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Supply Chain Risk Mitigation of Banana Bolen Agroindustry at CV Mayang Sari Bandar Lampung City

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ABSTRACT

The supply chain issues of banana bolen products at CV Mayang Sari include the decline in the quality of raw bananas, fluctuations in raw banana prices, difficulties in banana supply, and production constraints that affect product quality and the sustainability of the agroindustry. This study aims to analyze risks, particularly risk sources, and supply chain risk mitigation measures for banana bolen products at CV Mayang Sari in Bandar Lampung City. The research employs a case study method. The respondents in this study consist of supply chain actors, including the owner, banana, sugar, and flour suppliers, four production workers, one marketing staff, and two regular consumers. The data analysis method used is risk analysis utilizing the House of Risk (HOR) method. The results show that there are 33 risk events and 51 risk agents, with 23 priority risk agents. The highest-priority risk agents include weather changes that hinder banana bolen product delivery, sudden machine breakdowns, scheduling inaccuracies in product shipments, errors in oven temperature settings, and sudden large-volume orders of banana bolen. Additionally, 29 mitigation measures were identified, with 16 priority mitigation actions recommended as risk management strategies. The highest-rated mitigation measures include implementing a first-in, first-out (FIFO) system for banana raw materials, improving customer service, maintaining buffer stock, using weather-resistant packaging, and developing a well-structured and detailed production plan.

INTRODUCTION

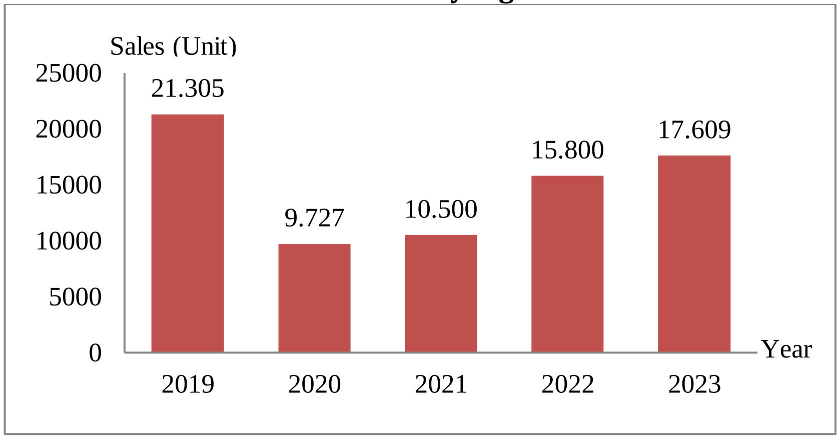
The agricultural sector has a close relationship with natural resources. The more abundant the available natural resources, the better the agricultural sector can develop, making it one of the main pillars of economic growth. Within the agricultural sector, there are several subsectors, including food crops, horticulture, plantations, livestock, and fisheries. Horticultural crops consist of various commodity types, such as fruits, vegetables, ornamental plants, and medicinal plants. Indonesia has a diverse range of horticultural crops, presenting significant opportunities for developing agro-industry in the agricultural sector. Fruits have high nutritional value, not only in their flesh but also in their seeds and peels, making them an essential addition to a nutritious diet that benefits human health (Syahroni, 2017).

One type of fruit with high development potential is bananas, which are part of the horticultural commodity group. Bananas are a leading commodity in Lampung Province, known as one of the largest banana-producing regions in Indonesia. Banana production in this province contributes to regional economic growth. According to data from Badan Pusat Statistik Indonesia (2023), banana production in Lampung Province ranked third highest after East Java and West Java from 2020 to 2022. To enhance economic growth, banana productivity must continue to improve. However, since bananas are perishable and have a relatively low market value, processing them into value-added products becomes an effective solution to increase competitiveness.

The agroindustry sector plays a crucial role in national development every year. This sector encompasses industrial activities that process agricultural products as raw materials while also designing and providing supporting equipment. Through processing, agricultural commodities are transformed into ready to consume products for the public. Bandar Lampung City has significant potential in the processing industry sector to boost economic growth. According to data from the Badan Pusat Statistik Kota Bandar Lampun (2023), the sector contributing to the Gross Regional Domestic Product (GRDP) at constant prices in 2022 was the processing industry sector, amounting to IDR 8.056.83 billion. Considering the substantial contribution of the industrial sector, government efforts are needed to promote economic development that maintains the linkage between the agricultural and industrial sectors through agro-industry.

The high banana production in Lampung Province has encouraged various food businesses to process bananas into different value added products. One example of an agro-industry specializing in banana-based processed products is CV Mayang Sari. CV Mayang Sari is an agro-industry that produces banana-based processed products and continues to operate actively. Additionally, this agro-industry is involved in three key activities: raw material procurement, processing, and marketing. Some of the processed products include premium banana bolen, melted chocolate-cheese bolen, combination bolen, and more. This innovation has attracted interest from both local consumers and tourists visiting Lampung Province, making these products popular as souvenirs (Andela *et al*., 2020). The sales performance of banana bolen at CV Mayang Sari is illustrated in Figure 1. Figure 1 presents the sales data of CV Mayang Sari over the past five years, which has experienced significant fluctuations. In 2019, sales reached 21.305 units but dropped drastically to 9.727 units in 2020. However, sales began to recover in 2022, increasing significantly to 15.800 units and further rising to 17,.609 units in 2023. These fluctuations indicate that the drastic decline in sales was caused by the Covid-19 pandemic, which disrupted activities in the agro industry sector.

Figure 1. Sales of Banana Bolen at CV Mayang Sari from 2019 to 2023 (units)



Source : CV Mayang Sari, 2024
Note : 1 Unit : 0,5 kilogram

If the processing activities in agroindustry are carried out properly, they will result in high-quality products and enable businesses to manage their operations effectively and accurately to ensure continuous growth (Anantapuri *et al*., 2021). Issues arising in the supply chain can affect agroindustry activities. These problems may be caused by various factors, including the availability of raw materials, disruptions in the production process, and distribution constraints that hinder the delivery of products to consumers. In its operations, CV Mayang Sari cannot avoid potential risks (Setyadi & Kusumawati, 2016). The price of bananas tends to fluctuate, ranging from Rp 5.000 to Rp 12.000, depending on the season, weather conditions, and other factors such as plant diseases and supply chain disruptions. These price fluctuations can affect the stability of production costs and profit margins for producers. During the peak harvest season, banana prices usually drop significantly due to an oversupply, while during the off-season, prices can soar due to limited supply.

This price instability poses a significant challenge for producers in planning and managing production costs. Errors in raw material planning, delays in raw material arrivals, and damaged raw materials are some of the risks that can arise in the supply chain activities of an agroindustry. The number of bananas used per order is 300–400 bunches and is utilized within three days of production, with a ripeness standard of 85%. This ripeness percentage is determined based on the banana skin color, which should not have brown spots and should not yet be yellow. Additionally, difficulties in obtaining a sufficient supply of high-quality bananas also present challenges for producers, especially during peak production periods. Prolonged rainy seasons, pest attacks, and plant diseases can lead to reduced banana production. This affects the availability of raw materials for banana processing industries, ultimately disrupting the production process and reducing production capacity. Producers often need to source bananas from other regions, which can increase transportation and logistics costs and impact the quality of the raw materials received.

The production process of banana bolen has been carried out using modern methods, including equipment such as mixers, dough flatteners, ovens, and others. However, issues such as improperly expanded pastry dough and overbaking due to excessive time in the oven remain challenges in the production process. At CV Mayang Sari, the standard dough weight for each banana bolen is set at 25 grams per piece. If the dough weight exceeds this limit, the bolen pastry may not expand properly in the oven. Additionally, errors in the product sorting process are another risk faced by agroindustry. One of the packaging process issues is improper packaging sizes, which can cause damage to the banana bolen products. These problems can lead to a decline in the quality of the final product and delays in product delivery to consumers.The marketing activities of banana bolen products at CV Mayang Sari also encounter challenges, such as delayed product deliveries and discrepancies in the number of products shipped. Delivery delays occur because the shipping service sometimes does not immediately dispatch the products, leading to postponed deliveries. Unsold products result from decreased consumer purchasing power. Communication errors with consumers also cause discrepancies in the number of products shipped, leading to potential losses for the agroindustry.

To reduce and address these risks, an analysis of supply chain risks and the development of risk mitigation strategies are necessary for CV Mayang Sari. This study presents a new approach to analyzing supply chain risks in agroindustry, as previous studies focused on agroindustry companies with an export market orientation and the implementation of Good Handling Practices (GHP) and Good Agricultural Practices (GAP) (Fitriandini *et al*., 2024). Unlike these studies, this research focuses on a small-scale banana-based processing agroindustry that produces only one type of product. The purpose of this research is to analyze risks, particularly risk sources and supply chain risk mitigation actions at CV Mayang Sari in Bandar Lampung. Therefore, this study utilizes the House of Risk method, which has the advantage of reporting and considering the likelihood of risk events occurring (Magdalena & Vannie, 2019). The contribution of this research to the banana-based processing agroindustry is to provide mitigation strategies expected to reduce supply chain risks. This study is also expected to help similar agroindustries implement quality standards in their business processes.

METHOD

This research was conducted at CV Mayang Sari in Bandar Lampung City using a case study approach. The research location was selected purposively. The respondents in this study included the owner, banana, sugar, and flour suppliers (one informant for each), four production employees, one marketing employee, and two regular consumers. Data collection was carried out from August to September 2024. Primary data obtained through Focus Group Discussion (FGD) was used to analyze risks. In addition, this study utilized secondary data from agroindustry records, journals, books, and government institutions. The research objectives were addressed using risk analysis with the House of Risk (HOR) method. The primary data included risk events, risk causes, risk occurrence frequency, and risk severity levels. Several advantages led to the selection of the HOR method. The HOR method reports and considers the probability of risk events occurring (Magdalena & Vannie, 2019). Other risk mapping methods do not account for all events caused by risk agents. Another highlighted benefit of the HOR method is its ability to prioritize risks and provide strategic priorities for quality improvement (Hartono *et al*., 2018).

The HOR method consists of two main steps: HOR 1 and HOR 2. HOR 1 identifies which risk agents should be prioritized for preventive actions. Meanwhile, HOR 2 focuses on proactive measures to maximize the effectiveness of actions related to risk agents while ensuring financial feasibility and resource commitment (Pujawan & Mahendrawathi, 2009). Using the Supply Chain Operations Reference (SCOR) model, the HOR 1 stage—risk identification begins by identifying activities at each actor or business process, including planning, sourcing, production, delivery, and returns (Puffal & Kuhn, 2018). The next step is identifying risk events. The severity level of each risk event is assessed on a scale of 1 to 10, where a higher score indicates a more severe impact. Subsequently, the risk agents or sources of risk events and their frequency levels are identified using a scale of 1 to 10. The higher the score, the greater the likelihood of the risk agent or source occurring. The severity level and frequency of risk occurrences are presented in Table 1.

Table 1. Scale of Risk Severity and Occurrence Frequency

Scale	Severity	Occurrence
1	None	Almost never
2	Very minor	Extremely rare
3	Minor	Rare
4	Low	Very low
5	Moderate	Low
6	Significant	Moderate
7	Major	Fairly high
8	Extreme	High
9	Severe	Very high
10	Hazardous	Almost certain

Source : (Sankar, N. R., & Prabhu, 2001)

Next, the correlation between risk events and risk agents is identified using scores of 0, 1, 3, or 9, where 0 indicates no correlation, 1 indicates low correlation, 3 indicates moderate correlation, and 9 indicates high correlation. Then, the Aggregate Risk Potential (ARP) is determined using the following formula:

$$ARPj = Oj.\Sigma i.Si.Rij \quad \text{(1)}$$

Oj represents the occurrence value of the risk agent, Si is the severity level of the risk event and Rij denotes the correlation between risk agent j and risk event i. After obtaining the ARP values, they are ranked form highest to lowest. In HOR phase 2, risk management strategies are determined to reduce the potential impact of risk agent. This phase begins by selecting several high priority risk agents based on the ARP result from HOR phase 1. Next, preventive actions (P) or mitigation strategies that are most effective in eliminating potential risk agents are identified. These mitigation actions can address one or multiple risk agents. Subsequently, the correlation between each mitigation action (P) and the risk causes (A) is assessed using a scoring system of 0,1,3, or 9. The total effectiveness value (TEk) for each strategy is then calculated using the following formula:

$$TEk = \Sigma j.ARPj.Ejk \quad \text{(2)}$$

Ejk represents the relationship between each strategy and the risk agents. Then, the difficulty level (Dk) for implementing each planned mitigation action is determined. This is rate in there levels (3, 4, dan 5), where 3 indicates an easy to determined, 4 indicates a moderately difficult action, dan 5 indicates a highly difficult action. The total ratio between total effectiveness (TEk) and difficulty level (Dk) is calculated using the following formula:

$$ETDk = TEk/Dk \quad \text{(3)}$$

Various priority rankings are selected based on each risk strategy (Rk), ordered by the highest Effectiveness to Difficulty (ETD) ratio. Mitigation actions with the highest ETD values are considered priority strategies that require further attention to prevent the emergence of risk agents.

RESULTS AND DISCUSSION

Characteristics of Respondents

The respondents in this study consist of four production workers, one administrative worker, one marketing worker, suppliers of bananas, sugar, and flour (one for each), and two loyal customers. The respondents are categorized based on age, gender, and educational background. They fall within a productive age range (23–51 years for workers, 27–35 years for suppliers, and 38–40 years for customers), indicating strong work productivity, adaptability to technology, and potential for long-term collaboration. In terms of gender, the majority of workers are female. Regarding education, most workers have completed high school (4 out of 7 people), while some hold D3 (Associate Degree) and S1 (Bachelor's Degree) qualifications, reflecting a combination of operational and strategic roles. Suppliers generally have an Associate Degree (D3), and all customers hold a Bachelor's Degree (S1), indicating that the target market consists of middle-to-upper-class consumers who are more conscious of product quality, presenting an opportunity for developing premium products.

Supply Chain Risk Analysis at CV Mayang Sari Bandar Lampung

HOR Phase 1

Risk management is crucial for supply chains due to seasonal challenges, supply surges, long lead times, and perishable goods (Behzadi *et al.*, 2018). Therefore, effective supply chain risk management is vital for ensuring business continuity and resilience, emphasizing the need for organizations to proactively approach risk management (Emrouznejad, A., Abbasi, S., & Sıcakyüz, 2023). The SCOR (Supply Chain Operations Reference) model, which consists of plan, source, make, deliver, and return, is used to identify risks. The risk variables include the severity of impact (severity) and the likelihood of occurrence (occurrence). The identification of risk events and the severity assessment for CV Mayang Sari can be seen in Table 2. Based on Table 2, the risk events with the highest severity score of 9 are production delays (E24), mixer breakdowns (E25), improperly risen products (E27), and burnt bolen pisang (E28). Production delays can be caused by a lack of coordination and unexpected technical issues. Mixer breakdowns may result from inadequate maintenance. Improperly risen products are due to incorrect ingredient measurements. Burnt bolen pisang occurs when the oven temperature is too high. The risk event with the lowest severity score of 3 is overproduction, which is considered to have a minimal impact and does not significantly threaten CV Mayang Sari's operations.

Table 2. Identification of Risk Events and Severity Assessment at CV. Mayang Sari

Process	Risk Event	Code	Severity
Plan	Miscalculation of demand forecasting	E1	5
	Delay in the delivery schedule of banana raw materials	E2	5
	Miscalculation of banana raw material requirements	E3	4
	Bolen banana production not following the schedule	E4	4
	Excessive production of bolen banana	E5	3
	Bolen banana production target not achieved	E6	4
	Unsold products	E7	7
	Changes in bolen banana product prices	E8	7

Process	Risk Event	Code	Severity
	Market competition	E9	5
	Inaccurate planning of bolen banana product delivery	E10	5
	Delay in bolen banana product delivery	E11	6
	Fluctuation in banana raw material prices	E12	8
	Supply chain process not aligning with the budget	E13	5
Source	Insufficient supply of banana raw materials	E14	6
	Delay in banana raw material supply from suppliers	E15	6
	Changes in banana raw material quality	E16	4
	Errors in identifying banana raw materials	E17	4
	Errors in recording the nominal amount of raw materials	E18	8
	Delay in payments to suppliers by the agroindustry	E19	7
	Mishandling of banana raw materials during delivery	E20	8
	Insufficient workforce	E21	8
Make	Full warehouse	E22	7
	Damage to banana raw materials during storage	E23	7
	Delay in bolen banana production process	E24	9
	Mixer damage	E25	9
	Oven malfunction	E26	7
	Bolen banana products not rising properly	E27	9
	Burnt bolen banana products	E28	9
	Damage to bolen banana product packaging	E29	5
Deliver	Delay in the delivery of banana raw materials	E30	5
	Delay in bolen banana product delivery	E31	8
Return	Banana raw material quality does not meet standards	E32	6
	Bolen banana products returned by consumers	E33	8

Source : Primary Data (processed), 2024

After risk events are identified, the sources of risk (risk agents) and the probability of risk occurrence are determined to design appropriate and effective risk mitigation measures. Data collection through FGD with supply chain actors at CV Mayang Sari provided information on 51 potential risk agents. The assessment results of the occurrence of risk agents at CV Mayang Sari are presented in Table 3. Based on Table 3, the highest occurrence value recorded is 9, which corresponds to the emergence of new competitors. An occurrence value of 9 indicates that the emergence of this risk agent is very high or occurs very frequently. The lowest occurrence value recorded is 2, which applies to several risk agents, including changes in consumer preferences (A2), workers being less meticulous in calculating the remaining raw material stock (A3), suppliers experiencing delivery delays due to transportation issues (A5), limited transportation facilities (A24), delivery time constraints (traffic congestion, bad weather, or other factors) (A25), prolonged storage of raw materials (A36), lack of coordination (A37), damage during packaging (A44), packaging not meeting size specifications (A45), and rushing while serving customers (A51).

Table 3. Risk Agent Occurrence Assessment at CV.Mayang Sari

Risk Agent	Code	Occurance
• Changes in market trends	A1	5
• Changes in consumer preferences	A2	2
• Workers being inaccurate in calculating the remaining raw material stock	A3	2
• Suppliers failing to meet the agreed delivery schedule	A4	7
• Suppliers facing transportation issues causing delivery delays	A5	2
• Inaccurate calculation of required raw material quantities	A6	6

Risk Agent	Code	Occurance
• Sudden large-volume orders	A7	6
• Discrepancy between production planning and actual realization	A8	5
• Increased product demand	A9	5
• Sudden machine or oven breakdowns	A10	3
• Changes in consumer tastes	A11	6
• Fluctuations in raw material prices	A12	6
• Emergence of new competitors	A13	9
• Inaccuracy in scheduling the delivery of bolen pisang products	A14	7
• Errors in delivering bolen pisang products ordered by customers	A15	7
• Disruptions in transportation	A16	7
• Weather changes hindering product delivery	A17	7
• Changes in the price of banana raw materials	A18	7
• The raw material purchase list lacks clear specifications	A19	3
• Delays in customer payment settlements	A20	3
• Supplier's limited ability to meet raw material demands in terms of quantity	A21	4
• Dependence on a single banana supplier	A22	4
• Unavailability of raw materials from suppliers due to climate change or logistical issues	A23	6
• Limited transportation facilities	A24	2
• Delivery time constraints (traffic congestion, bad weather, or other factors)	A25	2
• Raw materials not being available at the scheduled delivery time	A26	4
• Uncertain scheduling of banana raw material orders	A27	3
• Scheduling errors	A28	3
• Absence of delivery procedures	A29	4
• Errors in recording and measuring the quantity and quality during raw material inspection	A30	3
• Suppliers rushing product deliveries	A31	5
• Payment system disruptions	A32	3
• Damaged or unsuitable raw materials	A33	4
• Errors in workforce planning	A34	4
• Limited storage space	A35	6
• Excessive storage duration of raw materials	A36	2
• Lack of coordination	A37	2
• Sudden system failures or breakdowns	A38	8

Table 3. Risk Agent Occurrence Assessment at CV.Mayang Sari (Continued)

Risk Agent	Code	Occurance
• Inadequate maintenance	A39	7
• Oven failing to heat up	A40	8
• Uneven oven temperature distribution	A41	6
• Errors in measuring dough proportions	A42	6
• Errors in setting baking temperature	A43	6
• Damage during packaging	A44	2
• Packaging not matching the required size	A45	2
• Production completion not meeting the target timeline	A46	4
• Delivery time constraints such as weather conditions and vehicle technical issues	A47	3
• Damage to raw materials	A48	7
• Products not matching customer orders	A49	5
• Products being damaged	A50	7

Risk Agent	Code	Occurance
• Rushing when serving customers	A51	2

Source : Primary Data (processed), 2024

After identifying risk events and risk agents and assessing the severity and likelihood of occurrence, the data is then entered into the HOR Phase 1 table to determine the Aggregate Risk Potential (ARP) value for each risk. Risk agents with the highest ARP values are considered to have a significant impact on CV Mayang Sari's supply chain activities and should be prioritized in mitigation efforts. Based on calculations in Table 4, the risk agent with the highest ARP value is A17, which refers to weather changes that hinder product deliveries, with an ARP value of 3.213. This indicates that this risk requires greater attention in handling strategies. Meanwhile, the risk agent with the lowest ARP value is A3, which refers to workers' inaccuracy in calculating the remaining raw material stock, with an ARP value of 20.

Table 4. Calculation Result of ARP Values in HOR phase 1

Risk Agen	ARP Value	Risk Agent	ARP Value
A1	495	A27	183
A2	158	A28	981
A3	20	A29	436
A4	1.232	A30	234
A5	432	A31	265
A6	792	A32	249
A7	1.638	A33	712
A8	410	A34	308
A9	1.215	A35	936
A10	468	A36	282
A11	1.206	A37	384
A12	954	A38	2.208
A13	810	A39	602
A14	1.813	A40	552
A15	714	A41	558
A16	1.323	A42	792
A17	3.213	A43	1.782
A18	147	A44	160
A19	135	A45	138
A20	45	A46	1.632
A21	324	A47	450
A22	372	A48	210
A23	882	A49	260
A24	96	A50	1.316
A25	410	A51	78
A26	336		

Source : Primary Data (processed), 2024

Not all risk agents receive treatment due to limitations in cost, manpower, and time. Therefore, risk agents need to be prioritized. Priority risk agents are determined using the Pareto principle (80:20), applying the concept that 80% of risk events are caused by 20% of risk sources. Thus, risk sources with a cumulative contribution of 80% are selected, assuming that this 80% represents the majority of all risk sources (Permana & Suminartika, 2023). The Pareto diagram of priority risks at CV Mayang Sari in this study can be seen in Figure 2.

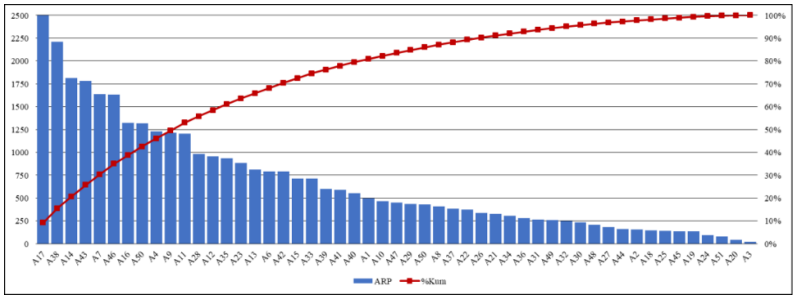


Figure 2. Pareto diagram HOR phase 1

Based on Figure 2, it is evident that there are 23 priority risk agents at CV Mayang Sari. The application of the Pareto 80:20 principle in identifying priority risk agents at CV Mayang Sari aligns with the study conducted by Wahyuni & Kusno (2023), which identified 31 risk events and 15 risk sources in the supply chain of Mahkota tea at CV Salama Nusantara, with 6 priority risks selected for mitigation. Another study by Sumantri & Marwati (2023), found 19 risk events and 20 risk sources, with 4 priority risks identified for mitigation. Additionally, research by Kusumaningtyas *et al.*, (2022) indicated that 22 risk agents contribute to risk events. Furthermore, Tama *et al.*, (2019) reported 47 risk events and 34 risk agents. The highest-priority risk agents at CV Mayang Sari can be seen in Table 5.

Table 5. Risk Agent Priority at CV.Mayang Sari

	Risk Agent	ARP	%Kum
A17	Weather changes hindering the delivery of bolen pisang products	3.213	9
A38	Unexpected trouble/damage	2.208	15
A14	Inaccuracy in the bolen pisang product delivery schedule	1.813	21
A43	Errors in temperature regulation during baking	1.782	26
A7	Sudden large orders of bolen pisang	1.638	30
A46	Production completion not meeting the target time	1.632	35
A16	Disruptions in transportation	1.323	39
A50	Product damage	1.316	43
A4	Supplier failing to meet the agreed delivery schedule	1.232	46
A9	Increase in demand for bolen pisang products	1.215	49
A11	Changes in consumer preferences	1.206	53
A28	Scheduling errors	981	56
A12	Fluctuations in the price of banana raw materials	954	58
A35	Limited storage space	936	61
A23	Unavailability of banana raw materials from suppliers due to climate change or logistical issues	882	64
A13	Emergence of new competitors	810	66
A6	Inaccurate calculation of required banana raw materials	792	68
A42	Errors in measuring dough ingredients	792	70
A15	Errors in the delivery of bolen pisang products ordered by customers	714	72
A33	Damaged or unfit banana raw materials	712	74
A39	Lack of maintenance	602	76
A41	Uneven oven heat distribution	588	78
A40	Oven not heating	552	79

Source : Primary Data (processed), 2024

HOR phase 2

The priority risk agents identified in HOR Phase 1 will then undergo the determination of mitigation actions to address these priority risk agents. This process involves conducting Focus Group Discussions (FGD) with supply chain actors and reviewing relevant literature related to the study. The mitigation actions for priority risk agents at CV Mayang Sari are presented in Table 6. The next step is to assess the correlation between priority risk agents and mitigation actions, followed by calculating the Tek, Dk, and ETDk values. The ETDk calculation aims to determine how effective the mitigation actions are in addressing the identified risk agents (Purnomo *et al.*, 2021). The evaluation of mitigation actions is conducted to determine priority mitigation measures based on ETDk values using a Pareto diagram, applying the 80:20 rule. The Pareto diagram for HOR Phase 2 can be seen in Figure 3. Based on Figure 3, it can be observed that there are 16 priority mitigation actions at CV Mayang Sari.

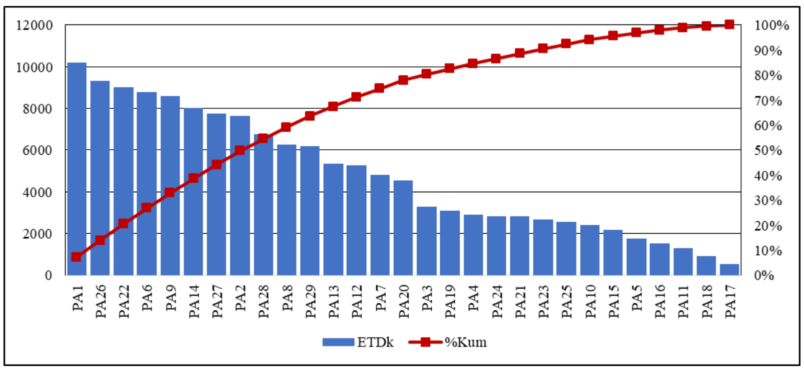


Figure 3. Pareto diagram HOR phase 2

The priority mitigation actions for CV Mayang Sari are presented in Table 6. According to Table 6, the number of priority mitigation actions determined using the Pareto 80:20 principle is 16. Table 6 also shows that these priority mitigation actions consist of 16 measures that can be implemented at CV Mayang Sari, one of which is PA26 (implementing the first in, first out (FIFO) system for banana raw materials). Implementing the FIFO system for banana raw materials is the top priority mitigation action because it is considered the most effective in addressing priority risk agents.

Table 6. Priority Mitigation Actions at CV.Mayang Sari

	Priority Mitigation Actions	ETDk	%Kum
PA26	Implementing a first-in, first-out (FIFO) system for banana raw materials	9.313	7
PA22	Improving customer service	9.032	13
PA6	Providing buffer stock	8.776	19
PA1	Using packaging resistant to weather changes	8.584	25
PA9	Developing a well-planned and detailed production plan	8.584	31
PA14	Establishing a pre-order system within a specific timeframe	8.136	37
PA27	Scheduling regular machine maintenance	7.757	42
PA2	Conducting routine maintenance and inspections on machines and equipment	7.659	48
PA28	Conducting regular temperature monitoring	6.762	52
PA8	Implementing an outsourcing system for additional production	6.264	57
PA29	Regularly checking heating elements	6.174	61
PA13	Establishing effective and proactive communication with suppliers	5.366	65
PA12	Providing information on proper product storage, such as temperature and humidity	5.271	69

	Priority Mitigation Actions	ETDk	%Kum
PA7	Optimizing the ordering process and communication with customers	4.819	72
PA20	Strengthening relationships and communication with raw material suppliers	4.565	75
PA30	Regularly monitoring market trends	4.338	78

Source: Primary Data (processed), 2024

Additionally, implementing the FIFO system for banana raw materials has a Dk value of 3, indicating that it is easy to implement. The findings of this study align with research conducted by Sukendar *et al*., (2022), which identified 23 successful mitigation measures. Similarly, a study by Fitriandini *et al.*, (2024) identified three recommendations for mitigation actions, consisting of collaborating with related agencies and institutions, conducting intense communication among supply chain actors, and providing counselling and supervision of farmer-level snake fruit cultivation activities.

CONCLUSION

The risk analysis at CV Mayang Sari indicates the presence of 33 risk events and 51 risk agents, with 23 identified as priority agents. The highest-priority risk agents include weather changes that hinder product delivery, sudden equipment failures, inaccuracies in scheduling banana bolen product shipments, errors in oven temperature settings, sudden large orders, production delays, transportation disruptions, product damage, suppliers failing to meet agreed delivery schedules, and increased product demand. Additionally, 29 mitigation actions were identified, of which 16 were prioritized as risk management strategies. The highest-rated mitigation actions include implementing a first-in, first-out (FIFO) system for banana raw materials, enhancing customer service, maintaining buffer stock, using weather-resistant packaging, developing a detailed and well-planned production schedule, establishing a pre-order system with a specific time frame, scheduling regular machine maintenance, conducting routine inspections of machines and equipment, monitoring temperature regularly, and implementing an outsourcing system for additional production.

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