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RISK ANALYSIS IN COCOA BUSINESS OF THE SARI BUMI PROCESSING UNIT (UPH) IN GUMBRIH VILLAGE, PEKUTATAN DISTRICT, JEMBRANA REGENCY

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Abstract. This research was aimed to: identify the risks that occur using each stage of the activity, analyze the risk ranking using the FMEA method, and develop a mitigation plan to minimize the Risk Events that occur in UPH Sari Bumi. UPH Sari Bumi is a Cocoa Product Processing Unit fostered by the Bali Province Agriculture and Food Security Office. UPH Sari Bumi processes fermented dry beans from farmers within UPH members and farmers outside UPH Sari Bumi. Data for this research were collected through interviews, brainstorming, and documentation from October 2023 to January 2024, involving primary and secondary sources. Results reveal 16 risk events across planning, procurement, production, delivery, and sales return stages, with Risk Priority Numbers (RPN) ranging from 7 (broadly acceptable) to 624 (intolerable). Key risks include insufficient harvest (RPN 624), worker negligence (RPN 531), and competition (RPN 392), driven by factors such as limited raw material supply, poor fermentation quality, and lack of legal permits (SIUP). Proposed mitigations include diversifying supply sources, implementing worker training and incentives, securing supplier contracts, and obtaining legal documentation (NIB) to enhance financing and export capabilities.

Keywords: Cocoa agroindustry, Risk management, FMEA, Risk priority number, Mitigation

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INTRODUCTION

Cacao (*Theobroma cacao L.*) is one of the agricultural commodities that significantly contributes to the Indonesian economy (Izzatin et al., 2023). Based on data from the Indonesian Ministry of Trade of the, cocoa ranks fourth among Indonesia's leading export commodities, with export destinations including Malaysia, Singapore, Thailand, China, India, Japan, the United States, Germany, Belgium, and the United Kingdom. At the regional level, Statistics Indonesia (BPS) of Bali Province (2022) reported that cocoa production in Bali Province reached 4,736 tons per year. Jembrana Regency is the largest contributor with a production of 2,943 tons, followed by Tabanan Regency at 1,039 tons. The

data indicate that Bali has sufficient raw-material potential to support the development of the local cocoa agroindustry. According to Suryana, Nugrahapsari, and Hasibuan (2022), stable raw material availability is a primary prerequisite for the development of agro-processing industry.

One of the cocoa agroindustry units in Bali is the Sari Bumi Processing Unit (UPH), located in Gumbrih Village, Pekutatan District, Jembrana Regency. This UPH is managed by the Sari Bumi Farmer Group, which was established in 1998 and began operating its processing unit in 2016 through machinery assistance from the Bali Provincial Government (Dewi & Astama, 2021). According to Dewi, Sukendar, and Putra (2024), its products include cocoa paste, cocoa butter, cocoa powder, chocolate powder, and chocolate bar, with cocoa paste being the most demanded product. The plantation area of Sari Bumi UPH is about 30 hectares and its average productivity is 330 kg/ha, with total cocoa bean production is approximately 9 tons per year.

However, the sustainability of cocoa processing businesses is heavily affected by various risk factors inherent in theactivity of agro-industry. Dewi and Artini (2023), state that the development of product and production facility will increase energy needs, which is an important element in industrial operations. Cocoa processing activities, such as grinding, refining, tempering, and cooling, require relatively high energy consumption. Noor (2025) emphasizes that industrial activities are highly dependent on the efficient utilization of natural resources in order to avoid inefficiency and production cost waste. In the context of the Sari Bumi UPH, the first risk faced is the instability of raw material supply. The minimum raw material required to optimize machine processing capacity is approximately 20 tons per year, whereas cocoa production from the plantations owned by UPH members is only around 10 tons annually. This supply shortage has thus far been addressed through procurement from farmers outside the group. Although, in theory, external supply can bridge the gap, its availability is often unstable due to factors such as harvest seasons, cocoa bean quality, and competition with other business actors in purchasing cocoa beans. This condition results in the processing machinery not always being utilized at its optimal capacity and constitutes a significant source of operational risk for Sari Bumi UPH. The seasonal harvesting pattern of cocoa, combined with intermediate harvest periods, also contributes to fluctuations in both the quantity and quality of cocoa beans. Variations in bean size and quality affect production efficiency as well as machine performance. Suryana, Nugrahapsari, and Hasibuan

The second risk is related to technological aspects and machinery maintenance. The machines used by Sari Bumi UPH have relatively limited capacity, with chocolate bar production of approximately 150 bars per day. Machine failure can lead to operational disruptions (downtime) that directly affect productivity and revenue considering the high investment value of the machinery. Susilo (2023) states that the maintenance of cocoa processing machines requires routine and scheduled servicing to ensure optimal performance. That is in line with Islam, Lestari, Fitriani, and Wardani (2020) explaining that maintenance is a crucial activity in supporting the continuity of the production process; without adequate maintenance, machinery is at risk of malfunction, which may disrupt the entire production process. The third risk is associated with human resources. The head of UPH stated that some workers do not yet possess specialized competencies in cocoa processing, thereby increasing the potential for work errors and operational inefficiencies. Suwinasih, Dewi, and Dewi (2023) emphasize that organizational success is not only determined by capital and technology, but also highly dependent on the quality of human resources in managing and utilizing these resources.

Theoretically, risk is defined as the possibility of an event occurring that may result in losses or deviations from expected outcomes (Khuril Ain, 2024). From a modern management perspective, risk is viewed as a consequence of uncertainty inherent in every business activity (H. S. Lestari et al., 2025). Therefore, risk management is a systematic approach encompassing the processes of risk identification, analysis, evaluation, and control to minimize negative impacts on the organization. In the agribusiness sector, Asrory et al. (2023) lassify risk into several main categories, namely production risk, market

risk, financial risk, institutional risk, and human resource risk. Production risk includes fluctuations in output and raw material quality; operational risk is related to process disruptions and machine failures; financial risk concerns costs and cash flow; and human resource risk relates to worker's competence and productivity. The urgency of risk analysis in the context of Sari Bumi UPH lies in the need to systematically map these various sources of uncertainty. Without risk analysis, managerial decision-making tends to be reactive and not based on prioritization according to likelihood and impact levels. Risk analysis assists organizations in determining risk-handling priorities so that resources can be allocated effectively and efficiently. Thus, the implementation of risk analysis at Sari Bumi UPH is expected to enhance business resilience, maintain production continuity, and support the sustainability of the cocoa agroindustry in Jembrana Regency.

METHOD

This study employs a quantitative descriptive analysis method to provide a comprehensive overview as well as a measurable analysis of operational risks in cocoa processing activities at the Sari Bumi Processing Unit (UPH). The research was conducted at the Sari Bumi Processing Unit, located in Gumbrih Village, Pekutatan District, Jembrana Regency, Bali. The selection of this location was based on the researcher's interest in cocoa-based business which represent a collaboration between farmer groups, and because Sari Bumi UPH is the only processing unit that produces chocolate from farmed cacao. This UPH operates under the business name Cho-Jaensan, producing various processed cocoa products such as nibs, cocoa paste, cocoa butter, chocolate bars, and cocoa powder.

This study involved three informants, which are the head of Sari Bumi UPH and two employees of the UPH. Purposive sampling was used to select informants, which involves deliberately determining data sources based on specific criteria and authority relevant to the research problem. Methodologically, the use of three informants consisting of the head of the UPH and two employees is considered representative, given that Sari Bumi UPH is a small-scale organization with a total workforce of only four people. In this study, data validity is not determined by the size of the sample, but rather by the depth of information obtained from key informants who are directly involved in the entire business process, from planning to distribution. Involving personnel with both technical and managerial expertise is crucial in the FMEA method to obtain accurate assessments of Severity, Occurrence, and Detection scores based on real field experience. Thus, the three informants are considered sufficient to achieve data saturation in identifying 16 operational risk events occurring at Sari Bumi UPH.

The data collection techniques in this study involved several methods that complement each other. First, direct observation was conducted at the Sari Bumi UPH site over a four-month period to understand operational processes within the UPH and to detect potential risks in real time. Second, in-depth interviews were carried out with key informants to obtain detailed information regarding constraints and risks encountered at each stage of production activities at Sari Bumi UPH. Third, brainstorming sessions were conducted with relevant stakeholders at Sari Bumi to identify risk events and their causes (risk agents) based on experience and historical data. Fourth, a literature review was used to gather theoretical references and previous studies that support the risk analysis.

The data analysis method used in this study is Failure Mode and Effect Analysis (FMEA), which is a systematic approach to identifying, evaluating, and managing risk. The analysis process begins with risk mapping based on stages of operational activities, followed by the assessment of three main components, namely severity (the impact level of a risk), occurrence (the probability of a risk happening), and detection (the ability to detect a risk before it occurs), each of which is scored on a scale of 1–10. The results of these three components are multiplied to generate the Risk Priority Number (RPN), with a value range of 1–1000, which is then used to classify risks into three categories: Broadly Acceptable (BA), As Low as Reasonably Practicable (ALARP), and Intolerable (INT). Based on the RPN values, risks classified as INT and ALARP are prioritized for the formulation of mitigation

plans, which include strategic measures to minimize the impact and frequency of risk occurrences, thereby supporting the operational sustainability of Sari Bumi UPH. This approach ensures that the analysis is not only descriptive but also provides practical solutions that can be implemented by the management.

RESULT AND DISCUSSION

Identification of Potential Risks at Sari Bumi UPH

The identification of potential risks at the Sari Bumi Processing Unit (UPH) was conducted through the collection of historical data, in-depth interviews, and brainstorming with management. This process aligns with the risk identification stage according to the International Organization for Standardization ISO 31000 standard as discussed in Haryanti and Hutomo (2024), which emphasizes the importance of a systematic and participatory approach in mapping the sources of organizational uncertainty. The study identified 16 risk events distributed across six operational stages: planning, procurement, production, sales, delivery, and returns. This approach is consistent with the concept of Supply Chain Risk Management as outlined by Zemlyakova (2023) which states that risks must be analyzed at each process point to prevent systemic disruptions in the supply chain. Several key risks identified include uncertainty in the quantity of raw material procurement (E1), maintenance problem and machine failure (E2–E3), high price and scarcity of cocoa bean (E7), raw material damage due to microorganism (E8), uneven roasting result (E9), product defect (E11), and product return by customer (E16). These risks are triggered by various risk agents, such as inaccurate forecasting of demand (A1), limited operational fund (A2), labor negligence (A10), the absence of peak harvest season (A6), and competition in raw material procurement (A5).

The identification results indicate that these risks have significant potential to disrupt the operational continuity of Sari Bumi UPH if not managed systematically. For example, the scarcity of cocoa beans due to the absence of a peak harvest period (A6) has the potential to halt the production process entirely, which in risk management theory is classified as a critical risk with high impact. Meanwhile, labor negligence (A10) can lead to waste of raw materials and a decline in product quality, which cumulatively affects reputation and customer satisfaction. Those findings are consistent with previous research by Wibisono, Syah, Negoro, and Iskandar (2023), which emphasizes the importance of risk identification based on operational stages in agribusiness supply chain management. Furthermore, Mokhatla et al. (2026) show that crop failure risk and market competition are priority threats in agroindustrial business, particularly for small and medium-scale businesses with limited resources. Therefore, strengthening risk identification based on risk management and supply chain theories becomes a crucial foundation for subsequent risk analysis and mitigation stages, in order to ensure the longterm operational sustainability of Sari Bumi UPH.

Ranking the Risks Using the FMEA Method

Risk analysis is a subsequent stage following the risk identification process, aimed at assessing the significance level of each risk so that handling priorities can be determined (Fauzi et al., 2022). Risk analysis is conducted by measuring identified risks. In the FMEA method, three aspects are evaluated: severity (the level of impact), occurrence (the likelihood of occurrence), and detection (the ability to detect), each measured on a scale of 1 to 10. The Risk Priority Number (RPN) is then calculated by multiplying these three values—severity (S), occurrence (O), and detection (D)—resulting in a score range from 1 to 1000. The values of S, O, and D are determined qualitatively based on criteria derived from brainstorming sessions with experienced personnel whose roles are relevant to the identified risks. This assessment considers how frequently risks occurred over a one-year period, specifically in 2022. The RPN scores are presented in the following Table 1.

Table 1. Risk agent, risk event, and RPN score of Sari Bumi UPH 2022

Code (Ei)	Risk Event	S	Code (Ai)	Risk Agent	O	D	RPN
E1	Forecasting fluctuations of raw material procurement quantity	6	A1	Inaccurate forecasting of customer demand by Sari Bumi UPH	1	2	12
			A2	Limited capital	5	1	30
			A6	Absence of harvest	8	6	288
E2	Constraints in conducting routine maintenance for machinery and equipment prior to the production process	2	A2	Limited capital	1	2	4
E3	Delays in repairing damaged tempering machines	6	A2	Limited capital	10	3	180
E4	Sudden changes in production planning quantitiy	2	A3	Changes in customer demand	2	2	8
E5	Delays in registration of BPOM (Indonesian FDA)	6	A2	Limited capital	10	3	180
E6	Failure to secure investor funding	5	A4	Lack of a Trading Business License (SIUP)	10	5	250
E7	Scarcity and high price of cocoa bean	7	A5	Presence of competitor	8	7	392
			A6	Absence of harvest	8	6	336
E8	Damaged raw material	7	A7	Bacterial, fungal, and other microbial infestation	2	2	28
			A8	Unsatisfactory quality of dried fermented cocoa beans	2	2	28
E9	Uneven roasting results of cocoa beans	7	A9	Rolling electricity outages by PLN	1	2	14
			A10	Worker negligence during the roasting process	3	3	63
			A8	Unsatisfactory quality of dried fermented cocoa beans	5	2	70
E10	Low cocoa butter yield	8	A8	Unsatisfactory quality of dried fermented cocoa beans	5	2	80
			A10	Worker negligence during the roasting process	3	5	120
E11	Defects in mass cocoa products, such as whitish discoloration and sour taste	7	A8	Unsatisfactory quality of dried fermented cocoa beans	5	2	70
			A10	Worker negligence during the roasting process	3	5	105
			A10	Worker negligence during the roasting process	7	3	147

E12	Inconsistent taste and texture of dark and milk chocolate products	8	A10	Worker negligence during the process of mixing, refining, conching	4	3	96
E13	Delays in the packaging process	3	A11	Limited Workforce	6	4	24
E14	Inability to expand the international sales of mixed products	6	A4	Lack of a Trading Business License (SIUP)	10	3	180
E15	Delayed or obstructed delivery of goods to customers in Bali	4	A12	Traffic congestion due to major religious or public holiday celebrations	4	2	32
E15	Delayed or obstructed delivery of goods to customers in Bali	4	A13	Limited transportation capacity	1	2	8
E16	Product discrepancy	7	A14	Inconsistent taste and texture of the products	1	1	7
			A15	Product shelf life does not meet the promised standards	1	1	7
			A16	Products damaged or crushed during transportation	1	1	7

Source : Data Processed, 2024

Table 2. Risk agent and RPN score of Sari Bumi UPH 2022

NO	RISK AGENT	CODE	RPN
1	Inaccurate forecasting of customer demand by Sari Bumi UPH	A1	12
2	Limited capital	A2	394
3	Changes in customer demand	A3	8
4	Lack of a Trading Business License (SIUP)	A4	430
5	Presence of competitors	A5	392
6	absence of harvest	A6	624
7	Infestation of bacteria, fungi, and other harmful microorganisms	A7	28
8	Unsatisfactory quality of dried fermented cocoa beans	A8	248
9	Rolling power outages by PLN	A9	14
10	Worker negligence	A10	531
11	Limited workforce	A11	24
12	Traffic congestion due to major holiday celebrations	A12	32
13	Limited transportation capacity	A13	8
14	Inconsistent product taste and texture	A14	7
15	Product shelf life does not meet the promised standards	A15	7
16	Products damaged or destroyed during transportation	A16	7

Source: Data Processed, 2024

Table 1 indicates that the most critical risk with the highest Risk Priority Number (RPN) is the high price and scarcity of cocoa beans (E7), with an RPN of 392 due to competition (A5) and 336 due

to harvest failure (A6). These results reflect a combination of high impact, high frequency of occurrence, and low detectability, thereby posing a significant threat to the sustainability of the company's operations. Qamara and Widiarta (2025) argue that fluctuations in raw material prices can significantly affect the stability of agricultural enterprises. In addition, another significant risk is the inability to secure investor funding (E6), with an RPN of 250 due to the absence of a trading business license called SIUP (A4), highlighting the importance of business legality. Sappeami, Dzulkifli, and Umi (2021) found that business legality directly influences investor trust, where the inability to obtain business permits increases operational risk. Conversely, risks such as product discrepancy (E16) and delayed delivery (E15) have low RPN values (7–8), indicating that although their impacts may be substantial, they occur infrequently and are relatively easy to detect. Recurring risk agents include limited capital (A2), which affects multiple aspects such as raw material procurement and machine maintenance; poor quality of dried fermented cocoa beans (A8), which impacts the final product; and worker negligence (A10), which frequently occurs during roasting, tempering, and mixing processes. Therefore, the next step is to aggregate the RPN values of each risk agent, as presented in Table 2.

Table 2 shows that the highest RPN score is 624, while the lowest RPN score is 7. Based on these RPN values, an FMEA level mapping is generated as illustrated in Figure 1.

Risk Level		RPN		
		1-71	72-391	392-1000
Severity	1-6	A1, A3, A11, A12, A13		A2, A4
	7-8	A7, A9, A14, A15, A16	A8	A5, A6, A10
	9-10			

Figure 1. FMEA level mapping of Sari Bumi UPH
Source: Data Processed, 2024

Based on Figure 1, the areas in the table marked in green are classified as Broadly Acceptable (BA), indicating that the risks in these areas are acceptable and only require control through existing systems. The yellow areas are categorized as As Low as Reasonably Practicable (ALARP), indicating that risks in these areas require control measures or risk treatment that should be promptly implemented. The red areas are classified as Intolerable (INT), indicating risks that require mitigation actions. Risks within the ALARP and INT categories require special attention as they may disrupt or hinder the performance of the company. Those risks become the primary focus in subsequent risk management. Table 3 presents the mitigation action plans for these risks.

Table 3. Risk agents of Sari Bumi UPH requiring mitigation measures

Code	Risk Agent	Category	RPN
A6	Absence of harvest	INT	624
A10	Worker negligence	INT	531
A5	Presence of competitors	INT	392
A4	Lack of a Trading Business License (SIUP)	ALARP	430
A2	Limited capital	ALARP	394
A8	Unsatisfactory quality of dried fermented cocoa beans	ALARP	248

Source: Data Processed, 2024

Risk Mitigation Planning for Sari Bumi UPH

The risk mitigation planning that can be implemented by Sari Bumi UPH is outlined in Table 3. First the absence of harvest (A6) is a critical risk that significantly hinders UPH operations. If there is no harvest, there will be no cocoa beans, and without cocoa beans, the production process cannot take place. Therefore, the mitigation plan that can be implemented include considering the diversification of cocoa bean supply sources, for example by establishing partnerships with farmers from different regions to reduce dependency on a single harvest location; and anticipating harvest schedules through forecasting and preparing funds to purchase raw materials in large quantities during available harvest periods.

Second Worker negligence (A10) results in various losses, particularly material waste during the production process. For instance, negligence during roasting—such as failing to check and stir the beans at regular intervals—may cause burning, which negatively affects product taste and reduces cocoa fat extraction. According to Kuizinaitė et al. (2023) dan Fauzi, Wibowo, Selayan, and Nst (2022) mitigation planning can include implementing a reward and punishment system to enhance employee motivation and encourage better performance; conducting performance evaluations across departments or among workers, for example through morning briefings to discuss and review previous mistakes so that employees become more careful and avoid repeating them; and implementing standard operating procedures (SOPs) for operating each machine. In addition, job training related to machine handling and maintenance can be an important step in reducing negligence.

Third the presence of competitors (A5) is an unavoidable condition considering the continuous development of the chocolate industry in Jembrana. Recently, a new chocolate factory has been established near Sari Bumi UPH, which has intensified competition for raw material supply. If other companies offer higher prices for cocoa beans than UPH, there is a risk that UPH will be unable to secure sufficient raw materials. Therefore, mitigation strategies, according to Marimin and Muzakki (2021) include establishing purchase contracts with farmers regarding quantity, price, and harvest schedules, thereby binding suppliers to sell their harvests to Sari Bumi UPH within a specified period; and expanding the supplier network by collaborating with farmers from other regions to reduce dependency on a single supplier or area.

Fourth the lack of a Trading Business License or SIUP (A4) occurs because the factory is not owned by UPH, but by the Provincial Department of Agriculture and Food Security of Bali. The absence of SIUP results in difficulties in exporting products abroad and obtaining financing or loans. Therefore, mitigation measures, according to Ulfah (2024), include conducting export activities for non-blended products through an undername export scheme; however, this approach is limited to non-blended products and may result in lower selling prices; and fulfilling export legality requirements by obtaining a Business Identification Number (Nomor Induk Berusaha/NIB), which serves as an alternative to SIUP. NIB can be processed online and is sufficient to meet export documentation requirements. With NIB, the export document processing system becomes more accessible and facilitates the company's participation in export activities.

Fifth, limited capital (A2) lead to various operational constraints, such as delayed raw material procurement, postponed repair of damaged machinery, and delays in obtaining BPOM (Indonesian FDA) certification. Mitigation measures, according to Ulfah (2022), include applying for financial assistance from the Provincial Department of Agriculture and Food Security of Bali, considering that Sari Bumi UPH is a processing unit directly supervised by the department; obtaining a Business Identification Number (Nomor Induk Berusaha/NIB), which serves as a legal requirement for business actors, including MSMEs, to facilitate access to financing from both banking and non-banking financial institutions. In this context, ownership of an NIB facilitates access to funding sources, enabling easier acquisition of loans; and reducing company operational costs through cost control and efficiency

measures. This requires careful financial planning by the finance department to ensure effective cost optimization.

Sixth unsatisfactory quality of dried fermented cocoa beans (A8) refers to conditions such as insufficient cleanliness, where impurities such as dirt, leaves, or other foreign materials remain mixed with the beans. Mitigation measures, according to Salasamuharram, Marsudi, and Baihaqi (2023), include improving supervision of cleanliness and quality control, as well as implementing sorting processes to ensure that contaminated beans do not proceed to the roasting stage; and evaluating collaborating suppliers, and if deviations or quality issues occur, conducting constructive discussions with farmers to address and improve performance. Through these measures, the quality of dried beans can be maintained, which in turn will positively affect the quality of the resulting cocoa products.

CONCLUSION

This study identifies 16 risk events across the operational stages of Sari Bumi Processing Unit (UPH), spanning planning, procurement, production, delivery, sales, and product returns. Using the Failure Mode and Effect Analysis (FMEA) method, risks are ranked by their Risk Priority Number (RPN), with harvest shortage (RPN 624), worker negligence (RPN 531), and competition for raw materials (RPN 392) emerging as the three most critical risks, classified as Intolerable (INT). Limited capital (RPN 394) and inadequate quality of dried fermented cocoa beans (RPN 248) are categorized as As Low as Reasonably Practicable (ALARP) and also require structured intervention.

Mitigation measures for Intolerable risks include diversifying cocoa bean supply sources, establishing purchase contracts with farmers, and implementing worker training alongside reward-and-punishment systems. For ALARP risks, obtaining a Business Identification Number (NIB) is recommended to resolve the absence of a trading license, facilitate export activities, and improve access to institutional financing. Improving quality control and supplier evaluation are also necessary to address raw material quality constraints.

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