes, namely Plan (production planning to balance demand and availability of raw materials to finished products), source (procurement and purchase of raw materials from suppliers), make (processing raw materials into semi-finished or finished products), deliver (inventory management, transportation, and warehousing to meet consumer demand), and return (return of products due to non-compliance with demand or expected quality).

House of Risk (HOR)

Failure Mode and Effect Analysis (FMEA) and House of Quality (HOQ) are two concepts that are used in House of Risk to quantitatively evaluate risks and identify which risk agents should be given priority for mitigation. Using this approach, companies may determine the best course of action to reduce possible hazards caused by risk agents. By focusing on preventive risk management, the HOR approach focuses on lowering the likelihood of risk occurrences within the supply chain (Magdalena & Vannie, 2019).

The two primary phases of the HOR model are phase 1 (risk identification) and phase 2 (risk management). Phase 1 focus on determining priority risk agents for preventive measures, while Phase 2 provides specific measures taking into account available resources (Trenggonowati & Pertiwi, 2017).

Pareto Diagram

The Pareto diagram is a method used to identify and prioritize the most significant problems, thereby assisting in more effective decision-making (Irfanto, 2022). The Pareto principle, often referred to as the 80/20 rule, explains that roughly 80% of issues originate from 20% of the key causes. Throughout a quality improvement program, Pareto analysis may be used to identify the best course of action for corrective action at different phases (Gunawan & Tannady, 2016).

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METHODS

The research was conducted at XYZ MSME located at Jalan Werkudara Gg. 1a No. 3, Semarapura Kelod Kangin, Klungkung District, Klungkung Regency, Bali. The research was conducted from March to August 2025. Data analysis and processing were carried out at the Industrial Engineering and Management Laboratory, Faculty of Agricultural Technology, Udayana University.

The data was sourced from primary and secondary data. Primary data were obtained through direct observation, interviews, and the distribution of questionnaires to expert respondents, while secondary data were collected from information already available at the company, such as an overview of XYZ MSME and coffee production data.

The selection of expert respondents was conducted using purposive or judgment sampling techniques, meaning that informants were picked according to predetermined standards pertinent to the study's goals. The expert respondents in this study consisted of one owner of XYZ MSME, one worker in the roasting department, one worker in the administration and product packaging department, and two academics from Udayana University who have expertise in the field of supply chains.

The House of Risk (HOR) approach, which comprises two phases HOR phase 1 and HOR phase 2. The following is an explanation of the HOR phase:

House of Risk 1

Identifying risk events and risk agents is the goal of HOR phase 1, which also attempts to rank the risk agents that should be given top priority when developing risk mitigation plans. The phases of HOR phase 1 are as follows:

a. Supply Chain Operations Reference (SCOR) method mapping of supply chain activities in XYZ MSME, which divides supply chain operations into five main activities: plan, source, make, deliver, and return.
b. Identify risk events and risk sources.
c. Assesment of impact severity (S) resulting from the occurrence of a risk event. As stated by Shahin (2004), the evaluation scale is a 1–10 scale that shows the risk's effect in decreasing order: none, very little, little, small, moderate, significant, large, very large, serious, and dangerous.
d. Assessment of the risk agent's occurrence (O). Shahin (2004) claims that the evaluation scale is a 1–10 scale that shows the effect of risk in the following decreasing order: almost never, very small, slight, small, moderate, fairly high, high, very high, and almost certain.

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e. Correlation assessment (R_{ij}) between identified risk events and risk agents, **using a scale of 0, 1, 3, and 9, which respectively indicate no correlation, low correlation, moderate** and high correlation.
f. The Aggregate Risk Potential (ARP) value is calculated using the following formula:

$$ARP_j = O_j \Sigma\, S_i R_{ij} \text{ .....(1)}$$

Explanation:
O_j : Occurrence risk agent
S_i : Severity risk event
R_{ij} : Correlation between risk event i and risk agent j

g. According to the ARP values, each detected risk agent is ranked from highest to lowest.
h. After that, a Pareto diagram is used to rank the risk agents according to their ARP values. Approximately 80% of all risk occurrences come from 20% of the risk agents, according to this graphic, which uses the 80/20 principle**.**

House of Risk 2

In HOR phase 2, prioritized risk agents that will be addressed by mitigation methods are further identified. The objective is to reduce the harm that these risk sources create. Phase 2 of HOR included the following steps:

a. Identify appropriate mitigation strategies for priority risk sagents
b. Calculating each mitigation strategy's correlation value (Ejk) with risk agents. This correlation is calculated on a scale of of **0, 1, 3, and 9,** which respectively represent **no correlation, weak correlation, moderate,** and **strong correlation.**
c. Next, each mitigation strategy's total effectiveness value (TEk) is computed using the following formula:

$$TEk = \Sigma ARP_j E_{jk} \text{.....(2)}$$

Explanation:
TEk : Total effectiveness of each action
ARP_j : Aggregate Risk Potential of risk agent j
E_{jk} : Correlation value between mitigation strategy k and risk agent j

d. Determining the degree of difficulty (Dk) of each mitigation plan to ascertain its applicability. The Dk evaluation employs a scale with values of 3, 4, and 5, which stand for easy, moderately easy, and difficult to apply.

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e. Determination of the total difficulty ratio effectiveness (ETD), which characterizes the possibility of implementing a mitigation approach. The following formula is used in the ETDk calculation:

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

Explanation:
ETD_k : Effectiveness to difficulty of ratio
TE_k : Total Effectiveness of Prevention Strategy
D_k : Degree of difficulty of mitigation actions

f. Ranking of mitigation strategies based on ETDk values from largest to smallest
g. Selection of priority handling strategies based on the ranking results of ETDK values according to the Pareto diagram.

RESULTS AND DISCUSSION

Supply Chain Structure

The supply chain structure of XYZ MSME consists of suppliers (coffee farmers in Tabanan Regency, particularly in the villages of Pujungan, Bongancina, and Pajahan), manufacturers (XYZ MSME) retailers (hotels, resorts, and villas), and end consumers. Coffee farmers act as suppliers of green coffee beans, which are then processed by XYZ MSME into ready-to-consume products through sorting, grading, roasting, grinding, and packaging. The coffee products are then distributed to consumers through two main channels, namely directly to end consumers or through retailers such as hotels, resorts, and villas. The supply chain structure of XYZ MSME is presented in Figure 1.

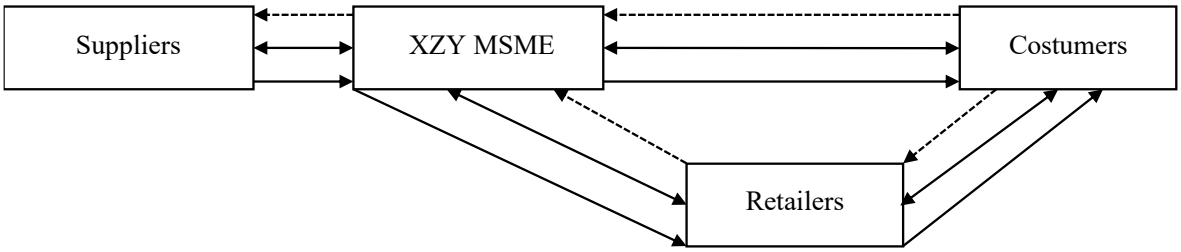


Figure 1. XYZ MSME Supply Chain Structure

: Material flow
: Information flow
: Financial flow

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Supply Chain Activity Mapping

The mapping of the supply chain activities of XYZ MSME was conducted using the Supply Chain Operations Reference (SCOR) model, which includes the processes of plan, source, make, deliver, and return. This activity mapping is used as the basis for identifying risk agents (Puji & Satriardi, 2024). XZY MSME uses SCOR to make it easier to identify risk occurrences and risk agents in each coffee supply chain activity. Table 1 displays the XYZ MSME's activity mapping.

Table 1. Supply Chain Activities of XYZ MSME

Process	Activity
Plan	Planning for green bean raw materials
	Production planning
	Raw material inventory control
Source	Supplier Selection
	Procurement of green beans raw materials
	Collection of raw materials from suppliers
	Raw material inspection
	Storage of raw materials
Make	Sorting green beans
	Roasting process
	Sorting roasted coffee beans
	Grinding process
	Packaging process
Deliver	Product delivery
Return	Return of coffee products from consumers

Source : Data processing (2025)

House of Risk Phase 1

In the House of Risk (HOR) Phase 1, risk identification represents the initial stage of the process. This phase emphasizes the identification of risk events and their associated risk agents, followed by the calculation of the Aggregate Risk Potential (ARP) to determine which risks should be prioritized for mitigation. The identification results in HOR Phase 1 revealed 31 risk events and 56 risk agents, as presented in Tables 2 and 3. After identifying

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the risk events and agents, assessments of severity and occurrence levels for each risk agent were conducted, the results of which are also presented in Tables 2 and 3.

Table 2. Risk Event

Process	Risk Events	Code	Si
Plan	Errors in determining the amount of raw materials	E_1	4
	Delays in ordering raw materials	E_2	4
	Sudden changes in production plans	E_3	4
	Production costs exceed budgeted targets	E_4	7
	Insufficient raw materials	E_5	7
Source	Supplier selection was repeated because the coffee quality did not meet standards	E_6	5
	Uncertainty regarding the availability of raw materials from suppliers	E_7	5
	Increase in the price of *green beans* raw materials from suppliers	E_8	6
	Delays in picking up raw materials	E_9	4
	The quantity of raw materials does not match the order details	E_{10}	5
	The quality of the raw materials received did not match the order	E_{11}	7
	Broken *green beans* detected in the raw materials received	E_{12}	6
	Green beans are not uniform in size	E_{13}	6
	Foreign objects found in raw materials such as twigs, stones, and other foreign objects	E_{14}	7
	Limited storage area/warehouse for raw materials	E_{15}	4
	Decline in the quality of *green beans* in storage warehouses	E_{16}	4

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Make	Coffee bean sorting does not meet standards and separation of foreign objects takes longer	E_{17}	6
	The coffee roasting process is hampered or incomplete	E_{18}	7
	Coffee bean *roast* level is not appropriate	E_{19}	6
	Coffee beans crack during *roasting*	E_{20}	5
	Coffee roasting machine is damaged	E_{21}	7
	Sorting *roasted* coffee beans that have broken during the roasting process takes longer	E_{22}	6
	The coffee grinding process is hampered or incomplete	E_{23}	6
	Coffee grinder is damaged	E_{24}	7
	Shortage of packaging materials such as *pouches* and label stickers	E_{25}	7
	Products are not sealed properly	E_{26}	7
	The packaging process takes a long time when order volume is high	E_{27}	6
Deliver	Product delivery is not on time	E_{28}	4
	Product transportation errors	E_{29}	4
	Products are damaged during shipping	E_{30}	5
Return	Consumer complaints about the quality of products received	E_{31}	4

Source : Data processing (2025)

It is evident from the Table 2 that the risk events with the highest severity value (Si = 7) are found in the *Plan, Source*, and *Make* processes. In the *Plan* process, the risks with the highest severity are *production costs exceeding budgeted targets (E4)* and *insufficient raw materials (E5).* In the *Source* process, The quality of the raw materials received did not match the order *(E11)* and *foreign objects found in raw materials such as twigs, stones, and other foreign materials (E14).* Meanwhile, in the *Make* process, several risks have the highest severity value, including *the coffee roasting process being hampered or incomplete (E18)*, *coffee roaster and grinder damage (E21 and E24),*

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shortage of packaging materials such as pouches and label stickers (E25), and *improperly sealed products (E26).*

Table 3. Risk Agent

Code	Risk Agents	Oj
A_1	Sudden changes in consumer demand, resulting in inaccurate raw material rquierements planning	4
A2	Human error when recording raw material requirements data	2
A3	Lack of coordination between the company and suppliers	2
A4	Limited working capital for initial raw material orders	8
A5	Sudden changes in consumer demand requiring rapid adjustments to production plans	4
A6	Availability of raw materials that do not meet production needs	6
A7	Increased operational costs	3
A8	No buffer stock for raw materials	3
A9	Supplier's inability to meet raw material specifications	6
A10	Lack of a strict supplier selection and evaluation process	5
A11	Coffee production declines due to bad weather or crop failure	6
A12	No long-term cooperation contracts with suppliers	8
A13	Limited number of alternative suppliers	4
A14	Limited production capacity of suppliers	4
A15	Fluctuations in coffee commodity prices on the global market	6
A16	Transportation for picking up raw materials is problematic	2
A17	Traffic congestion or disruption during raw material pickup	3
A18	Errors in the raw material ordering process	4
A19	No re-checking upon receipt of raw materials	4
A20	No comprehensive quality checks are performed during the raw material collection process	5
A21	Careless post-harvest handling at the supplier/farmer level	4
A22	Transportation process of green beans causing pressure and impact	3
A23	Lack of sorting process to separate coffee beans based on size at the supplier level	5

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A24	The sorting process of raw materials at the supplier level is not yet optimal in separating mixed foreign objects	5
A25	Lack of warehouse space planning based on demand projections	3
A26	Failure to implement a quality monitoring system during storage	2
A27	Damage to raw material storage bags	4
A28	Temperature and humidity in the storage room not meeting standards	3
A29	Shortage of labor in the green bean sorting section	3
A30	The amount of raw materials entering the sorting process is too much at one time	3
A31	Limitations of the green bean sorting equipment	3
A32	Power outage during coffee roasting	4
A33	The roasting machine suddenly malfunctioned	3
A34	Error in setting the temperature during the roasting process	2
A35	Roasting time does not meet standards, such as being too fast or too long	2
A36	The temperature is too high and/or the roasting process is too long	3
A37	Uneven moisture content of green beans	5
A38	Uneven size of green beans	4
A39	No regular maintenance of the roasting machine	5
A40	Shortage of labor in the roasted coffee bean sorting section	2
A41	Limitations of roasted coffee bean sorting equipment	3
A42	Power outage during coffee grinding	2
A43	The coffee grinder suddenly malfunctioned	2
A44	The sorting process for roasted coffee beans takes longer	2
A45	Damage to packaging in the grinding machine	5
A46	No buffer stock for packaging support materials	5
A47	Human error in calculating packaging supporting materials	2
A48	The packaging process is carried out in a hurry	2
A49	Workers are not careful enough during packaging sealing	2
A50	Shortage of workers in the product packaging department	2
A51	Traffic congestion during product delivery	2
A52	Limited transportation for delivery	2
A53	Inaccurate product labeling	2

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A54	Packaging does not meet protection standards (not shock-resistant)	2
A55	Product layout during shipping causes risk of damage	3
A56	Product damage due to improper handling during shipping	2

Source : Data processing (2025)

It is evident from the Table 3 that the risk agents with the lowest value have a score of 2, while the top occurrence value has a score of 8. Each risk agent's ARP value is determined upon risk agent identification. By calculating the severity, incidence, and correlation between the risk event and the risk agent, the ARP value for each risk agent is established. A risk's degree of hazard increases with its amount of ARP value. The degree of danger, on the other hand, decreases with a risk's ARP value (Purwaningsih et al., 2021). A Pareto diagram, as seen in Figure 2, is used to identify the priority risk agents after the computation and ranking of each risk agent's ARP values.

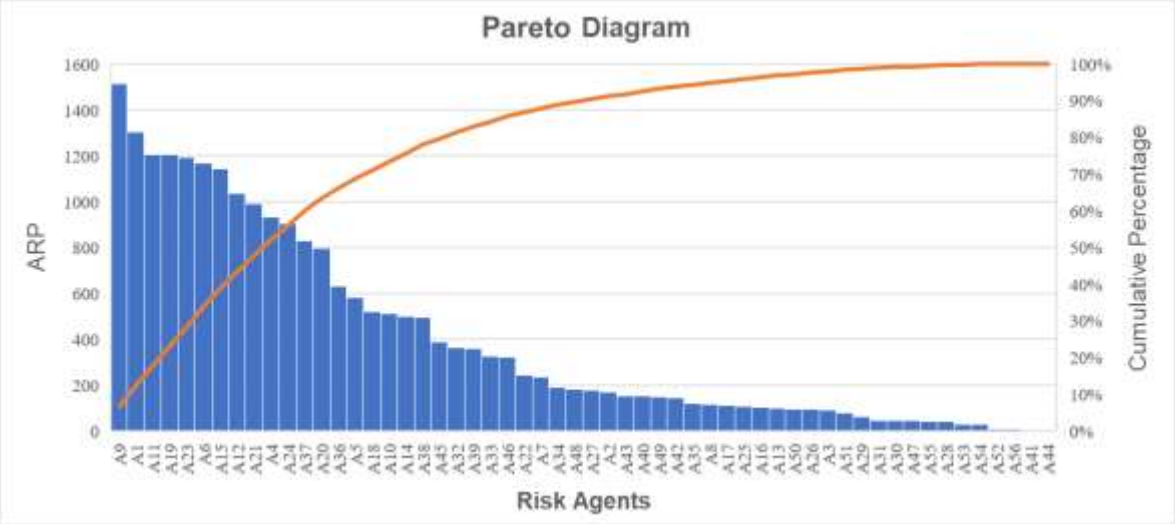


Figure 2. Pareto Diagram of Risk Agents

23 priority risk agents were found using the Pareto diagram method, as shown in Figure 2. According to the 80:20 concept, 20% of risk agents are usually responsible for 80% of risk events that occur. This strategy adheres to this notion. According to the 80:20 principle of the Pareto diagram, 20% of risk agents are responsible for 80% of risk occurrences. Table 4 displays the findings from the first HOR phase's risk agent priority determination.

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Table 4. Priority Risk Agents

Code	Risk Agents	ARP
A9	Supplier's inability to meet raw material specifications	1514
A1	Sudden changes in consumer demand, resulting in inaccurate raw material rquierements planning	1302
A11	Coffee production declines due to bad weather or crop failure	1205
A19	No re-checking upon receipt of raw materials	1204
A23	Lack of sorting process to separate coffee beans based on size at the supplier level	1191
A6	Availability of raw materials that do not meet production needs	1167
A15	Fluctuations in coffee commodity prices on the global market	1140
A12	No long-term cooperation contracts with suppliers	1033
A21	Careless post-harvest handling at the supplier/farmer level	992
A4	Limited working capital for initial raw material orders	931
A24	The sorting process of raw materials at the supplier level is not yet optimal in separating mixed foreign objects	901
A37	Uneven moisture content of green beans	830
A20	No comprehensive quality checks are performed during the raw material collection process	796
A36	The temperature is too high and/or the roasting process is too long	631
A5	Sudden changes in consumer demand requiring rapid adjustments to production plans	583
A18	Errors in the raw material ordering process	518
A10	Lack of a strict supplier selection and evaluation process	510
A14	Limited production capacity of suppliers	501
A38	Uneven size of green beans	496
A45	Damage to packaging in the grinding machine	389
A32	Power outage during coffee roasting	363
A39	No regular maintenance of the roasting machine	360
A33	The roasting machine suddenly malfunctioned	324

Source: Data processing (2025)

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House of Risk Phase 2

The second step of HOR involves creating a plan to mitigate priority risk agents. Phase 2's steps include identifying risk management strategies based on priority risk agents, figuring out how mitigation strategies relate to priority risk agents, figuring out how much of an impact each mitigation strategy has on priority risk agents, figuring out how difficult it is to implement mitigation strategies, and figuring out how effective ETDk is in determining priority management strategies. Table 5 presents the risk mitigation strategy design.

Table 5. Proposed Preventive Action

Code	Preventive Action	Dk
PA1	Improve supplier selection and evaluation	4
PA2	Conducting production evaluations to determine consumer fulfillment estimates	5
PA3	**Setting quality standards for green beans from suppliers**	3
PA4	Implementing a safety stock system for raw materials	4
PA5	Adding potential suppliers from different locations	3
PA6	Establishing cooperation contracts for a specific period with stardardized price	4
PA7	Creating SOP for receiving raw materials in the warehouse	3
PA8	Forming a Quality Control (QC) team	4
PA9	Providing a buffer stock of raw materials	3
PA10	Strictly enforce penalty systems or price reductions	3
PA11	Establishing cooperation with financial institutions	4
PA12	Consistently and regularly evaluating production scheduling	3
PA13	Create SOP for coffee roasting	4
PA14	Creating SOP for production machine maintenance	4
PA15	Double-checking the quantity of raw material orders before sending the purchase order to the supplier	4
PA16	Use of backup power (generator)	4
PA17	Preparing new suppliers	4

Source: Data Processing (2025)

The value of Total Effectiveness (TEk) must then be determined. When the TEk value of each risk mitigation method is determined, it is insufficient to show how well the

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strategy handles hazards (Purwaningsih et al., 2021). To determine the priority mitigation techniques, the ETDk is computed. A mitigation strategy's success in lessening the impact of risk agents is shown by its ETDk value, which compares the strategy's implementation complexity to its effectiveness. Table 6 displays the outcomes of the ETDk computation for every risk mitigation strategy.

Table 6. Rangking of Mitigation Strategy

Code	Preventive Action	ETD	Prioritas
PA3	Setting quality standards for green beans from suppliers	12406	1
PA10	Strictly enforce penalty systems or price reductions	10254	2
PA9	Providing a buffer stock of raw materials	8362	3
PA4	Implementing a safety stock system for raw materials	8234	4
PA5	Adding potential suppliers from different locations	7593	5
PA1	Improve supplier selection and evaluation	6429	6
PA6	Establishing cooperation contracts for a specific period with stardardized price	5840	7
PA17	Preparing new suppliers	4653	8
PA8	Forming a Quality Control (QC) team	4560	9
PA2	Conducting production evaluations to determine consumer fulfillment estimates	4245	10
PA7	Creating SOPs for receiving raw materials in the warehouse	4084	11
PA14	Creating SOP for production machine maintenance	1859	12
PA12	Consistently and regularly evaluating production scheduling	1396	13
PA11	Establishing cooperation with financial institutions	1352	14
PA13	Create SOP for coffee roasting	1252	15
PA15	Double-checking the quantity of raw material orders before sending the purchase order to the supplier	972	16
PA16	Preparing new suppliers	544	17

Source: Data Processing (2025)

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Based on the table above, the next step is to rank the response strategies to determine the priority strategies for risk agents using a Pareto diagram. Based on the Pareto principle, response strategies with ETDk values of less than 80% will be selected as recommendations for the company as risk mitigation measures. From the analysis results, nine main response strategies were obtained, as follows:

a. Setting quality standards for green beans from suppliers (PA3)

   Raw material quality standards are very important for maintaining the quality of the final product. XYZ MSME needs to establish quality criteria for green beans before accepting them from suppliers. This is to ensure that the raw materials meet the desired specifications and to maintain the consistency of the final product quality. According to Ambar Wulandari et al. (2024), applying coffee bean quality standards is crucial to guaranteeing the ultimate quality of ground coffee.

b. Strictly enforce penalty systems or price reductions (PA10)

   XYZ MSME need to implement a penalty or price reduction system for suppliers who do not meet the quality and quantity standards for raw materials. This strategy encourages suppliers to be more disciplined in maintaining the quantity and quality of raw materials. Based on research by Aktas & Ulengin (2016), the implementation of penalty contracts can improve coordination between supply chain members and reduce supply chain operating costs.

c. Providing a buffer stock of raw materials (PA9)

   XYZ MSME need to provide buffer stock (additional inventory) so that the production process can continue even if there are delays or disruptions from suppliers. According to Damayanti et al. (2023), the buffer stock method can reduce the risk of raw material shortages in the production process and is able to meet large order demands.

d. Implementing a safety stock system of raw materials (PA4)

   Safety stock is used to anticipate fluctuations in demand and short-term supply delays. XYZ MSME need to determine the optimal amount of safety stock to maintain smooth production processes and meet customer demand. Implementation of safety stock can prevent raw material shortages and maintain production stability, according to study by Marlina et al. (2024).

e. Adding potential suppliers from different locations (PA5)

   To anticipate the risk of bad weather or crop failure, XYZ MSME need to add potential suppliers from other subdistricts outside the area that has been the main source of raw materials. This strategy helps maintain the sustainability of raw

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material supplies when one area experiences production disruptions. Research by Khusnaini et al. (2023) also proposes the implementation of a strategy of purchasing raw materials from suppliers in other areas to prevent risks such as limited supply from collectors and difficulties for large traders in obtaining pineapples.

f. Improve supplier selection and evaluation (PA1)

Supplier selection and evaluation need to be carried out regularly to ensure thatselected suppliers have the ability to consistently meet raw material requirements. This step is important to anticipate the risks of supply delays, raw material quality discrepancies, and disruptions to the production process. Based on research conducted by Sugengriadi et al. (2025) on *Keripik Singkong Imunk* MSME, it was found that selecting the right suppliers can minimize the risks of supply delays and raw material quality discrepancies.

g. Establishing cooperation contracts for a specific period with stardardized price (PA6)

Establishing contracts with suppliers for a specific period need to be accompanied by standard pricing to avoid fluctuations in raw material costs. This strategy maintains supply stability and strengthens long-term partnerships. According to Cahyanto et al. (2021), formal cooperation contracts help ensure smooth supply and reduce the risk of raw material delays.

h. Preparing new suppliers (P17)

Dependence on a single main supplier can increase the risk of supply disruptions. Therefore, XYZ MSME need to separe new alternative suppliers in the main location of raw material supply so that the production process can continue if there are problems with the main supplier. According to Chintia et al. (2025), a supplier diversification strategy can increase supply chain resilience and ensure greater availability of raw materials

i. Forming a Quality Control (QC) team (PA8)

The formation of a Quality Control (QC) team is necessary to ensure that raw materials and final products meet quality standards. The QC team is tasked with conducting inspections and quality validation, thereby helping to detect and follow up on potential risks before they become serious problems. Based on research by Pangestu et al. (2021), effective QC implementation reduces defective products, lowers repair costs, maintains customer satisfaction, and supports the company's operational sustainability through consistent quality control.

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CONCLUSION

The findings of the study at XZY MSME showed that there were 56 risk agents and 31 risk events, with 23 of them classified as priority risk agents. There are 17 risk management strategies that can be implemented by XZY MSME based on the 23 priority risk agents. Among the 17 risk management strategies, considering the effectiveness of mitigation actions in their implementation, there are 9 main risk management strategies, namely setting quality standards for green bean suppliers, implementing a strict penalty or price reduction system, providing a buffer stock of raw materials, implementing a safety stock system for raw materials, adding potential suppliers from different locations, improving supplier selection and evaluation, establishing cooperation contracts for a specific period of time with price standards, preparing new suppliers, and forming a Quality Control (QC) team.

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