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Risk Mitigation Analysis in a Supply Chain of Coffee Using House of Risk Method

Analisis Mitigasi Risiko Rantai Pasok Kopi Menggunakan Metode House of Risk

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Abstract

Perusahaan Daerah Perkebeunan (PDP) Kahyangan Jember in East Java is a regional company owned by The Jember Regency Government that is engaged in the plantation business. PDP Kahyangan Jember implements supply chain management in its business, however there are still some problems in its implementation and management. Some of the issues are the quantity of ground coffee production that does not meet the targeted quantity, decreased coffee beans quality, and reduced coffee yields. These problems can be reduced using a risk management approach. This study aimed to identify the activities of the ground coffee supply chain in PDP Kahyangan Jember and its risks, to determine the level of the risks, and to develop a risk management strategy for PDP Kahyangan Jember ground coffee supply chain. This study used the House of Risk (HOR) method which consists of two phases, i.e. HOR 1 and HOR 2. HOR 1 is used to identify risks in the supply chain. HOR 2 is used to develop a strategy for handling these risks. The HOR 1 analysis results show there are 28 risk events and 33 risk sources, with 15 priority risk sources being considered in the risk management strategies preparation. The results of HOR 2 analysis show eight priority management strategies that can be implemented by PDP Kahyangan Jember.
Keywords: House of Risk, risk management, supply chain

Abstrak

Perusahaan Daerah Perkebunan (PDP) Kahyangan Jember di Jawa Timur adalah perusahaan daerah milik Kabupaten Jember yang bergerak pada bidang usaha perkebunan. PDP Kahyangan Jember menerapkan manajemen rantai pasok pada bisnisnya, namun dalam penerapan dan pengelolaannya masih terdapat beberapa permasalahan. Permasalahan tersebut antara lain adalah jumlah produksi kopi bubuk tidak sesuai target perencanaan produksi, penurunan kualitas biji kopi, dan hasil panen kopi yang menurun. Pendekatan manajemen resiko dapat digunakan untuk mengurangi permasalahan tersebut. Tujuan penelitian ini adalah mengidentifikasi aktivitas rantai pasok kopi bubuk di PDPD Kahyangan Jember dan risikonya, menentukan tingkat risiko, dan menyusun strategi penanganan risiko pada rantai pasok kopi bubuk di PDP Kahyangan Jember. Metode yang digunakan pada penelitian ini adalah House of Risk (HOR) *yang terdiri dari dua fase, yaitu* HOR1 *dan* HOR 2. HOR 1 *digunakan untuk mengidentifikasi risiko pada rantai pasok.* HOR 2 *digunakan untuk menyusun strategi penanganan risiko tersebut. Hasil analisis* HOR 1 *menunjukkan bahwa terdapat 28 kejadian risiko dan 33 agen risiko dengan 15 agen risiko prioritas yang dipertimbangkan dalam penyusunan strategi penanganan risiko. Hasil analisis* HOR 2 *menunjukkan bahwa terdapat 8 strategi penanganan prioritas yang dapat diimplementasikan oleh PDP Kahyangan Jember.*
Kata kunci: House of Risk, *manajemen risiko, rantai pasok*

INTRODUCTION

PDP Kahyangan Jember in East Java is a regional company in the plantation sector established in 1969, managing coffee, rubber, and cloves commodities. According to the Jember Business Plan 2016, PDP Kahyangan Jember managed 3,800,6039 hectares of plantation area (Perusahaan Daerah Perkebunan, 2016). PDP Kahyangan Jember in 2011 introduced ground coffee products under the brand Kopi Kahyangan. PDP Kahyangan Jember involves several parties which form a supply chain in running its production. The supply chain must be managed to maintain smooth production to compete with other companies. According to Wuwung (2013), supply chain management is a system that involves the production, delivery, storage, distribution, and

sale of products to meet consumer demand. The supply chain is a network of organizations with a common goal of creating and delivering products to the final consumer (Suryaningrat, 2016).

The implementation of supply chain management at PDP Kahyangan Jember currently still faces several problems. PDP Kahyangan Jember experienced a mismatch between the actual production quantity and its targeted quantity. There are hoarding coffee beans because the availability of coffee beans is not supported by good production planning, resulting in a quality decrease, impacting the company's losses. It also faces the problem of decreased coffee bean quality which ranges from the color and taste changes, decreased coffee aroma, and pests attack on coffee beans. The coffee cherries yield in PDP Kahyangan Jember is also decreasing over the times. Uncertain weather and climate factors causing coffee yields to decline. Coffee cherries production at Gunung Pasang Plantation (a plantation belonging to PDP Kahyangan Jember) in 2017 was 249,208 kg with a productivity rate of 439.18 kg/ha. This production decreased in 2018, producing only 211,751 coffee cherries with a productivity rate of 359.64 kg/ha (Perusahaan Daerah Perkebunan Kahyangan, 2017). This decrease disrupted the ground coffee production at PDP Kahyangan Jember because the coffee beans quantity did not meet the target for ground coffee production. Hence, PDP Kahyangan Jember had to take coffee beans raw materials from other plantations.

PDP Kahyangan Jember may face risks in running its business due to the involvement of many parties in its supply chain. According to Yasa, Dharma, & Sudipta (2013), a risk is a potential event that can be detrimental due to the uncertainty of an event originating from various activities. PDP Kahyangan Jember has the potential for having these risks in its supply chain, so good risk management is needed to reduce the emergence possibility of the supply chain risk agents. This study aims to identify the PDP Kahyangan Jember ground coffee supply chain activities and its risks, to determine the level of risk, and to develop its risk management strategy.

House of Risk (HOR) is a renewable method of risk analysis (Magdalena & Vannie, 2019). The HOR application uses the FMEA principle combined with the HOQ model to measure risk quantitatively. The HOR method is risk management focused on prevention, reducing the occur possibility of risk agents. The HOR method consists of 2 phases; HOR 1 and HOR 2. HOR 1 is used to identify risks and determine priority risk agents to be mitigated. Risk agents who have high Aggregate Risk Potentials (ARP) are selected in HOR because the risk agent has a high probability of occurrence that causes many risk events with severe impacts (Cahyani, Pribadi, & Baihaqi, 2016). HOR 2 aims to prioritize treatment strategies based on their level of effectiveness. Several studies on determining risk mitigation strategies using HOR have been carried out previously (Astuti, Silalahi, & Rosyadi, 2017; Astuti, Dewi, & Levitasari, 2019; Noerdyah, Astuti, & Sucipto, 2020). These studies show that HOR is an appropriate method for agricultural commodity supply chains where a source of risk can cause several risk events (Astuti, Dewi, & Levitasari, 2019).

METHODS

This research was conducted at PDP Kahyangan Jember, Jl. Gajah Mada No. 245, Kaliwates Kidul, Kaliwates District, Jember Regency. The primary data was obtained through direct observation, interviews, and questionnaires to expert respondents, while secondary data was obtained from PDP Kahyangan Jember documents and literature study. The expert respondents in this study were the Head Office of Gunung Pasang Plantation, the Head Factory of Gunung Pasang Plantation, and the Head Business Unit of PDP Kahyangan Jember.

House of Risk 1 (HOR 1)

HOR 1 is the phase of risk identification and priority risk agents/sources determination as a basis for developing risk management strategies. The stages in HOR 1 are as follows:

1. Identification of risk events based on supply chain activities mapping. Supply chain activities are mapped using the Supply Chain Operations Reference (SCOR) method based on five supply chain activities: plan, source, make, delivery, and return.
2. Identification of risk agents.
3. Assessment of the risk impact severity. According to Asmono, Setiawan, & Dhan (2018), the severity value used is on a scale of 1-5. Each value has a different risk impact severity. The severity value is higher if the risk impact severity is higher.
4. Assessment of the agents/risk sources occurrence probability for each identified risk agent. According to Maharani & Karningsih (2018),

the occurrence value used is on a scale of 1-5. Each value has a different risk agent occurrence probability. The occurrence value is higher if the risk agent's occurrence frequency is high.

5. Assessment of the relationship (correlation) between risk events and risk agents by assigning a value of 0, 1, 3, 9, which respectively show no correlation, low correlation, moderate correlation, and high correlation.
6. Calculation of aggregate risk potential of risk agent (ARP) with the equation (Tama et al., 2019):

$$ARP_j = O_j \Sigma S_i R_{ij} \quad (1)$$

where,
ARP_j = Aggregate risk potential of risk agent j
Oj = Occurence probability of risk agent j
S_i = Impact of risk event i
R_{ij} = The degree of relationship between the risk j source with the risk event i

7. Ranking of risk agents ARP values as the basis for determining mitigation actions.
8. Pareto chart to select priority risk sources based on ARP rankings. The Pareto 80/20 principle is used as the basis for choosing mitigated risk agents: 80% of risk events come from 20% of the risk sources that cause them.

House of Risk 2 (HOR 2)

HOR 2 is a phase to determine the risk mitigation strategies priority based on their effectiveness level. The stages in HOR 2 are as follows:

1. Selection of the highest Aggregate Risk Potential based on the value of the HOR 1.
2. Identify Preventive Action (PA) to prevent the risk emergence.
3. Determining the relationship between preventive action and risk agents.
4. Calculation of the Total Effectiveness (TE_k) value of actions for each risk mitigation strategy using the equation (Tama et al., 2019):

$$TE_k = \sum ARP_J R_{jk} \quad (2)$$

where,
TE_k = Total Effectiveness k mitigation strategy
ARP_j= Aggregate Risk Potentials from risk agents j
R_{jk} = Relationship between preventive action i and risk agent j.

The relationship between preventive action and risk agents is measured using a rating scale shown in Table 1.

5. Assessment of Degree of Difficulty (D_k). D_k is an assessment to determine the level of difficulty of implementing risk mitigation strategies. The degree of difficulty (D_k) rating scale is shown in Table 2.
6. Determination of the Effectiveness to Difficulty (ETD_k) ratio value shows the effectiveness of implementing risk mitigation compared to the level of difficulty. The ratio is calculated using the following equation (Tama et al., 2019):

$$ETD_k = \frac{TEk}{Dk} \quad (3)$$

where,
ETD_k = Rasio Effectiveness to Difficulty
TE_k = Total Effectiveness
D_k = Degree of Difficulty.

7. Ranking the ETD_k ratio value to determine the priority of risk mitigation strategies.
8. Selection of prioritized risk mitigation strategies based on the Pareto chart.

Table 1. Assessment scale of the relationship between preventive action and risk agent (R_{jk})

Value	Criteria	Description
0	Not related	There is no relationship between preventive action and risk agent
1	Low	There is a weak relationship between preventive action and risk agent, which means that preventive action plays a small role in minimizing agent risk
3	Moderate	There is a moderate relationship between preventive action and risk agent, which means that preventive action plays a moderate role in minimizing agent risk
9	High	There is a high relationship between preventive action and risk agent, which means that preventive action plays a high role in minimizing agent risk

Table 2. Degree of difficulty (D_k) rating scale

Value	Description
3	Mitigation actions are easy to implement
4	Mitigation actions are a bit easy to implement
5	Mitigation actions are difficult to implement

RESULTS AND DISCUSSION

Supply Chain Activity Mapping

Supply chain activities at PDP Kahyangan Jember are focused on supply chain activities in Gunung Pasang plantation as a supplier of coffee beans and in PDP Kahyangan's business unit as a producer of ground coffee. The processing of coffee beans is performed in the Gunung Pasang farm, and then the ground coffee production process is performed at the PDP Kahyangan business unit. The supply chain flow in PDP Kahyangan is shown in Figure 1.

The ground coffee supply chain activities in PDP Kahyangan Jember were mapped using the SCOR method based on five supply chain activities: plan, source, make, delivery, return. The supply chain activities at PDP Kahyangan Jember involve three supply chain members: suppliers (PDP Kahyangan Jember's plantation), manufacturers and warehouses (PDP Kahyangan Jember), and distributors. Kahyangan ground coffee distributors are located in several cities: Jember, Lumajang, Bondowoso, Situbondo and Probolinggo. The ground coffee supply chain activity in PDP Kahyangan Jember is shown in Figure 2.

House of Risk 1 (HOR 1)

HOR 1 identifies risk events and supply chain risk sources in PDP Kahyangan Jember. The risk identification process in the supply chain flow is performed by interviewing expert respondents. The results of risk identification show that there are 28 risk events. Expert respondents then perform the risk severity assessment.

Identification of risk agents based on risk events is performed through interviews with expert respondents and literature studies. Risk agents are factors that cause the emergence of risks that need to be controlled to reduce the impact that occurs. The occurrence value is used to determine the Aggregate Risk Potentials (ARP) value, which is the basis for the risk agent's priority to be mitigated. Assessment of occurrence on risk agents in PDP Kahyangan Jember is performed by giving questionnaires to expert respondents. The identification results show that 33 risk agents cause the emergence of risk in PDP Kahyangan Jember. Expert respondents also assessed the relationship between risk events and risk agents. Aggregately risk agents have a high potential to create risks disrupting supply chain activities, so it is necessary to determine preventive actions. The results of risk identification and risk agents are shown in Table 3.

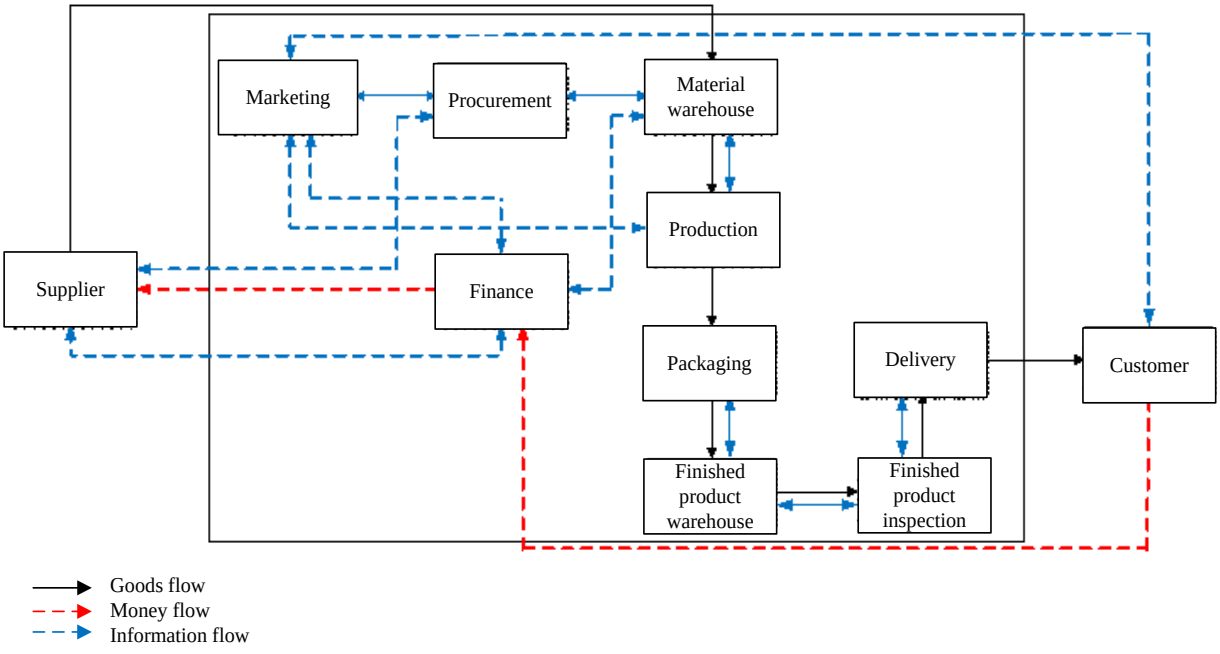

Figure 1. PDP Kahyangan Jember Supply Chain Flow

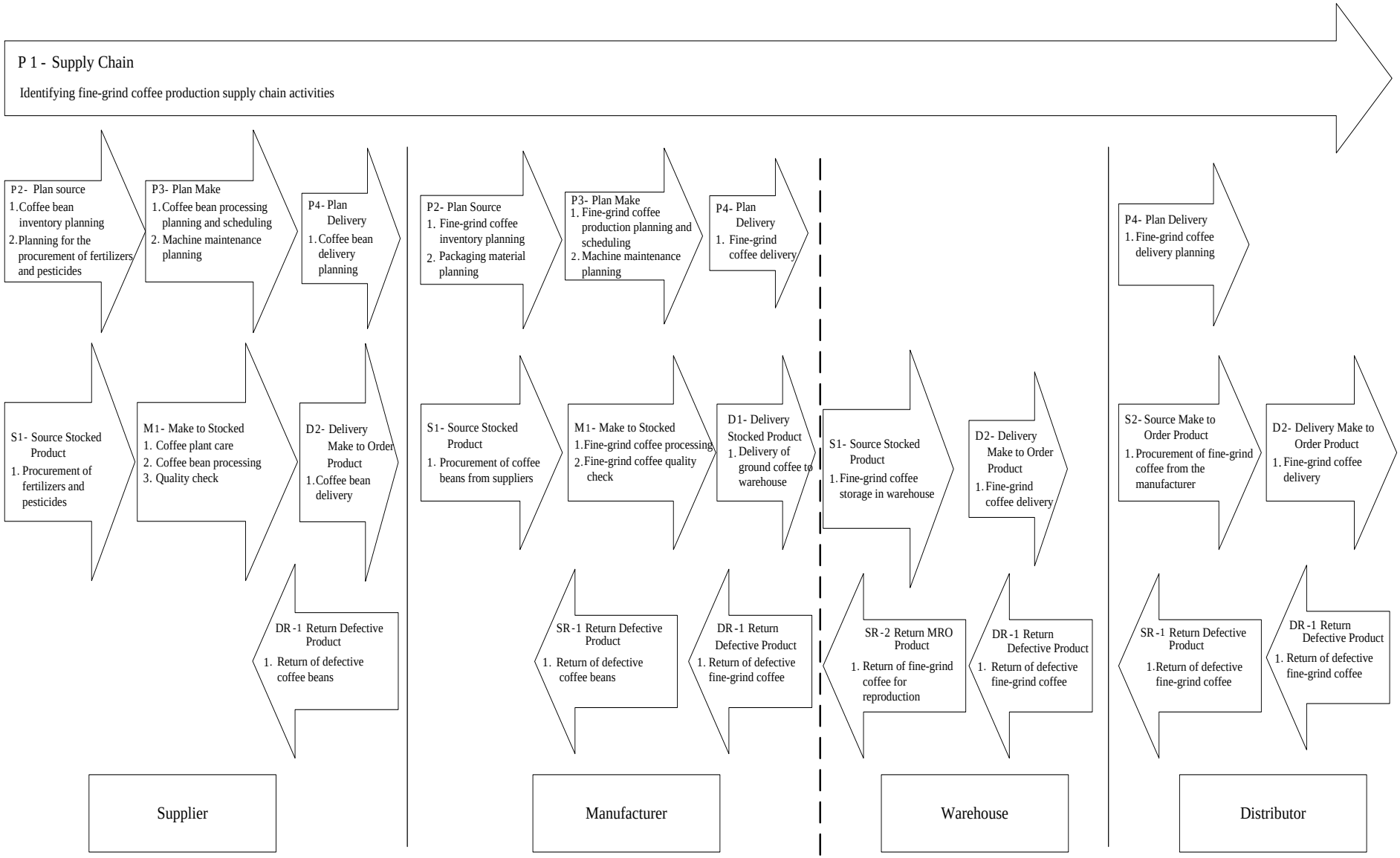

Figure 2. PDP Kahyangan Jember Supply Chain Activities

Table 3. Results of risk identification and risk agent

Risk Event	Description	Severity (S_i)	Risk Agent	Description	Occurance (O_i)
E1	Yield decrease	4	A1	Unpredictable weather and climate	4
E2	A mismatch between inventory and consumer purchasing power	1	A2	Lots of competitors	3
			A3	Uncertain market demand	1
E3	Packaging material is not fully used	1	A4	Changes of new packaging design	1
E4	Incidental changes of production schedule	2	A5	Raw materials that do not meet specifications	1
			A6	Incidental consumer demand	3
E5	Broken production machine	3	A7	Obsolete machine	4
E6	Lack of employees ability	1	A8	Limited labor	3
E7	Costs exceed budgeted targets	3	A9	Operating costs increase	4
			A10	Costs are not well planned	2
E8	Incidental change of coffee bean delivery schedule	1	A11	Delay in ground coffee processing	1
E9	Incidental additional orders outside the delivery schedule	1	A12	Adjustment to consumer demand	3
E10	Decrease coffee bean quality	5	A13	Pest attack	4
			A14	Process of storing coffee beans are not following the Standard Operating Procedure (SOP)	2
E11	Fertilizers and pesticides that are not available as needed	3	A15	Limited financial	2
			A16	Fertilizers and pesticides scarcity	3
E12	Decrease coffee taste	4	A17	Incorrect room temperature and humidity levels	2
E13	Coffee bean color changes	4	A18	Storage time of ground coffee beans is too long	2
E14	Damaged ground coffee packaging	2	A19	Product stack exceeds capacity	1
E15	Coffee cherries fall off	4	A20	Heavy rainfall	4
E16	Coffee beans weight loss	3	A21	Roasting temperature and process	1
E17	Long sorting process	1	A22	Manual sorting technique	5
E18	Many coffee beans are broken	3	A23	Grinding machine too tight	2
E19	Error on coffee bean grade selection	3	A24	Less scrupulous employees	3
E20	Burnt coffee beans	4	A25	Roasting process is too long	1
E21	Damage packaging during packaging process	2	A26	Non-optimal packaging machine performance	3
E22	Unperfectly selected coffee beans	2	A27	Insufficient supervision	2
E23	Unselected defective ground coffee products	4			
E24	Uncontrol overall maintenance of tools and machines	2	A28	Lack of inspection on every tool and machine	1
E25	Overdue coffee beans delivery	2	A29	Troublesome transportation	2
			A30	Limited choice of transportation types	3
E26	Defective product during transit	3	A31	Inattentive to the shipping goods procedure	2
E27	Delay in handling coffee bean return	1	A32	Long re-sorting process	3
E28	Extra cost beyond estimate	2	A33	The product does not sell and must be replaced with a new product	3

Severity values, occurrence values, and the value of the relationship between risk events and risk agents are then used to calculate the ARP value. The ARP value is obtained from the calculation between the severity, occurrence, and correlation values from the questionnaire results to experts. This correlation assessment was carried out with the criteria of 0, 1, 3, 9. After obtaining the severity, occurrence, and correlation values, these values were inserted into the HOR 1 matrix in Figure 3.

The next step is to determine the priority risk agents that the company will prevent from appearing. The determination of this risk agent uses the Pareto 80/20 principle, which is applied to the Pareto chart. Risk sources with cumulative ARP value up to 80% of the total ARP values will be considered as risk agents that need to be prevented from occurring. The Pareto chart of the ARP value can be seen in Figure 4. The selection of risk agents based on the Pareto principle (Table 4) shows that 15 risk agents will have their risk mitigation strategies determined. The risk agent with the highest ARP value (286) is the unpredictable weather and climate (A1) and pest attack (A13), while the risk agent with the lowest ARP value (6) is the choice of transportation mode (A30).

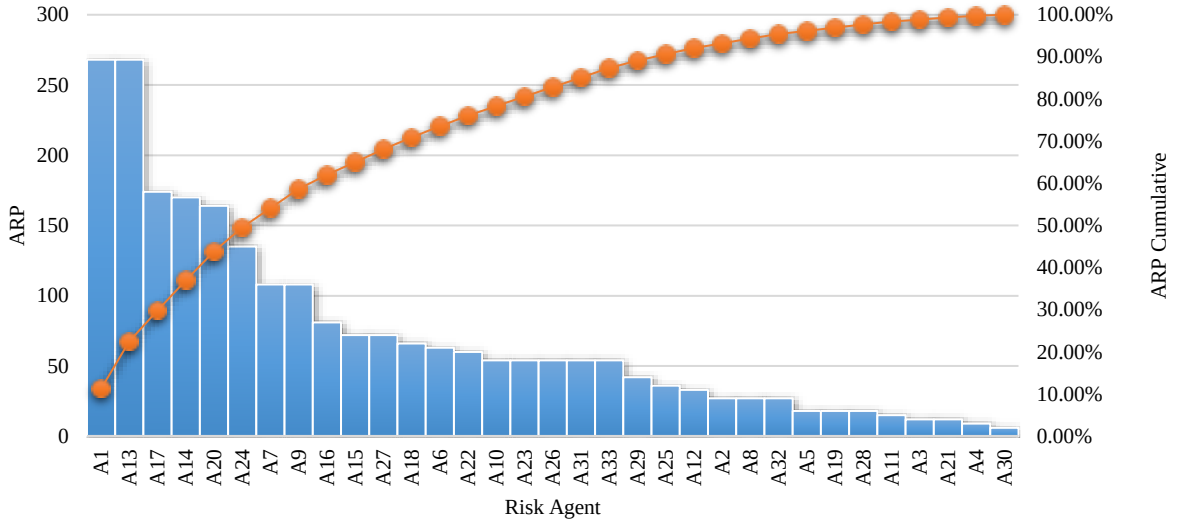

Figure 4. Risk Agent Pareto Chart

T**able 4.** Dominant risk source

Rank	Risk Agent	Description	ARP Value	ARP Cumulative (%)
1	A1	Unpredictable weather and climate	268	11.27
2	A13	Pest attack	268	22.53
3	A17	Incorrect room temperature and humidity levels	174	29.84
4	A14	The storing coffee beans process are not following the SOP	170	36.99
5	A20	Heavy rainfall	164	43.88
6	A24	Less scrupulous employees	134	49.56
7	A7	Obsolete machine	108	54.10
8	A9	Operating costs increase	108	58.64
9	A16	Fertilizers and pesticides scarcity	81	62.04
10	A15	Limited financial	72	65.07
11	A27	Insufficient supervision	72	68.10
12	A18	Storage of ground coffee beans is too long	66	70.87
13	A6	Incidental consumer demand	63	73.52
14	A22	The sorting technique is still manual	60	76.04
15	A10	Costs are not well planned	54	78.31

Risk Event (E_i)	Risk Agent (A_j)																																S_i
	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8	A 9	A 10	A 11	A 12	A 13	A 14	A 15	A 16	A 17	A 18	A 19	A 20	A 21	A 22	A 23	A 24	A 25	A 26	A 27	A 28	A 29	A 30	A 31	A 32	A 33	
E1	9												1							3														4
E2		9	9																															1
E3				9																														1
E4			1		9	9					3	1																						2
E5							9																											3
E6								9																										1
E7									9	9					3																			3
E8											9																		3					1
E9			1			3						9																						1
E10	3												3	9			3	3		1														5
E11															9	9																		3
E12	3												3	1			9																	4
E13													9	9			9																	4
E14																		9	9															2
E15	1																			9														4
E16																					9													3
E17																						9												1
E18																							9											3
E19																						1		9										3
E20																									9									4
E21																										9								2
E22																								9										2
E23																											9							4
E24																												9						2
E25																													9	1				2
E26																															9			3
E27																																9		1
E28																																	9	2
0j	4	3	1	1	1	3	4	3	4	2	1	3	4	2	2	3	2	2	1	4	1	5	2	3	1	3	2	1	2	3	2	3	3	
ARP	268	27	12	9	18	63	108	27	108	54	15	33	268	170	72	81	174	66	18	164	12	60	54	135	36	54	72	18	42	6	54	27	54	
Ranking	1	23	30	32	26	13	8	24	9	15	29	22	2	4	10	9	3	12	27	5	31	14	16	6	21	17	11	28	20	33	18	25	19	

Figure 3. House of Risk 1

Table 5. Prioritized risk mitigation strategies

Risk Agent	PA Code	Description of Preventive Action (PA)	Degree of Difficulty (D_k)
Unpredictable weather and climate	P1	Develop a climate change early detection system that includes the event time and duration, intensity, and potential impacts	5
	P2	Applying coffee cultivation techniques adaptive to climate change	5
Pest attack	P3	Eradicating pests in the coffee bean storage warehouse regularly	3
	P4	Creating pest traps with ethanol and methanol	3
Incorrect temperature and humidity levels	P5	Creating automatic temperature and humidity detection systems	4
	P6	Inspecting every procedure for coffee beans storage	3
The storing coffee beans process are not following the SOP	P7	Creating SOP for coffee bean storage	4
Heavy rainfall	P8	Planting canopy plants to protect coffee plants from heavy rainfall	3
Less scrupulous employees	P9	Pre-work employees briefing	3
	P10	Provide reward, punishment, and work motivation to all employees	3
Obsolete machine	P11	Performing production machine updates	5
	P12	Maintaining tools and machines regularly	3
Operating costs increase	P13	Increase the selling price of coffee beans and ground coffee products	5
Fertilizers and pesticides scarcity	P14	Creating organic fertilizers and pesticides	3
Limited financial	P15	Cooperating with third parties	4
Insufficient supervision	P16	Improve discipline among employees	4
Storage of ground coffee beans is too long	P17	Immediately sell ground coffee at a lower price	4
Incidental consumer demand	P18	Increase inventory to meet incidental demand	3
The sorting technique is still manual	P19	Procurement of a more modern sorting machine	5
Costs are not well planned	P20	Performing more efficient cost planning	4

House of Risk 2 (HOR 2)

HOR 2 is the stage of determining Preventive Action (PA) on prioritized risk agents to be mitigated. Identification of preventive action is performed by discussing with expert respondents to assess the implementation of the most accessible and effective risk mitigation strategy. The degree of difficulty (D_k) from the risk mitigation strategy implementation at PDP Kahyangan Jember was then assessed by expert respondents. This assessment considers the available and needed resources to implement the risk mitigation strategy. The identification of risk mitigation strategies and the level of difficulty of their implementation are shown in Table 5.

The Effectiveness of Difficulty Ratio (ETD_k) value calculation using equation (3) is performed after the value of difficulty degree from each risk mitigation strategy is obtained. The ETD_k value is a ratio value that compares the total effectiveness (TE) of implementing risk mitigation strategies with the degree of difficulty from each of these risk mitigation strategies. The total effectiveness value of the risk mitigation strategy implementation is calculated by considering the linkage of the risk mitigation strategy with the source of the risk that will be prevented from occurring. The highest ETD_k value indicates that the risk mitigation strategy has high implementation effectiveness. The HOR 2 analysis results in a ranking of risk mitigation strategies shown in Figure 5.

Priority determination of risk mitigation strategies is then performed based on the Pareto

chart. The Pareto chart of risk mitigation strategies is shown in Figure 6. PDP Kahyangan Jember considers that the company can implement risk mitigation strategies efficiently and effectively by applying up to 70% of the cumulative value of ETD_k, so that eight risk mitigation strategies (Table 6) are considered to be implemented in PDP Kahyangan Jember.

Ground Coffee Supply Chain Risk Mitigation Strategy at PDP Kahyangan Jember

The results of HOR 2 provide recommendations that PDP Kahyangan Jember can apply eight risk mitigation strategies for ground coffee supply chains. These risk mitigations are eradicating pests in the coffee bean storage warehouse regularly, creating pest traps with ethanol and methanol, planting canopy plants to protect coffee plants from heavy rainfall, inspecting every procedure for coffee beans storage, pre-work employees briefing, creating automatic temperature and humidity detection systems, maintaining tools and machines regularly, as well as creating SOPs for coffee beans storage.

Eradicating Pests in the Coffee Bean Storage Warehouse Regularly

Pest eradication in the coffee bean storage warehouse is one of the quality control efforts managed by a company. Insecticides are still the primary way to eradicate pests in warehouses. The ideal insecticide to control pests should kill pests quickly but must be safe for humans and stored raw materials. The company can use plant-based insecticides. According to Wiryadiputra, Rusda, & Asyiah (2014), using plants as insecticides generally shows a high level of safety because the compounds are easily biodegradable and safe. One of the plant-based insecticides that the company can potentially use is the *Pangium edule* because it contains cyanide, flavonoid, and saponin compounds.

Creating Pest Traps with Ethanol and Methanol

The company can make simple and low-cost pest traps. The pest trap is made from a red-painted mineral water bottle with a hole on the side for pests to enter. Water plus detergent is filled at the bottom of the bottle as a place for pests. The ethanol-based liquid in plastic or small bottles is then hung in a trap as an attractant (Harni et al., 2015).

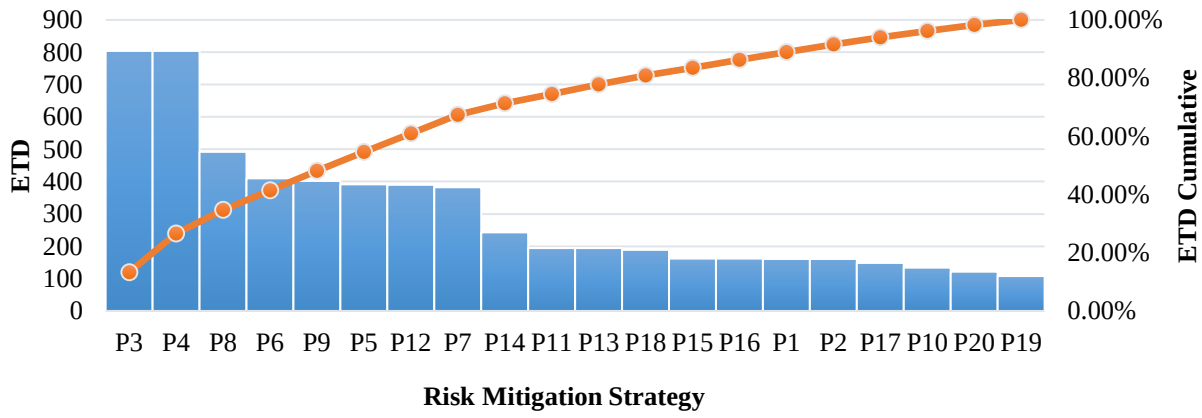

Figure 6. Pareto Chart of Risk Mitigation Strategy

Table 6. Priority of risk mitigation strategy

Rank	PA Code	Description of Risk Mitigation Strategy (PA)	D_k	TE_k	ETD_k
1	P3	Eradicating pests in the coffee bean storage warehouse regularly	3	2,412	804
2	P4	Creating pest traps with ethanol and methanol	3	2,412	804
3	P8	Planting canopy plants to protect coffee plants from heavy rainfall	3	1,476	492
4	P6	Inspecting every procedure for coffee beans storage	3	1,230	410
5	P9	Pre-work employees briefing	3	1,206	402
6	P5	Creating automatic temperature and humidity detection systems	4	1,566	391.5
7	P12	Maintaining tools and machines regularly	3	1,170	390
8	P7	Creating SOP for coffee bean storage	4	1,530	382

Risk Agent	Risk Mitigation Strategy (PA)																				ARP
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	
A1	3	3																			268
A13			9	9																	268
A17					9	3															174
A14						3	9														170
A20								9													164
A24									9	3											134
A7											9	9									108
A9													9								108
A16														9							81
A15															9						72
A27																9					72
A18						3						3					9				66
A6																		9			63
A22																			9		60
A10																				9	54
Total Effectiveness of Proactive Action k (TE_k)	804	804	2,412	2,412	1,566	1,230	1,530	1,476	1,206	402	972	1,170	972	729	648	648	594	567	540	486	
Action k (D_k)	5	5	3	3	4	3	4	3	3	3	5	3	5	3	4	4	4	3	5	4	
Effectiveness to Difficulty Ratio of Action k (ETD_k)	160.8	160.8	804	804	391.5	410	382.5	492	402	134	194.4	390	194.4	243	162	162	148.5	189	108	121.5	
Rank of Proactive Action k	15	16	1	2	6	4	8	3	5	18	10	7	11	9	13	14	17	12	20	19	

Figure 5. House of Risk 2

Planting Canopy Plants to Protect Coffee Plants from Heavy Rainfall

Coffee plants generally require canopy plants to support their productivity. According to Sobari, Sakiroh, & Purwanto (2012), the various canopy plants' management practices will affect coffee cherries' growth, production, and quality. The primary role of this canopy plant is to protect the coffee from too much direct sunlight and heavy rainfall. Canopy plants can also increase nutrients in the soil. Pruning should regularly conduct to reduce humidity.

Inspecting Every Procedure for Coffee Bean Storage

Product inspection in the warehouse is a part of the quality control process. Quality control is a process that makes the entity a quality reviewer of all factors involved in production activities. Quality control aims to prevent goods that are not following the desired quality standards (second quality) continuously. Quality control also seeks to control, select, and assess quality so that consumers feel satisfied and the company does not make a (Tampai, Sumarauw, & Pondaag, 2017). Coffee bean inspections are held every day to take immediate action if there is a deviation from the coffee bean storage process that is not following the SOP. The employees must carry out inspections carefully and correctly to maintain the quality of the coffee beans before being sent for ground coffee production.

Pre-Work Employees Briefing

Employee briefings are needed to socialize company rules and policies. According to Batlajery (2016), a briefing is a process to foster motivation in employees to work hard and be active. The briefing is also a process of guiding employees in implementing plans to achieve goals effectively and efficiently. The briefing held at PDP Kahyangan Jember aims to motivate employees to do their jobs and continuously socialize SOPs.

Creating Automatic Temperature and Humidity Detection System

PDP Kahyangan Jember must take advantage of technological advances by implementing them in storage warehouses. An automatic control system is needed so that the storage warehouse temperature and humidity are always stable according to production standards. The monitoring system will provide information about the current temperature and humidity condition of the storage warehouse. Users will find it easier and faster to get information about storage warehouse conditions to maintain the food quality stored in the warehouse (Wicaksana et al., 2018).

Maintaining Tools and Machines Regularly

Production tools and machines are critical in PDP Kahyangan, so the company must regularly maintain production tools and machines. According to Ebeling (2019), a company must periodically schedule preventive maintenance includes a set of maintenance tasks, such as inspection and repair, replacement, cleaning, lubrication, adjustment, and calibration. The impact of machine maintenance is very significant for companies that use automated tools and machines. The company will bear huge losses if production stops due to machine breakdown. Maintenance is needed to reduce the possibility of tools and machine breakdown.

Creating SOP for Coffee Bean Storage

The company needs SOP to realize professional, practical, efficient, and better work systems. SOP that must exist in a coffee company is the coffee beans storage SOP. SOP for coffee beans storage including the identification of coffee beans characteristics to place coffee in a similar group, determine the effective storage location according to the coffee beans characteristics, handling the coffee beans to the designated storage area, and recording the coffee beans codes (Sitorus & Nasution, 2017).

CONCLUSIONS

The ground coffee production at PDP Kahyangan Jember involves several parties that form a production supply chain. The several parties' involvement may lead to potential risks for the supply chain. Pest attacks and heavy rainfall mitigation are the prioritized risk agents at suppliers. Incorrect temperature and humidity levels and less scrupulous employees' mitigation are the prioritized risk agents at the manufacturer. Risk mitigation strategies triggered by the pest attacks and heavy rainfall can be carried out by routinely eradicating pests in coffee bean storage warehouses, creating pest traps with ethanol and methanol, and planting canopy plants to protect coffee plants from heavy rainfall. The risk mitigation strategy that stems from the incorrect temperature and humidity levels is to check every coffee bean storage and follows the implemented procedure. The risk

mitigation strategy that originates from the less scrupulous employees is briefing the employees before the work started. The implementation of a risk mitigation strategy is expected to reduce the risk of ground coffee supply chain at PDP Kahyangan Jember.

The analysis of ground coffee supply chain risk in this study was only carried out on suppliers and manufacturers, which means the risk identification, risk agents, and risk mitigation strategies were not comprehensive. Further research can be carried out to analyze the supply chain risk up to the end consumers to identify whole risks and risk agents so the risk mitigation strategies can be applied to all supply chain members.

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