Supply Chain Risk Management in Fried Shallot SMEs

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Abstract. SMEs of fried shallots are faced with various risks in the form of raw material constraints, errors in planning, interference from operating machines, defective products, government policies, complaints, and others. This research aims to analyze the flow of the shallot supply chain, identify risks supply chain, analyze the priority order of risks, and determine preventive action prioritize in fried shallot SMEs. The methods used in this study are descriptive analysis, supply chain operation reference (SCOR), and risk analysis using the House of Risk (HOR) method. The risk analysis HOR 1 shows that the most significant risk agents of supliers level, was farmers who fail to harvest (AP10) with total score 572 that accounted for 19.8% of problems. Risk agents with the highest ARP scores at the SMEs level are labor negligence (AI9) that account for 12% of problems. The risk agent with the highest ARP value at the retail level was a forecasting miscalculation (AR1), with a total score 243 that accounting for 14.17% of problems. The result of the HOR 2 assessment selected primary preventive actions to be implemented first, for supplier is farmer partnership by creating a 1-year contract system (PAP4), for SMEs is, record and analyze shallots' needs based on fixed requests from customers (PAI7) and for retail is collaborating with SMEs with almost the same type and quality (PAR1). By implementing this preventive action, companies can manage risks well to reduce losses and improve the company's business performance.

1 Introduction

Shallots are one of the horticultural subsectors with strategic and high economic value. This is because the majority of Indonesian people need it, especially for everyday cooking spices, which affects macroeconomics and the inflation rate [1]. BPS [2] states that shallot production in Indonesia is 2 million tons, and the average shallot consumption rate of the population in Indonesia per capita in 2021 reaches 2,491 kg/month. The shallot production is distributed to the household sector by 80.34%, processing industry and other business activities by 11.54%, exports by 2.25%, and others by 5.87%. Shallots are horticultural commodities that have distinctive properties, namely seasonal and perishable, which not all regions produce and are needed every day by the community. As a result of these conditions,

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it is not impossible that there will be turmoil and gaps between supply and demand, causing prices to increase and resulting in shallot imports. Turmoil will also occur in the supply chain as a whole, including the onion processing industry, which is the second largest sector of the shallot distribution flow.

The development of the shallot industry is still primarily dominated by small and medium enterprises (SMEs) with products such as fried shallot, shallot powder, and shallot paste [3]. For example, in Bogor City there are 95 shallot businesses, and as many as 38 firms or 40% of them, are fried shallot SMEs [4]. Fried shallots are the dominating product of several products in the shallot industry tree. This is because the process of processing fried shallots is straightforward and does not need to require special tools. This shallot-processing business can generate up to Rp 28,560,605 per month [5]. The profit level of this shallot processing business is the highest compared to other supply chain actors, which is 50.77% [6].

Based on the results of initial observations, CV. Mito Dua Saudara is one of the fried shallot SMEs with a capacity of up to 1-1.5 tons per day, and it runs its supply chain CV. Mito Dua Saudara will face various risks in the form of raw material constraints, errors in planning, interference from operating machines, defective products, government policies, complaints, and others. In the production planning process, companies often need to be more accurate in determining production scheduling. Research on risk management in fried shallot SMEs is scarce. Research on shallot supply chains in the agro-industrial sector is still general, such as performance analysis, added value, and risk mitigation of the shallot agro-industry supply chain [6], literature review of shallot agroindustry [7], and shallot agroindustry supply chain management [8]. Based on this, research is needed for shallot supply chain risk management in fried shallot SMEs to create value from processed products that pay proportionally and equitably to the contribution of actors along the supply chain.

The goals of this research are analyze the flow of the shallot supply chain in fried shallot SMEs, identify risks supply chain fried shallot SMEs, analyze the priority order of risks, and prioritize preventive action strategies. This research is limited to operational risks in SMEs. Therefore, supply chain actors are observed only in the first layer of the supply chain, namely suppliers, SMEs, and retailers.

2 Material and Method

2.1 Location and Time Research

The research was carried out at CV Mito Dua Saudara, located in the Ciomas District, Bogor Regency, West Java 16610. The study is planned to begin in January 2024-March 2024. This location selection is done intentionally (Purposive Sampling) with a case study approach.

2.2 Data Collection Method

The methods used in collecting this primary data are in-depth interviews, field surveys, observations, and questionnaires to fried shallot supply chain actors. Secondary data is obtained through literature, relevant data from related agencies or agencies, books, scientific journals, interests, scientific articles, and other supporting documents.

2.3 Respondent Determination Method

The study's respondents were selected using purposive sampling, a non-probability sampling technique that involves specific considerations. Primary data is obtained from

respondents who are chosen deliberately, namely someone who is considered an expert/expert. The number of respondents consisted of 3-10 experts [8]. Therefore, in this study, the respondents were the Logistics and Procurement Division of Material Materials (Supply Chain), Production Division, Quality Division, and Marketing Division. Data of the experts shown in Table 1. Experts have expert criteria in their fields and criteria for experience in the process of producing fried shallots, as well as experts/researchers who have knowledge related to shallots and/or fried shallots for at least five years. The following are the uses and usage criteria of this study.

Table 1. Information of expert.

No	Stages of analysis	Number of respondents	Information
1	Risk identification	10	Company owner, main supplier, main retailer, head of planning and production division, production helper, head of raw material procurement division, head of quality division, head of finance division, marketing helper, head of marketing division.
2	Risk selection	8	Company owner, main supplier, main retailer, head of planning and production division, head of raw material procurement division, head of quality division, head of finance division, head of marketing division.
3	HOR 1 and HOR 2	8	Company owner, main supplier, main retailer, head of planning and production division, head of raw material procurement division, head of quality division, head of finance division, head of marketing division.
4	DEMATEL strategy	8	Company owner, main supplier, main retailer, head of planning and production division, head of raw material procurement division, head of quality division, head of finance division, and head of marketing division.

3 Analysis Method

3.1 Descriptive Analysis

Descriptive analysis explains the flow of the fried shallot supply chain, starting from procurement of raw materials, production processes, and marketing. Collecting, structuring, summarizing, and presenting data is the core of descriptive analysis, aimed at making the data more meaningful, readable, and understandable for data users [10]. Descriptive analysis is solely focused on providing a general overview or description of the features of the object being studied, providing information about data without generalizing the sample to the population.

3.2 Supply Chain Operation Reference (SCOR)

The performance of the supply chain was assessed using the SCOR method [11]. The specific level 1 of the SCOR method was employed, which outlines the scope and components of the supply chain. At this stage, SCOR encompasses the five primary business processes: planning, sourcing, manufacturing, delivery, and returns [12]. Among the five business processes, risks are identified and categorized into two interconnected variables: risk events and risk agents. A risk event refers to an occurrence that could lead to potential losses. A risk agent is the cause of the risk event. An overview of risk identification using SCOR can be seen in Table 2, Table 3, Table 4, Table 5, Table 6, and Table 7.

Table 2. Risk event variables at the supplier level (Modified [13], [14], [15], [16])

Business Sub Process	Risk Event	Code
	Planning	
Financial and capital planning	Limited capital and borrowed funds	P1
	Income mismatch with business capital issued	P2
	Shallots price fluctuations	P3
Delivery from farmers	Mismatch of delivery planning from farmers with realization	P4
	Mismatch of shallot types from farmers	P5
Planning deliveries to SMEs	Inaccuracy of forecast results compared to demand	P6
	The gap in shallot availability with design	P7
	Source	
Shallots procurement	Farmers are experiencing a delay in delivering shallots	P8
	Uncertainty in the amount of shallot supply	P9
	Dependence on a few farmers	P10
	Shallots received did not meet specifications	P11
	Changes in shallots quality	P12
	Farmers do not accept returns	P13
	Shallots price fluctuations	P14
	The discrepancy between the number of shallots arriving and the demand	P15
	Make	
Storage	The number of shallots does not match the stock card	P16
	Inaccuracy in the number of stock items to be shipped	P17
	Shrinkage of shallots quantity and quality	P18
	Large amount of reject production	P19
Packaging	Shallots quality deterioration due to packaging	P20
	Lack of labor	P21
	Deliver	
Shallots delivery to SMEs	Quality degradation due to shipping/transportation process	P22
	Shortage of shallots shipping capacity	P23
	Shortage of finished product stock in the warehouse	P24
	Errors in the type or quantity of shallots delivered	P25
	Order cancellation	P26
	Damaged vehicle	P27
	Delivery delays	P28
	Transportation rental is expensive	P29

Table 2. Risk event variables at the supplier level (Modified [13], [14], [15], [16]) (continue)

Business Sub Process	Risk Event	Code
Shallots delivery to SMEs	Weight depreciation during travel	P30
	Uncertainty of payment deadline	P31
	Return	
Shallots returns	The determination analysis error of customer complaint	P32
	Products are sold at low prices due to low-quality	P33
	Complaints from SMEs	P34

Table 3. Risk event variables at the SMEs level (Modified [13], [14], [15], [16])

Business Sub Process	Risk Event	Code
	Planning	
Production planning	Poor production planning and scheduling	I1
	The mismatch between supply chain activity planning and capital adequacy	I2
	Production delays and not following the scheduling plan	I3
Financial planning	Inaccurate raw material price reference	I4
	The gap between raw material availability and design	I5
	Source	
Raw material procurement	Delay in receiving raw materials from suppliers	I6
	Raw materials received do not meet the specifications	I7
	Excessive amount of shallots	I8
	Changes in raw material quality	I9
	Suppliers do not accept returns	I10
	Make	
Shallots processing	The amount of raw materials/materials does not match	I11
	Delays in the implementation of the production process	I12
	Machine breakdown or failure	I13
	Labor shortage	I14
	Large amount of rejects produced	I15
	Inspection results of non-conforming products	I16
	Shrinkage of shallots quantity and quality	I17
	Damage or rejects of the resulting product	I18
	Product output cannot be achieved	I19
Packaging and storage	Inaccuracy of finished goods stock quantity	I20
	Shallots quality deterioration due to improper packaging	I21
	Shallots quality deterioration due to storage	I22
	Insufficient warehouse capacity	I23
	Deliver	
Product delivery	Quality degradation due to the shipping/transportation process	I24
	Lack of product delivery capacity	I25
	Shortage of finished products in warehouses or distribution centers	I26
	Errors in the type or quantity of shallots delivered	I27
	Order cancellation	I28

Table 3. Risk event variables at the SMEs level (Modified [18], [14], [19], [20]) (continue)

Business Sub Process	Risk Event	Code
Product delivery	Damaged vehicle	I29
	Delivery delays	I30
	Uncertainty of payment deadline	I31
	Return	
Product returns	Production stability is disrupted	I32
	Product reprocessing cost	I33
	Rescheduling of product delivery	I34
	The determination analysis error of customer complaint	I35
	Products are sold at low-prices due to low quality	I36
	The product is nearing expiration	I37

Table 4. Risk event variables at the retail level (Modified [13], [14], [15], [16])

Business Sub Process	Risk Event	Code
	Planning	
Order planning and fulfillment	Mismatch of demand with the stock of fried shallots	R1
	The rising price of fried shallots from SMEs	R2
	Purchasing the wrong amount of shallots	R3
	Source	
Procurement of fried shallots	Delays in receiving products from SMEs	R4
	Products received are not according to specifications	R5
	Changes in product quality during storage	R6
	The SMEs does not accept returns of goods	R7
	Scales are not suitable	R8
	Make	
Increased product - added value	Damage or failure of repackaging equipment	R9
	Lack of labor	R10
	Weighing error of fried shallots	R11
	The finished product inspection results do not meet the required standards	R12
	Shrinkage of quantity and quality of fried shallots	R13
	Product damage or rejects	R14
	Reject during processing in large quantities	R15
Product warehousing	Warehouse capacity does not match the amount of shallots that must be stocked	R16
	Deliver	
Product delivery	Quality degradation due to the shipping/transportation process	R17
	Lack of product delivery capacity	R18
	Shortage of finished products in warehouses or distribution centers	R19
	Error in the type or quantity of fried shallots delivered	R20
	Order cancellation	R21
	Damaged vehicle	R22

Table 4. Risk event variables at the retail level (Modified [13], [14], [15], [16]) (continue)

Business Sub Process	Risk Event	Code
Product delivery	Delivery delays	R23
	Uncertainty of payment deadline	R24
	Return	
Product returns	Product reprocessing cost	R25
	Rescheduling of product delivery	R26
	The determination analysis error of customer complaint	R27
	Products are sold at low prices due to low-quality	R28

Table 5. Risk agent variables at the supplier level (Modified [13], [14], [16], [17])

Code	Risk Agent
AP1	Miscalculation of production design/forecasting
AP2	Sudden demand from customers
AP3	Raw material availability cannot meet the demand
AP4	Less competent labor
AP5	The damage to equipment and machinery
AP6	Lack of maintenance on equipment and machinery
AP7	Limited warehouse/storage space
AP8	Disregard for work procedures by employees
AP9	Shrinking weight
AP10	Farmers fail to harvest
AP11	Natural factors or disasters
AP12	Traffic jams or stoppages
AP13	Lack of transportation or vehicles
AP14	Shallots damaged in transit
AP15	Prolonged stockpiling of raw materials
AP16	Stockpiling of finished product stock in the warehouse
AP17	Dependence on specific raw material suppliers
AP18	Limited stock of finished products in the warehouse
AP19	Storage error
AP20	Packaging error
AP21	Delayed delivery schedule
AP22	Unconducive area conditions
AP23	Farmer management is less organized
AP24	Decreasing number of farmers
AP25	Shallots do not meet standards/specifications
AP26	Techniques for checking vegetable quality are not appropriate
AP27	Number of unrecorded requests
AP28	Unclear buyer information
AP29	Uncertainty order
AP30	Vegetable treatment or handling techniques are less optimal
AP31	Plants infected by pest diseases
AP32	Increased cost of shallot cultivation
AP33	The loading and unloading process is done roughly

Table 6. Risk agent variables at the SMEs level (Modified [13], [14], [16], [17])

Code	Risk Agent
AI1	Miscalculation of production design/forecasting
AI2	Sudden demand from customers
AI3	Raw material availability cannot meet production capacity
AI4	Less competent labor
AI5	Technical glitches in the production process
AI6	Production target not achieved
AI7	The occurrence of damage to production equipment and machinery
AI8	Lack of maintenance on production equipment and machinery
AI9	Negligence committed by workers
AI10	Disregard for work procedures by employees
AI11	Shrinking weight
AI12	Demand does not decrease or increase
AI13	Natural factors or disasters
AI14	Traffic jams or stoppages
AI15	Lack of proper transportation or vehicles
AI16	Shallots damaged in transit
AI17	Prolonged stockpiling of raw materials
AI18	Stockpiling of finished product stock in the warehouse
AI19	Dependence on certain suppliers
AI20	Limited stock of finished products in warehouses/distribution centers
AI21	Storage error
AI22	Packaging error
AI23	Delayed delivery schedule
AI24	Unconducive area conditions
AI25	Supplier management is less organized
AI26	Raw material quality that does not meet the standards
AI27	Finished products do not meet standards/specifications
AI28	The technique of checking shallot quality is not good
AI29	Number of unrecorded requests
AI30	Unclear buyer information
AI31	Uncertainty order
AI32	Vegetable treatment or handling techniques are less optimal
AI33	The loading and unloading process is done roughly

Table 7. Risk agent variables at the retail level (Modified [13], [14], [16], [17])

Code	Risk Agent
AR1	Forecasting calculation error
AR2	Sudden demand from customers
AR3	Raw material availability cannot meet production capacity
AR4	Less competent labor
AR5	Technical problems in the production process
AR6	High production target
AR7	The occurrence of damage to production equipment and machinery
AR8	Lack of maintenance on production equipment and machinery
AR9	Negligence committed by workers
AR10	Disregard for work procedures by employees
AR11	Natural factors or disasters

Table 7. Risk agent variables at the retail level (Modified [13], [14], [16], [17]) (continue)

Code	Risk Agent
AR12	Traffic jams or stoppages
AR13	Lack of proper transportation or vehicles
AR14	Fried shallots damaged in transit
AR15	Stockpiling of finished product stock in the warehouse
AR16	Dependence on specific SMEs products
AR17	Limited stock of finished products in the warehouse
AR18	Storage error
AR19	Delayed delivery schedule
AR20	Unconducive area conditions
AR21	Product quality that does not meet the standard
AR22	The technique of checking shallot quality is not good
AR23	Lack of transportation/vehicles
AR24	Number of unrecorded requests
AR25	Unclear buyer information
AR26	Uncertainty Order
AR27	Vegetable treatment or handling techniques are less optimal
AR28	The product loading and unloading process is done roughly

3.3 House of Risk (HOR)

The HOR (House of Risk) is employed in this research, utilizing a blend of the FMEA (Failure Modes and Effects Analysis) approach and the House of Quality (HOQ) model to rank risk sources and establish priorities for risk mitigation strategies [18]. House of Risk 1 (HOR 1) is a first-level analysis to establish which risk factors must be addressed before implementing other preventive measures. The priority of preventive measures proposed to be implemented first in House of Risk 2 (HOR 2) will be determined through an analysis that considers the effectiveness and capability of the company, including resource capabilities and the level of difficulty of implementation. The following is the sequence of HOR steps of the first phase:

1. Identify potential supply chain risks. The identified risks are classified in each business process using SCOR.
2. Identify the risk agents that cause previously identified risks to occur.
3. Identify the impact of the risks that occur (severity). Next, give a value to the severity of the risk that occurs. The assessment uses a scale of 1 (very small) – 5 (very large).
4. Provide an evaluation of the likelihood of risk agents occurring, using a scale from 1 (rare) to 5 (almost certain).
5. Evaluate the correlation between each risk event, identified risk, and the risk agent using a scale of 0, 1, 3, and 9. A score of 0 indicates no correlation, 1 indicates low correlation, 3 indicates medium correlation, and 9 indicates high correlation between risk events and risk agents.
6. Perform ARP calculations using severity, occurrence, and correlation value data that have been previously determined.
7. Rank each identified risk agent according to the previously calculated Agregate Risk Potential (ARP) value. These ratings are given in order of largest to smallest values.
8. The phase 1 HOR model is shown in Table 8.

Table 8 HOR 1.

SCOR Model	*Risk Event*	*Risk Agent*			*Severity*
		A1	**A2**	**A3**	
Plan	RE1	RA11	RA12	RA13	SE1
Source	RE2	RA21			SE2
Make	RE3				SE3
Deliver	RE4				SE4
Return	RE5				SE5
Occurrence (Oi)		OC1	OC2	OC3	
ARP		ARP1	ARP2	ARP3	

Following the completion of the initial phase of the HOR model, the subsequent stage involves developing the second phase of the HOR model. The subsequent actions entail establishing the second phase of the HOR model:

1. Identify the risk factor that has the top rating or assessment by employing a Pareto chart.
2. Using Ishikawa's diagram, identify suitable mitigation strategies for each pre-selected risk factor.
3. Assess the correlation between the chosen risk factor and the mitigation plan.
4. Calculate the effectiveness of each strategy that has been determined.
5. Rank the difficulty for each predetermined mitigation strategy.
6. Determine the overall efficiency of the challenge factor, which is represented as ETDk.
7. Rank each mitigation strategy based on previously calculated ETDk values from largest to smallest.
8. The phase 2 HOR model is shown in the Table 9.

Table 9. HOR 2.

Risk Agent	ARP	Mitigation Strategy	
		PA1	**PA2**
RA1	ARP1	G11	G12
RA2	ARP2		
RA3	ARP3		
RA4	ARP4		
Total effectiveness of action k		TE1	TE2
Degree of difficulty performing action k		D1	D2
Effectiveness to difficulty ration		ETD1	ETD2
Rank of priority			

4 Result

4.1 The Fried Shallot Supply Chain

Supply chain CV. Mito Dua Saudara started by purchasing raw materials from suppliers in the form of fried shallots. Most raw material purchases are obtained from onion suppliers in the Brebes area, Central Java. The raw materials received are Brebes-type shallots and Sumenep-type shallots. This shallot is processed by washing, peeling, frying, and packaging. Fried shallots are sold to consumers directly or through offline and online retail throughout

Indonesia. Products CV. Mito Dua Saudara is marketed 40% to supermarkets, 20% to specialty stores, 20% directly (offline), and 20% online (to various regions in Indonesia). Flow patterns and supply chain cycles of fried shallots CV. Mito Dua Saudara presented in Figure 1.

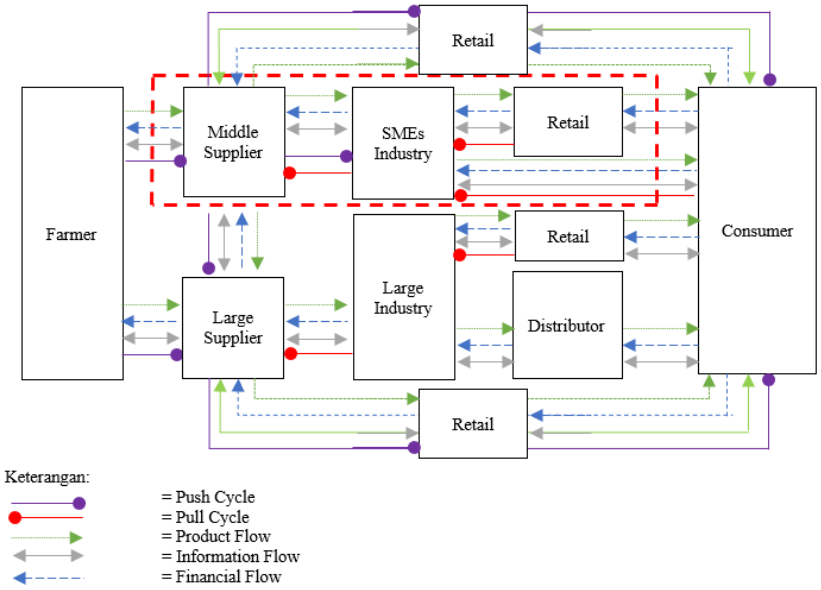

Figure 1. Fried shallot supply chain stakeholders considered in the model.

CV. Mito Dua Saudara obtained raw materials from middle suppliers in the Brebes, Pati, Demak, Ngajuk, Sumenep, Bandung, and Majalengka areas. Brebes, Central Java is the company's largest supplier of shallots because the company only processes shallots with Brebes and Sumenep types. Central Java Province is the largest producer of shallots in Indonesia, with a percentage of production contribution reaching 28.15%. The price of onion ingredients fluctuates every year. Usually, the price of shallots rises in December and January. Then, it drops between July, August, and September. The average purchase price of shallots from suppliers is Rp10,000-Rp12,000. The highest price ever purchased by the company is Rp25,000 per kg, and the lowest price is Rp6,000 per kg.

CV. Mito Dua Saudara usually buy shallots with low quality grade to make the price cheaper. The quality of shallots purchased by the company is shown in Table 10. The efficiency of this process refers to shallots that will be chopped before frying, so there is no significant difference between good quality and low quality of shallots.

Table 10. Shallot quality grade.

Characteristic	Quality Grade
Color	Red until white
Solidity	Solid
Diameter	Less than 1.5 cm
Damage (w/b)	Maks 5%, no insect
Waste (w/b)	Maks 0,1%

Furthermore, the raw materials are converted into fried shallots. The processing process of fried shallots consists of washing, sorting, slicing, centrifugation 1, mixing, frying, centrifugation 2, drying, and packaging. The purpose of the washing process is to clean the

onion from onion peels and dirt in the form of soil, stones, and other foreign objects, while the sorting process is to separate low-quality shallots. The slicing process aims to cut the onion into thinner shapes. Centrifugation process 1 aims to remove washing water on onions after the slicing process. The onion from the slicing process is then placed on a unique table to mix with the special formula flour. Frying is carried out on a pan with a capacity of 15 kg. The frying time per 15 kg of onion slices is 8-10 minutes, depending on the moisture content of the shallot. The frying onion is put into a centrifugal machine. This process aims to remove the oil content of shallots from frying. Fried shallots are then put into a unique tub. The purpose of this process is to dry the onion and lower the temperature of the fried onion to 27-30 °C. Fried shallots are then packaged using polyethylene (PE) plastic with a capacity of 15 kg, 10 kg, 1 kg, 0.5 kg, and 60 grams. The packaging process is carried out manually. After packing, fried shallots are stored in warehouses with a capacity of up to 4 tons.

4.2 Identify Fried Shallot Supply Chain Risks

The first step in any risk management activity is to identify the risks, which is crucial for successful supply chain risk management. To begin, supply chain mapping is performed using the SCOR (Supply Chain Operation Reference) method. The SCOR model is utilized to identify the company's business processes and supply chain activities, which are categorized into sub-processes/dimensions of plan, source, make, deliver, and return. Furthermore, the department/section responsible for each business process is identified, along with the risk specifications for each business process. After the initial risk identification, there were 34 instances of risk and 33 risk contributors identified at the supplier level, 37 instances of risk and 33 risk contributors identified at the SMEs industry level, and 28 instances of risk and 28 risk contributors identified at the retail level. Following focus group discussions and detailed interviews with experts, changes in risk were observed, specifically 30 instances of risk and 35 risk contributors identified at the supplier level, 33 instances of risk and 35 risk contributors identified at the SMEs level, and 21 instances of risk and 28 risk contributors identified at the retail level. The outcomes of risk identification with experts are presented in Table 11.

Table 11. Result risks identification and risks selection with expert.

Risk	Type	Subject	Description
P7 P21 P24 P32	Risk Event	Supplier	Eliminated
Dependence on one expedition (AP34) Lack of capital from SMEs (AP35)	Risk Agent	Supplier	Added
I8 I11 I16 I17 I35	Risk Event	SMEs	Eliminated
High production costs (I38)	Risk Event	SMEs	Added
AI5 AI10 AI12 AI25	Risk Agent	SMEs	Eliminated

Table 11. Result risks identification and risks selection with expert (continue)

Risk	Type	Subject	Description
Raw material prices rise (AI34) Lack of labor (AI35) Lack of transportation capacity (AI36) Lack of capital from retail (AI37) Complaints from retail (AI38) Product is nearing expiration (AI39)	Risk Agent	SMEs	Added
R12 R13 R15 R18 R25 R26 R27 AR10 AR15 AR17 AR27	Risk Event	Retail	Eliminated
Loading and unloading process was carried out roughly (AR28) Lack of capital to buy fried shallots (AR29) Workers on leave (AR30) High shallot production cost (AR31)	Risk Agent	Retail	Added

4.3 House of Risk (HOR) 1 Supply Chain Risk Analysis

An essential part of developing a risk mitigation strategy is understanding supply chain risks and determining the risk mitigation approach that an actor will carry out [19]. Therefore, handling supply chain risks needs to be done to avoid losses. The levels of supply chain actors identified are farmers, suppliers, distributors, and industries.

After identifying the risk event and agent, a risk assessment is conducted. This assessment involves evaluating the severity of the risk impact (Severity / S) on the risk event, gauging the likelihood of occurrence (O) concerning the risk agent, and appraising the connection between the risk agent and the risk event that transpires. The impact severity scale for risk (S) ranges from 1 to 5, representing very small, small, medium, large, and very large impacts. Risk event occurrence probability (O) is rated on a scale of 1 to 5, depicting rarely, unlikely to occur, likely to occur, very likely to occur, and definitely to occur. When assessing the correlation between risk factors and risk events, a meaningful scale of 0, 1, 3, and 9 is employed, indicating no correlation, low correlation, medium correlation, and high correlation respectively.

The calculation of HOR 1 has produced a way to assess critical risk agents based on the calculation of Aggregate Risk Potential (ARP). ARP is determined by considering the severity of risk events, the frequency of risk agents, and the correlation between the two. Each risk agent is assigned an overall ARP value and a rating using the pareto diagram principle, from highest to lowest. The ranking shows that the greater the ARP value, the more essential priorities the risk agent has to mitigate because it has a severe impact.

The ARP ratings above are used to effectively and efficiently prioritize risk agents with Pareto charts. A diagram based on the ARP rating above is utilized to create Pareto charts.

These charts are a quality control tool in a chart shape that orders problems by type according to quantity and displays cumulative totals. The principle of this Pareto diagram is that a small part of the cause can cause most problems. The name Pareto comes from Vilfredo Pareto (1828-1923), an Italian sociologist and economist who observed that 80% of effects are caused by 20% of cases, commonly referred to as the 80/20 rule. Pareto diagrams' uses include identifying problems depicted graphically, analyzing problems from different groups, prioritizing problem-solving effectively and efficiently, and sorting a problem based on its importance and frequency [20]. This chart is a bar chart that shows classifications and line charts to represent cumulative data totals.

Table 12 and Figure 2 display the outcomes of the supplier-level HOR 1 analysis, which was analyzed using a pareto diagram.

Table 12. Risk priority for supplier level.

Code	Risk Agents	ARPD	Percentage	Cumulative
AP10	Farmers fail to harvest	572	19,8%	19,8%
AP11	Natural disaster factors	464	16,1%	35,8%
AP32	Rising price of shallots	324	11,2%	47,1%
AP31	Plant infected by pest disease	162	5,6%	52,7%
AP9	Weight shrinkage	150	5,2%	57,9%
AP25	Shallots out of standards	144	5,0%	62,8%
AP12	Traffic jam	136	4,7%	67,5%
AP2	Sudden demand from customers	90	3,1%	70,7%
AP17	Dependence on certain farmers	82	2,8%	73,5%
AP1	Forecasting calculation errors	65	2,2%	75,7%
AP19	Storage errors	52	1,8%	77,5%
AP24	The number of farmers is declining	52	1,8%	79,3%
AP23	Farmer management is less organized	46	1,6%	80,9%

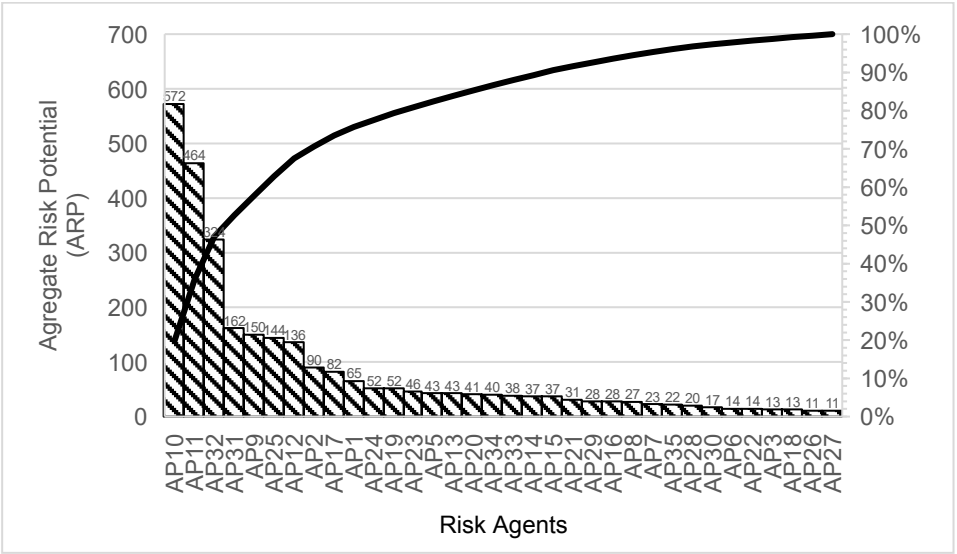

Figure 2. Pareto diagram of risk agent for supplier.

Table 13 and Figure 3 display the outcomes of the SMEs-level HOR 1 analysis, which was analyzed using a pareto diagram.

Table 13. Risk priority for SMEs level

Code	Risk Agents	ARPD	Percentage	Cumulative
AI9	Labor negligence	591	12,0%	12,0%
AI3	Raw material availability does not meet production capacity	372	7,6%	19,6%
AI1	Miscalculation of production planning	318	6,5%	26,0%
AI2	Sudden demand from customers	245	5,0%	31,0%
AI26	Poor quality of raw materials	234	4,8%	35,7%
AI27	Finished product out of standard	232	4,7%	40,5%
AI37	Lack of capital from retail	230	4,7%	45,1%
AI34	Rising prices of raw materials for production	220	4,5%	49,6%
AI35	Lack of labor	200	4,1%	53,7%
AI11	The weight of shallots decreases	192	3,9%	57,6%
AI7	The damaging occurrence and technical problem of production machinery and equipment	166	3,4%	60,9%
AI36	Lack of transportation capacity	146	3,0%	63,9%
AI18	Overstock of finished product in the warehouse	140	2,8%	66,7%
AI8	Lack of maintenance on production equipment and machinery	138	2,8%	69,5%
AI17	Overstock of raw materials	110	2,2%	71,8%
AI6	Production target not achieved	108	2,2%	74,0%
AI31	Uncertainty order	102	2,1%	76,0%
AI15	Unworthy transportation	97	2,0%	78,0%
AI16	Shallots damaged in transit	92	1,9%	79,9%
AI29	Unrecorded requests	86	1,7%	81,6%

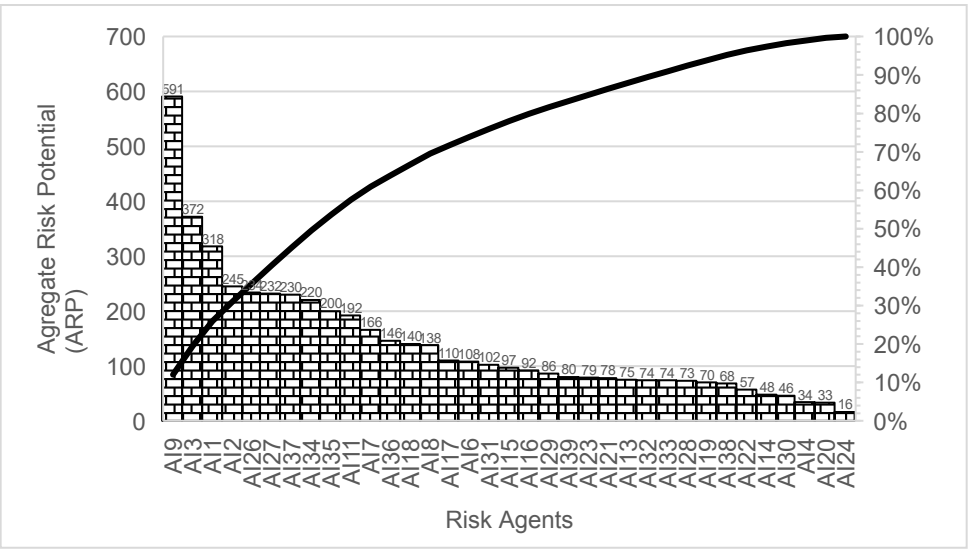

Figure 3. Pareto diagram of risk agent for SMEs.

Table 14 and Figure 4 display the outcomes of the SMEs-level HOR 1 analysis, which was analyzed using a pareto diagram.

Table 14. Risk priority for retail level.

Code	Risk Agents	ARPD	Percentage	Cumulative
AR1	Production planning/forecasting miscalculation	243	14,17%	14,17%
AR9	Labor negligence	232	13,53%	27,70%
AR16	Dependence on specific SMEs	156	9,10%	36,79%
AR6	Production target not achieved	108	6,30%	43,09%
AR29	Lack of capital to buy fried shallots	108	6,30%	49,39%
AR31	High production cost of shallots	108	6,30%	55,69%
AR2	Sudden demand from customers	72	4,20%	59,88%
AR5	Technical problem in the production process	72	4,20%	64,08%
AR4	Less competent labor	60	3,50%	67,58%
AR8	Lack of maintenance on production machinery	60	3,50%	71,08%
AR7	Broken machine	57	3,32%	74,40%
AR30	Workers on leave	54	3,15%	77,55%
AR21	Poor quality of product	45	2,62%	80,17%

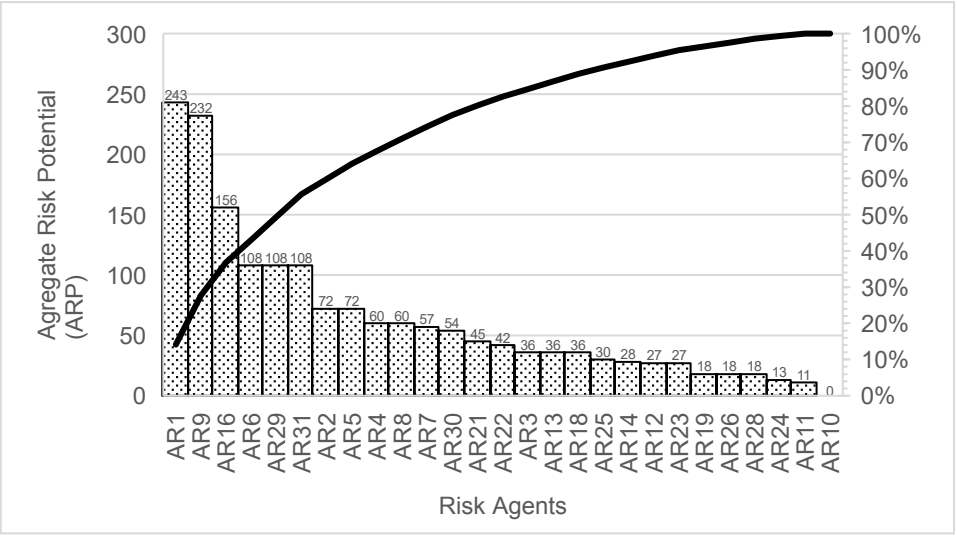

Figure 4. Pareto diagram of risk agent for retail.

4.4 House of Risk 2 (HOR) Preventive Action Analysis

HOR 2 aims to pinpoint and give priority to the initial steps that the company needs to take in order to avoid the occurrence of a selected risk factor identified in HOR 1. The selection of preventive action strategies also considers calculating the effectiveness of the company's efforts and resources. The preparation of preventive action begins with researchers searching literature related to various references to strategies applied to deal with problems related to risk agents who are prioritized for action. The strategy reference is then discussed in depth

through an interview. Conducting an in-depth interview involves gathering data for research by engaging in person-to-person dialogue, where interviewers and respondents or interviewees ask and answer questions, following interview guidelines or not [21]. An interview is required to gather the thoughts and assessments of experts or respondents concerning the development of the preventive action. The following is a preventive action strategy for fried shallot supply chain actors.

Preventive action for suppliers:

1. Farmer partnership by creating a 1-year contract system or 2-3 harvest cycles (PAP 1)
2. Make SOPs on shallot post-harvest handling techniques (PAP 2)
3. Collaborate with several shipping transportation agents to SMEs (PAP 3)
4. Create a sales SOP (PAP 4)
5. Classifying shallots by specific grade (PAP 5)
6. Record demand and supply regularly (PAP 6)
7. Tighten the quality check of shallots when goods are purchased from farmers (PAP 7)

Preventive action for SMEs:

1. Scheduling preventive maintenance activities regularly so that the condition of production equipment and machinery can be appropriated maintain (PAI 1)
2. Preparing backup/replacement equipment and machines for damage replacement (PAI2)
3. Evaluate and tighten the series of processes in the production system (PAI 3)
4. Evaluate and tighten the process of receiving raw materials (PAI 4)
5. Cooperate with several suppliers (PAI 5)
6. Enforce SOPs for pre-order sales with a certain amount (PAI 6)
7. Record and analyze shallots' needs based on fixed requests from customers (PAI 7)
8. Create SOPs for handling and storing raw materials (PAI 8)
9. Conduct routine monitoring of employee performance (PAI 9)
10. Entering into a contract or written agreement regarding payment with retail (PAI 10)
11. Create SOPs for handling, storing, and shipping finished products (PAI 11)
12. Conduct periodic monitoring and maintenance of transportation (PAI 12)

Preventive action for retail:

1. Collaborating with SMEs with almost the same type and quality (PAR 1)
2. Apply sales SOP for a specific amount (PAR 2)
3. Perform maintenance of packaging machines (PAR 3)
4. Create production and storage SOPs (PAR 4)
5. Check the quantity and quality of fried shallots when they have been sent by SMEs (PAR5)
6. Create worker licensing SOPs (PAR 6)
7. Creating a payment system with SMEs (PAR 7)
8. Conduct regular training for workers (PAR 8)

The preventive action strategy that has been selected is then processed based on its correlation with the risk agent results of HOR 1. The order of preventive action priority ranking to be applied is based on the largest to most negligible Effectiveness to Difficulty (ETD) ratio value. EDT value is a value that determines the level of effectiveness of preventive action on risk agents. A high ETD value indicates that preventive action is related to risk agents, so they have high-risk mitigation effectiveness in managing these risk agents. Preventive measures with a high ETD value are seen as simpler to put into place as a risk management strategy when compared to other preventive measures. If the ETD value is lower, the mitigation action is regarded as less effective in reducing the risk factor. Evaluate the ease of implementation based on the Degree of Difficulty (DK) in performing the action, which means that the higher the DK value, the more challenging it will be to execute. The results of the analysis of preventive action strategies at the supplier level can be seen in the Table 15, Table 16, and Table 17.

Table 15. Preventive action analysis for supplier level.

Code Risk Agent Supplier	Preventive Action (PAi)							
	PAP1	PAP2	PAP3	PAP4	PAP5	PAP6	PAP7	ARPi
AP10	9	1		3				572
AP11	9							464
AP32	9				9			324
AP31	9				3			162
AP9		9		9	3	9		150
AP25	3				1		9	144
AP12				9				136
AP2	9			9		3		90
AP17	3		9					82
AP1				1		9		65
AP19		9		9			1	52
AP24	9							52
AP23	9	3				1		46
TEk	16068	2528	738	5633	3996	2251	1348	
Dk	5	4	3	3	3	4	3	
ETD	3213,6	632,0	246,0	1877,7	1332,0	562,8	449,3	
ARP	1	4	7	2	3	5	6	

TEk = Total effectiveness of Action k
Dk = Degree if difficulty to performing action k
ETD = Effectiveness to difficulty ratio
ARP = Rank of preventive action

Table 16. Preventive action analysis for SMEs level.

Code Risk Agent SMEs	Preventive Action (PAi)												
	PAI1	PAI2	PAI3	PAI4	PAI5	PAI6	PAI7	PAI8	PAI9	PAI10	PAI11	PAI12	ARPi
AI9			9	9	3				9		1		591
AI3					9		3						372
AI1						3	9						318
AI2		1				9	1			1			245
AI26	1		3	9	1			9					234
AI27	1		9	3				1			9	1	232
AI37										9			230
AI34					9					3			220
AI35									9				200
AI11				9			3	9					192
AI7	9	9	1										166
AI36					3	3					3	9	146
AI18						1	9				9		140
AI8	9	3	1										138
AI17				1				9		1			110
AI6					1				3				108
AI31							9			1			102
AI15	3										3	9	97
AI16	3	9	9	1				9			9	1	92
AI29						9	9		1				86
TEk	3769	2981	9241	10051	7881	4511	7751	5884	7529	3187	5496	2511	
Dk	3	3	4	4	4	3	3	3	4	5	3	3	
ETD	1256,3	993,7	2310,3	2512,8	1970,3	1503,7	2583,7	1961,3	1882,3	637,4	1832,0	837,0	
ARP	9	10	3	2	4	8	1	5	6	12	7	11	

TEk = Total effectiveness of Action k
Dk = Degree if difficulty to performing action k
ETD = Effectiveness to difficulty ratio
ARP = Rank of preventive action

Table 17. Preventive action analysis for retail level.

Code Risk Agent Retail	Preventive Action (PAi)								
	PAR1	**PAR2**	**PAR3**	**PAR4**	**PAR5**	**PAR6**	**PAR7**	**PAR8**	**ARPi**
AR1	1	3					9		243
AR9	3			9				9	232
AR16	9								156
AR6			1	1	1	3	1	1	108
AR29	9	3					1		108
AR31	9								108
AR2		9							72
AR5			9	3					72
AR4								9	60
AR8			9						60
AR7			9	1				1	57
AR30						9			54
AR21	3		3		9			3	45
TEk	4422	1701	1944	2469	513	810	2403	2928	
Dk	4	3	3	3	3	3	4	3	
ETD	1105,5	567	648	823	171	270	600,8	976	
ARP	1	6	4	3	8	7	5	2	

TEk = Total effectiveness of Action k
Dk = Degree if difficulty to performing action k
ETD = Effectiveness to difficulty ratio
ARP = Rank of preventive action

5 Discussion

Planning and controlling activities in a supply chain can be seen from a push-and-pull review. Push reviews are carried out to anticipate consumer demand that has yet to be discovered. Meanwhile, a pull review occurs when incoming consumer orders are known for sure [14]. Based on the supply chain flow pattern (Figure 1), it is known that push reviews occur between farmers to suppliers, suppliers to retailers, suppliers to SMEs, and retailers to consumers. The pull review occurs between suppliers to SMEs and large industries, SMEs to consumers, SMEs to retail, and large industries to retail.

The pull process occurs in the consumer order cycle, which means this cycle is carried out after an order is received from the consumer. Meanwhile, the push process occurs in the raw material procurement cycle and production cycle which is carried out to anticipate incoming consumer orders. The production cycle carried out by business actors is carried out according to schedule and taking into account the availability of raw material stock. Meanwhile, the procurement cycle is carried out when raw material stocks start to run low, taking into account daily production amounts, capital conditions, space availability, transportation costs, and developing issues such as scarcity and/or increases in the price of shallot raw materials.

The primary members in this supply chain are suppliers, small processing industries (CV. Mito Dua Saudara) directly with production activities, and retail. Parties directly engaged in production activities in the supply chain are referred to as primary members. Parties that do not directly participate in production activities but affect business operations in the supply chain include farmers, retailers, large processing industry retailers, distributors, and consumers and are called secondary members. Retailers are traders of raw or fried shallots who sell products in small volumes. Distributors are the parties responsible for distributing products directly to consumers and retailers. Relationships between fried shallot supply chain members are generally not bound by contractual agreements. The agreement that occurs is

usually only a sale and purchase agreement based on the principle of trust. However, contractual agreements can be made between SMEs and large industries that require large amounts of supplies, such as the fried noodle and chili sauce industries. Arranged product quality, price, delivery time, and supply quantity agreements. This agreement is made at the start of the cooperation agreement.

As a result, there are 13 risk agents priority at the supplier level. At the supplier level, identify the risk agent that has the highest ARP value is farmers who failed to harvest (AP10) with a total ARP score of 572 and contributed 19.8% to the problem. Farmers' harvest failure is usually caused by internal factors of the farmer such as inappropriate planning, decreased land productivity, choosing the wrong planting location, wrong seed selection, and lack of care for shallots. AP10 correlates strongly with many risk events. Risk events that are strongly correlated and caused by AP10 include discrepancies between delivery plans from farmers and realization (P4), discrepancies in the types of shallots from farmers (P5), uncertainty in the quantity of shallot supplies from farmers (P9), fluctuations in the price of shallots from farmers (P14), and a mismatch in the number of shallots coming from farmers with demand (P15).

The SMEs level has a total of 20 risk agents according to the Pareto principle. At the SMEs level, the risk agent with the highest ARP value is worker negligence (AI9), which has a total ARP score of 591 and accounts for 12% of the issues. This workforce negligence refers to issues in SMEs that often result in considerable losses, such as products not meeting standards, a lot of production waste, or products damaged due to incorrect storage. AI9 is strongly correlated with machine damage or failure (I13), finished product damage or rejects (I18), product output unable to be met (I19), inaccuracies in finished product stock (I20), decreased quality of shallots due to inappropriate packaging (I21), reduced quality of shallots due to storage (I22), and disturbed production stability (I32).

The retail level has a total of 13 risk agent priority, and these should be the primary focus for resolution. At the retail level, the risk factor with the highest ARP value is forecasting calculation error (AR1), scoring a total ARP of 243 and accounting for 14.2% of the issues. This error in calculating forecasting/needs results in too many fried shallots in warehouses and retail stores, so the quality of the fried shallots decreases and ends up being wasted because they are already soft. This AR1 is strongly correlated with a mismatch between demand and stock of fried shallots (R1), purchasing shallots in the wrong quantity (R3), warehouse capacity not matching the number of shallots that must be stocked (R16), and a lack of stock of finished products in the warehouse (R19).

Based on the table above, the priorities preventive actions at the supplier level:

1. Partnership with farmers by creating a 1-year contract system (2-3 harvest cycles) (PAP1)
2. Creates sales SOPs (PAP4)
3. Classifying shallots based on specific grades (PAP5)
4. Make SOPs on shallot post-harvest handling techniques (PAP2)
5. Record demand and supply regularly (PAP6)
6. Tighten quality checks on shallots when purchased from farmers (PAP7)
7. Finally, collaborate with several transportation agents for delivery to SMEs.

The partnership between suppliers and farmers aims to maintain the continuity of shallot volume and quality. The interview results show that PAP1 will very difficult to implement, value Dk is five. However, suppliers realize that the risks currently experienced are most strongly correlated (correlation value is 9) with other preventive actions especially on the quantity and quality of shallots. The need for shallots continues to increase because they are a commodity that is needed every day. Therefore, implementing partnerships with farmers is a strategic step to maintain supply and quality for the needs of shallots for households and the processing industry. Other strategic steps can be taken if inventory volume and quality are well maintained and controlled.

The results of the analysis of preventive action strategies at the SME level can be seen in the Table 16. The priorities preventive actions at the SME level:

1. Record and analyze shallots needs based on fixed demand from customers (PAI7)
2. Evaluating and tightening the process of receiving raw materials (PAI4)
3. Evaluating and tighten the series of processes in the production system (PAI3)
4. Collaborate with several supplier (PAI5)
5. Create SOPs for handling and storing raw materials (PAI8)
6. Conducting routine monitoring of employee performance (PAI9)
7. Create SOPs for handling, storing, and shipping finished products (PAI11)
8. Enforce SOPs for purchasing pre-orders with a certain amount (PAI6)
9. Schedule preventive maintenance activities regularly so that the condition of production equipment and machinery can be apropriated maintained (PAI1)
10. Preparing backup/replacement tools and machines for damage replacement (PAI2)
11. Conduct periodic monitoring and maintenance of transportation (PAI12)
12. Entering into contracts or written agreements regarding retail payment (PAI10)

One of the weaknesses of SMEs is the company's need for more awareness and neatness regarding administration. Observations in the field show that in the production process, SMEs are still based on the average sales results in the previous month and the price of shallots. Therefore, companies need to record demand better than analyze the need for shallots so that the product does not experience shortages or excesses. By implementing this preventive action, companies can reduce operational costs such as raw material procurement, production, and storage costs. Furthermore, companies can focus on evaluating the receipt of raw materials, sales, employee performance assessments, and machine repairs to make the business more effective and efficient.

The results of the analysis of preventive action strategies at the retail level can be seen in the Table 17. The priorities preventive actions at the retail level:

1. Collaborating with SMEs with almost the same type and quality (PAR1)
2. Conducting regular training for workers (PAR8)
3. Making production and storage SOPs (PAR4)
4. Maintaining packaging machines (PAR3)
5. Creating a payment system with SMEs (PAR7)
6. Implementing sales SOPs for specific quantities (PAR2)
7. Making worker licensing SOPs (PAR6)

Consumer preferences are something that retailers pay special attention to. The results of field observations show that retailers want to avoid the risk of price increases that are too high and product quality that is not suitable. Therefore, the right strategy is to collaborate with SMEs of almost the same type and quality. This strategy is highly correlated with other risk agents, such as dependence on certain SMEs, lack of capital to purchase fried shallots, and high production costs. By collaborating with other SMEs, retailers can also compare prices from each SME, thereby increasing profits.

The findings of this research have important managerial implications for fried shallot SMEs. In practice, companies do not need to carry out all preventive actions, it’s only choose preventive actions that significantly influence other preventive actions. Preventive action priorities will help companies manage risks effectively and efficiently to reduce costs and develop the company's business performance. Therefore, to align with the preventive action in this research, the company budget needs to focus on procuring raw materials by managing shallot producers, such as creating farmer groups and developing appropriate cooperation schemes.

However, this research has limitations. The lead firm in the supply chain studied is a small and medium-sized enterprise (SMEs) that produces fried shallots. Therefore, it might be necessary to adjust the findings in order to better describe the overall functioning of the

shallot product supply chain. In future research, the risk could be for other supply chain actors such as farmers, large industries, and distributors. Future research should also evaluate several preventive actions from the cause and effect diagram on the broader shallot supply chain, not only on the operational side of fried shallot production.

6 Conclusion

The results of risk identification with experts and supply chain actors obtained 30 risk events and 35 risk agents at the supplier level, 32 risk events and 34 risk agents at the SMEs level, and 21 risk events and 23 risk agents at the retail level. The analysis of HOR 1 results revealed that the risk factor scoring the highest ARP at the supplier level was farmes fail to harvest (AP10), totaling 572, which constituted 19.8% of the issues. Risk agents with the highest ARP scores at the SMEs level are labor negligence (AI9), with a total score 591 that accounts for 12% of problems. At the retail level, the production design/forecasting miscalculation (AR1) had the highest ARP value, scoring a total of 243 points, which accounted for 14.17% of the problems.

Based on the results of HOR 2 analysis, preventive action is the top priority at the supplier level sequentially, namely farmer partnership by creating a 1-year contract system (2-3 harvest cycles) (PAP1), create a sales SOPs (PAP4), classifying shallots based on certain grades (PAP5), make SOPs on shallot post-harvest handling techniques (PAP2), record demand and supply regularly (PAP6), tighten the quality checks of shallots when goods are purchased from farmers (PAP7), and finally, collaborate with several shipping transportation agents for delivery to SMEs. Preventive action priorities at the SMEs level in general, namely record and analyze shallots' needs based on fixed requests from customers (PAI7), evaluating and tighten the process of receiving raw materials (PAI4), evaluating and tighten the series of processes in the production system (PAI3), collaborate with several suppliers (PAI5), create SOPs for handling and storing raw materials (PAI8), conduct routine monitoring of employee performance (PAI9), create SOPs for handling, storing, and shipping finished products (PAI11), enforce SOPs for purchasing pre-orders with a certain amount (PAI6), scheduling preventive maintenance activities regularly so that the condition of production equipment and machinery can be appropriated maintain (PAI1), preparing backup/replacement tools and machines for damage replacement (PAI2), conduct periodic monitoring and maintenance of transportation (PAI12), entering into a contracts or written agreements regarding retail payment (PAI10). Then, preventive action priorities at the retail level, namely collaborating with SMEs with almost the same type and quality (PAR1), conduct regular training for workers (PAR8), create production and storage SOPs (PAR4), apply sales SOPs for specific amount (PAR2), creating a payment system with SMEs (PAR7), perform maintenance of packaging machines (PAR3), making worker licensing SOPs (PAR6), and finally, check the quantity and quality of fried shallots when they have been sent by SMEs (PAR5).

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