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Integrating ERM with HACCP for Enhanced Efficiency in SME Beverage Manufacturing: The Case of SME Beverage Manufacture Company in Rembang, Indonesia

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ABSTRACT: This study presents an approach to determining the most impactful risks faced by an SME beverage manufacturing company in Rembang, Indonesia. Indonesia's food and beverage market is highly competitive, especially for small and medium-sized enterprises (SMEs) that aim to sustain and grow their businesses. Focusing more on their business strategy, these SMEs often overlook risk management, which can lead to significant losses. The study employs a methodology that combines Enterprise Risk Management (ERM) with Hazard Analysis Critical Control Points (HACCP) to detect and evaluate potential risks in the production process, ultimately providing recommendations for the best possible corrective actions to manage these risks. The ERM framework highlighted three major risks associated with defective products, water shortage, and blackout, while the HACCP analysis pinpointed five critical control points (CCPs) in the production process of boiling, cooling, mixing, filling/bottling, and packaging. Based on these results, the study suggests corrective actions of installing backup generators, securing additional water supplies, and implementing homogenizers will benefit the company.

KEYWORDS: Beverage Manufacture, Critical Control Points, Enterprise Risk Management, Hazard Analysis, Hazard Vulnerability Assessment, Production Process.

I. INTRODUCTION

In 2020, the Indonesian food and beverage market generated a total revenue of US$5.08 million. With a projected compound annual growth rate (CAGR) of 13.30% from 2022 to 2027, the market size is expected to reach US$10.35 million by 2027. [1] Additionally, in the second quarter of 2020, the food and beverage industries experienced a contraction making the food and beverage industry one of the sectors that is relied upon as driving forces of Indonesia’s manufacturing industry going forward. [2] These facts emphasize the significant size and growth potential of Indonesia's food and beverage sector. For small to medium-sized enterprises (SMEs) entering this highly competitive market, a well-formulated business strategy is crucial. An important factor to consider in this business strategy is the implementation of comprehensive enterprise risk management, as SMEs are more exposed to such types of risk. [3] For these companies, adopting a risk-aware perspective is crucial to navigating the competitive landscape.

In addition to the well-known financial risks, SMEs encounter various enterprise risks, such as operational risks such as production failures and natural disasters. Inadequate risk management can leave companies vulnerable to unexpected difficulties, posing a threat to their survival. An initial strategy to raise risk awareness among management can be done by assigning appropriate financial values to individual risks. This approach ensures that the management system prioritizes the mitigation of significant risks rather than solely focusing on their direct consequences. [4] Understanding and proactively managing these potential risks can help shield the company from disasters, ensuring operational continuity through well-devised control measures and business continuity plans. This underscores the importance of identifying, mitigating, and managing risks before pursuing further business expansion.

This paper seeks to identify potential hazards and risks that the company may face in its production process, identify the Critical Control Points (CCPs) in the production process, establish the critical limits for each CCP, and finally develop corrective actions that the company can take to prevent deviations from critical limits at CCPs to maintain the process in control. To achieve these objectives, the paper combines the ERM framework with HACCP principles to evaluate the beverage production process. The methodology is illustrated through an analysis of how various risks could impact the company's ability to meet its business objectives with its ultimate goal to maintain a seamless production process and prevent disruptions.

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II. BACKGROUND

The background of this study begins with a thorough examination of internal documents from an SME beverage manufacturing company located in Rembang, Indonesia, hereinafter referred to as the 'Beverage Manufacturer.' According to the analysis of these documents, the production records from 2018 to 2022 show that the Beverage Manufacturer achieved an average actual capacity that was only 51.1% of the expected production capacity. This significant shortfall, representing a 48.9% deficit, translates to a substantial financial loss for the company.

The primary reason for this gap in production capacity is disruptions that necessitated production shutdowns. These shutdowns were frequently triggered by uncontrolled and unmitigated risks encountered during the production process. As the Beverage Manufacturer embarks on a new strategic initiative to expand its operations to neighboring cities and online marketplaces, it becomes imperative for the company to achieve its expected production capacity. However, this goal will remain elusive if the Beverage Manufacturer continues to neglect and inadequately manage the operational risks that it faces on a daily basis. Addressing these risks is crucial to ensure a stable and efficient production process that supports the company's expansion plans.

III. PROPOSED LITERATURE REVIEW AND FRAMEWORK

Lam [5] defines enterprise risk management (ERM) as a comprehensive and ongoing process designed to manage risks across an organization, including strategic, financial, operational, compliance, and reputational risks. Its goal is to minimize unexpected performance fluctuations and maximize the intrinsic value of the firm. Integrating Lam's ERM framework with the COSO ERM framework [6], the general ERM process involves establishing internal objectives, identifying risks, assessing risks, responding to risks, implementing control activities, and monitoring risks. To tailor ERM implementation more specifically to the industry context, this study integrates ERM with HACCP. HACCP is a management system focused on food safety, addressing biological, chemical, and physical hazards from raw material production through to the final product's manufacturing, distribution, and consumption. HACCP consists of five preliminary tasks and seven principles. The preliminary tasks are assembling the HACCP team, describing the product and its distribution, outlining the intended use and consumers of the product, developing a process flow diagram, and verifying the flow diagram. [7] The seven principles include conducting a hazard analysis, determining critical control points (CCPs), establishing critical limits, establishing monitoring procedures, defining corrective actions, establishing verification procedures, and maintaining record-keeping and documentation procedures. [8]

The framework employed in this study combines elements from the existing ERM framework and HACCP principles to tailor it to the specifics of this case. The study starts with a preliminary analysis that includes assessing the internal environment and objectives, followed by initial HACCP tasks. The internal environment assessment focuses on identifying business objectives, risk appetite, and risk ownership using ERM concepts, followed by the HACCP preliminary analysis, which includes defining product description, intended usage, and consumer description, and outlining the production process flow. These steps aim to evaluate the company's current status and identify its goals or desired future state. The HACCP methodology is particularly relevant for the beverage production industry due to stringent quality control standards mandated by regulatory bodies, while the ERM framework provides a comprehensive guide to ensure a thorough analysis aligned with ERM standards.

After the preliminary analysis are done, this research will continue to get into the analysis and starts with a hazard assessment, involving the identification, categorization, evaluation, and Critical Control Point (CCP) assessment. Risks are identified based on the production processes outlined in the preliminary HACCP tasks. The identified risk will be assessed by using a Hazard Vulnerability Assessment (HVA). An HVA is a systematic approach to identify all possible hazards that may affect a specific population, assess the risk associated with each hazard [9] HVA uses a scoring mechanism to quantify risks, highlighting those with the highest scores based on their probability and impact on both quality and business aspects. Descriptive terms (such as very high, high, medium, low, and very low) or numeric values can be used for probability and impact. Where numeric values are used, these can be multiplied to give a probability-impact score for each risk, which allows the relative priority of individual risks to be evaluated within each priority level. [10] The HVA results are then transformed into a heat map. Based on Monat & Doremus [11], a heat map is a two-dimensional array that typically lists risk impact on the abscissa and risk probability on the ordinate. Heat maps commonly serve to prioritize risks and subsequently assist in identifying appropriate risk responses. Once individual risks have been prioritized and the degree of overall project risk exposure has been understood, consideration can be given to appropriate actions for addressing individual threats and opportunities, as well as to how overall project risk can be tackled. [12]

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After gathering information on the highest priority risks, Critical Control Points (CCPs) are identified by applying a decision tree to the available data. CCPs can be defined as specific points, stages, or procedures in the food processing workflow that can be managed to prevent or reduce hazards to safe levels. [7] Determining a CCP involves using a CCP decision tree, where the outcomes guide the prioritization of business processes by addressing three key qualification questions. Once CCPs are identified, critical limits will be set and is used to distinguish between safe and unsafe operating conditions at a CCP. In this study, the will critical limit will be set in the form of Recovery Time Objectives (RTO) and Recovery Point Objectives (RPO) where the RTO can be defined as the length of time that the organization can operate with a function disabled before the effect of the loss of the function affects other functions, [13] while RPO indicates the defined point in time in which key activities should be restored after an incident in order to initiate the continuity of operation. [14] These limits are defined using insights from the HVA and CCP determination, with a focus on mitigating high-priority risks at CCPs.

After identifying the highest-ranking risks and CCPs, the researcher will recommend corrective actions to maintain the previously determined RTO and RPO for each CCP. These recommendations will take into account the existing risk controls and the acceptable deviations specified by the Beverage Company. To evaluate the effectiveness of these corrective actions, a cost-benefit analysis (CBA) will be conducted to determine if the proposed measures offer more benefits than costs. Hiles [15] describes CBA as a financial analysis tool used to determine the benefits provided by a project against its costs. The first rationale for using CBA is that it provides a model of rationality. Independently of its use of money measures of gain and loss, CBA forces the decision-maker to look at who the beneficiaries and losers are in both the spatial and temporal dimensions. [16] Optimal allocation of resources to maximize the probability of achieving the business objectives of an enterprise is a key deliverable of the business planning process undertaken annually by leading companies. [17] The conceptual framework, including this process, is depicted in Figure 1 below.

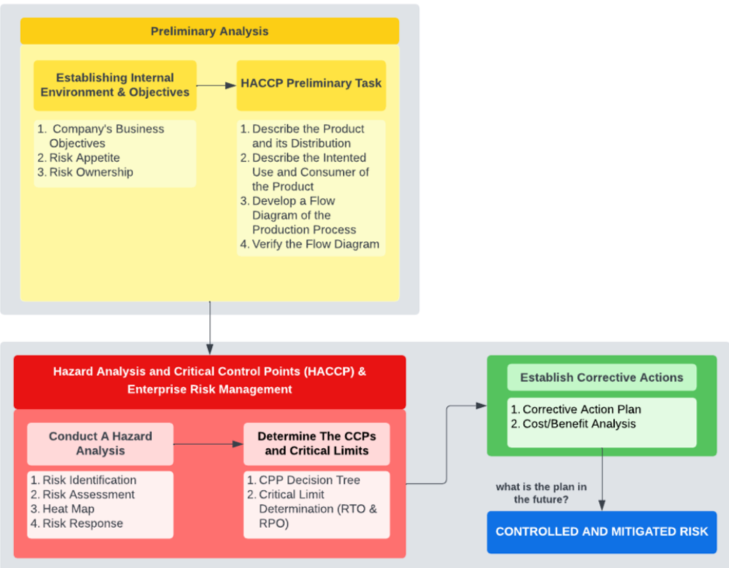

Figure 1. Conceptual Framework of Research

IV. METHODOLOGY

The methodology employed in this paper integrates an ERM framework with the HACCP principles. Adopting a qualitative approach, the study focuses on a case study of a small-scale beverage manufacturer in Rembang, Indonesia. Data collection involved various methods such as observation, interviews, document reviews, and focus group discussions (FGDs) to gain insights into the beverage production process and the implementation of existing risk control measures. This study will be conducted into four phases of research: internal environment identification, hazard analysis, determination of Critical Control Points (CCPs) and critical limits, and development of corrective actions.

The choice of tools for each phase is tailored to the specific required pieces of information. In the first phase, process mapping is used to identify the production process. In the subsequent hazard analysis phase, an HVA and heat map are utilized to assess and rank risks, pinpointing the highest priority risks. The third phase involves the identification of CCPs and determination of critical limits, using a CCP decision tree to identify critical control points within the production process. Once CCPs are identified, critical limits in the form of RTO and RPO are established. The final phase involves developing corrective actions, using a cost/benefit analysis to determine the most effective measures for addressing the highest priority risks at critical control points.

V. RESULT AND DISCUSSION

The analysis centered on the manufacturing process of a syrup product, encompassing its entire production journey from raw material acquisition to packaging. Key considerations included the manufacturing site's location, the processing procedures involved, and the machinery and equipment utilized. The outcome will be layouts corresponding to each phase of the research.

A. Phase 1: Internal Environment Identification

Phase 1 involves identifying the internal environment, focusing on comprehending the company's current status. This phase incorporates the ERM framework and the preliminary HACCP task to identify this internal environment identification. First, using the ERM framework, the researcher will identify the Beverage Manufacturer's business objectives, risk appetite, and risk ownership. As proposed by the COSO, the internal environment of a company is the basis for all other components in an organization's ERM model, influencing how strategies and objectives should be established, how risk-related business activities are structured, and how risks are identified and acted upon. [6]

This step will be followed by the HACCP preliminary task of defining product description, intended usage and consumer of product description and outlining the production process flow. The preliminary HACCP task concentrates on comprehending the production flow process, which subsequently reveals the critical process and those most vulnerable to the risks identified later. Using the combined framework, analysis reveals alignment across all three areas of business objectives, risk tolerance, and risk ownership, all geared towards achieving predetermined business objectives. This alignment is a crucial aspect of the ERM framework. Ensuring that these components are aligned and supportive of the business objectives helps the company's ERM planning to be focused and efficient.

Furthermore, a pivotal component of this phase is the production process flow diagram of the HACCP preliminary task. It identifies a sequential process consisting of six steps: 1) receiving raw material, 2) boiling, 3) cooling, 4) mixing, 5) filling/bottling, and 6) packaging. This process is linear, with each step dependent on the completion of its predecessor, highlighting their interdependence. This information will subsequently serve as the foundation for applying the HACCP principles in this study. Figure 2 presents the flowchart illustrating the end-to-end production process.

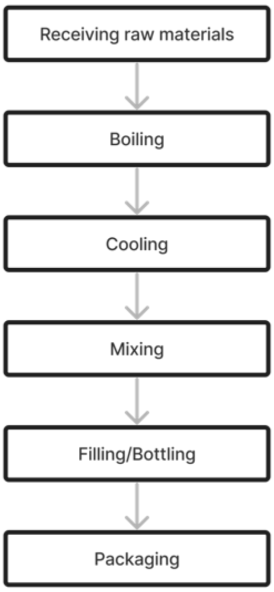

Figure 2. Production Flow Process

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B. Phase 2: Hazard Analysis

Phase 2 encompasses hazard analysis, involving risk identification, risk assessment, creation of a heat map, and development of risk responses. As implemented in Phase 1, this phase also integrates the principles of both ERM and HACCP to systematically identify and assess risks. Risk identification reveals eight major risks that could affect production steps, categorized into two main groups: physical hazards and manufacturing failures. Physical hazards include 1) fire, 2) blackout, and 3) flood, while manufacturing failures encompass: 1) water shortages, 3) supply chain disruptions, 4) machine downtime, 5) defective products, and 6) employee shortages. These identified risks will later be evaluated to determine which processes are affected and which risks are classified as the most urgent, requiring immediate control by the Beverage Company.

Following the ERM framework, the risk identification step will be succeeded by risk assessment. Risk assessment will utilizes a scoring method based on the HVA to calculate risk scores, derived from the likelihood multiplied by the impact. Integrating the ERM framework and HACCP principles in the HVA enables a structured and quantitative assessment of potential hazards. The scoring scale for likelihood is defined as follows: A score of 3 indicates a risk is highly likely, a score of 2 indicates it is likely, and a score of 1 indicates it is unlikely. Likelihood is determined based on the frequency of occurrence, with risks occurring more than three times a year considered highly likely, those occurring between one and three times a year considered likely, and those occurring annually but inconsistently considered unlikely.

Furthermore, the scoring scale for impact is delineated as follows: A score of 3 indicates a significant impact, a score of 2 indicates a moderate impact, and a score of 1 indicates a minor impact. Impact is assessed based on specific criteria within each rating group, and it is not cumulative. For risks to be categorized into a particular impact group, they only need to meet one criterion within that rating group. Criteria for significant impact include significant material financial loss, production pause lasting more than one week, quality degradation rendering the product unsellable, and incidents resulting in worker fatalities. Moderate impact entails moderate material financial loss, production pause of less than one week, partial quality degradation allowing some products to be sold, and potential physical injury to workers. Risks categorized as minor impact entail negligible material financial loss, no production pause required, no impact on product quality, and no harm to workers.

The risk assessment is aligned with the ERM principle where risks are analysed, considering likelihood and impact, as a basis for determining how they should be managed. [18] Integrating the ERM framework ensures a thorough risk management strategy, whereas the HACCP principles concentrate on pinpointing the processes affected by particular risks. This dual-theory integration enhances the robustness of the risk analysis and the effectiveness of the subsequent risk management strategies. Table 1 presents the results of the HVA for the identified risks and the production process impacted by it.

Table I. Hazard Vulnerability Assessment (HVA)

No.	Hazard	Impacted Process	Likelihood	Impact	Risk Score	Risk Rank
Physical Hazard						
R1	Fire	The Entire Process	1	3	3	4
R2	**Blackout**	**Boiling, Cooling, Mixing, Filling/Bottling, and Packaging**	**2**	**2**	**4**	**3**
R3	Flood	The Entire Process	1	3	3	4
Manufacture Failure						
R4	**Water Shortage**	**Boiling and Packaging**	**3**	**2**	**6**	**2**
R5	Supply chain disruption	Receiving Raw Materials	1	3	3	4
R6	Machine downtime	Boiling, Mixing, Filling/Bottling, and Packaging	1	2	2	5
R7	**Defective Products**	**Boiling and Mixing**	**3**	**3**	**9**	**1**
R8	Employee shortage	Boiling, Mixing, Filling/Bottling, Packaging	2	1	2	5

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The analysis highlights the 3 highest-scoring risks: 1) blackout, 2) water shortage, and 3) defective products. To illustrate the urgency level of these risks, the researcher developed a heat map which indicates the location of each risk in terms of its high or low likelihood and impact, as well as the appropriate risk response for each risk. Below is a detailed explanation for each highest-scoring risk:

Blackout

A production blackout refers to an interruption in electricity supply, typically from the State Electricity Company (PLN). Since much of the production relies on automated machinery, switching to manual processes is possible but often results in differences in quality and time spent. Such blackouts can moderately disrupt business operations and compromise the quality of the company's products. In addition to the severity of its impact, the likelihood of this risk occurring is notable as it typically happens at least once a year, resulting in production interruptions.

Water Shortage

Besides electricity, water is another indispensable element for production, particularly crucial for the syrup manufacturing process itself. Without water, syrup production would be impossible. Additionally, water is used in the packaging stage, where filled bottles need to be rinsed before being prepared for sale. Water shortage profoundly affects the business's operations, and unfortunately, is highly likely to happen and lead to a pause in production until the water supply is restored. The water quality in Rembang doesn't meet the required standards for use as an ingredient. Despite utilizing two water sources (PDAM and groundwater), the company still encounters challenges in maintaining consistent availability and quality.

Defective Products

In this scenario, a defective product refers to instances where the liquid sugar is subjected to an incorrect temperature. This typically occurs during the cooling and mixing phases. If the liquid sugar is either too cold or too hot, it cannot proceed to the mixing stage. Consequently, it becomes challenging to blend the syrup with other ingredients such as coloring and flavoring. The resulting mixture will not blend properly, leading to visible separation between oil and liquid phases, rendering the product unsuitable for sale. With manual monitoring, this risk is particularly high.

After pinpointing the highest-scored risks, the researcher generated a heat map to visually represent the risk response, aligning with the HVA table previously shown. Figure 3 below illustrates this heat map, revealing that these three top-scoring risks are situated in the red and orange spectrum. This visual portrayal underscores the urgency of these risks, suggesting that they require prioritization by the Beverage Company. Once the urgency level for each risk is determined based on its position in the heat map, the appropriate risk response will be identified. The allocation of these risk responses is based on the risk control technique stated by Hopkin, P [18] where the most convenient classification system is to describe these controls as preventive, corrective, directive and detective. Using this control classification and the risk location on the heat map, it is determined that blackout risk involves treatment through corrective control activities, whereas the risks of water shortage and defective products require preventive control activities for mitigation.

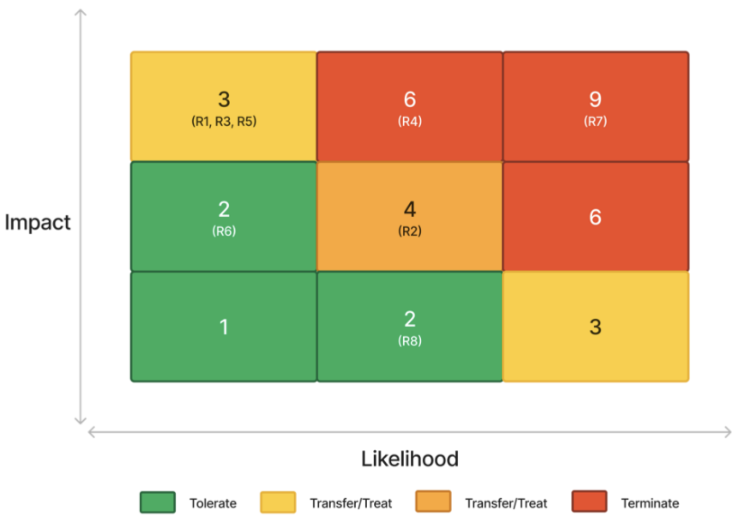

Figure 3. Risk Response Heat Map

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C. Phase 3: CCPs and Critical Limit Determination

Phase 3 revolves around identifying which production processes qualify as CCPs and establishing their critical limits. By consolidating data from Phases 1 and 2 with the three formulated questions in a CCP decision tree, the outcome entails evaluating whether a procedure satisfies the prerequisites to be categorized as a CCP. This determination, integral to the second principle of HACCP, employs the decision tree to separate whether a hazard warrants classification as a CCP. To qualify as a CCP, a hazard must meet the criteria outlined in all three questions. Using the previously identified 6 production processes and associated risks, it shows that 5 of the production processes are identified as CCPs including: 1) boiling, 2) cooling, 3) mixing, 4) filling/bottling, and 5) packaging. Table II below presents a tabular version of the decision tree used to identify which production processes can be designated as CCPs.

Table II. CCP Decision Tree

Process	**Hazard**	**(Q1)**	**(Q2)**	**(Q3)**	**CCP?**
		Does this step involve a hazard of sufficient likelihood of occurrence and severity to warrant its control?	Does a control measure for the hazard exist at this step?	Is corrective or preventive control at this step necessary to prevent, eliminate, or reduce the risk of the hazard to consumer?	
Receiving raw materials	Fire, Flood, Supply Chain Disruption	yes	yes	no	no
Boiling	Fire, **Blackout**, Flood, **Water Shortage**, Machine Downtime, Employee Shortage	yes	yes	yes	yes
Cooling	Fire, **Blackout**, Flood, **Defective Product**	yes	yes	yes	yes
Mixing	Fire, **Blackout**, Flood, Machine Downtime, **Defective Product**, Employee Shortage	yes	yes	yes	yes
Filling/Bottling	Fire, **Blackout**, Flood, Machine Downtime, Employee Shortage	yes	yes	yes	yes
Packaging	Fire, **Blackout**, Flood, **Water Shortage,** Machine Downtime, Employee Shortage	yes	yes	yes	yes

According to the outcome of the CCP decision tree analysis, which aligns with theories of risk management and hazard analysis, the only production process exempt from CCP classification is the raw material receiving step. This determination arises due to the absence of discernible risks necessitating additional corrective actions to prevent, eliminate, or mitigate hazards to consumers, particularly those classified as the three highest priority risks. Once CCPs are identified, the subsequent phase involves determining the RTO and RPO as critical limits. In grasping the significance of RTO and RPO to avert consequential losses for the Beverage Company, determining the critical limit necessitates initially assessing the expected deviations within the company's operations. Essential data includes acceptable deviations and processing times for each CCP process.

Drawing from information provided by the Beverage Company regarding acceptable deviations, it becomes evident that even a single production day loss is untenable for the company. Consequently, the RTO for each production step is determined by

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subtracting the processing time from 8 hours (working hours). For example, if the boiling process takes 3 hours, the acceptable downtime or RTO for this process is 5 hours. However, for the cooling process, which must be ready immediately after boiling, the RTO is 3 hours which is the process time of the boiling process. The subsequent mixing, filling/bottling, and packaging processes have respective RTOs of 7.3 hours, 2 hours, and 5.5 hours. The RPO represents the acceptable product loss the company can tolerate, with consistent values across all steps totalling 103,540 ml or 166 bottles per day.

Ensure the ongoing operations of the Beverage Company remain uninterrupted, the primary focus and objectives of the implemented control or mitigation plan should revolve around restoring the production process in accordance with the determined RTO and RPO. Table III below displays the critical limits for each CCP process. Table III below provides comprehensive details regarding all critical limits for each CCP process.

Table III. Critical Limit Determination

CCP Process	Process Time	Critical Limits (per day)	
		RTO	RPO
Boiling	3 hours	5 hours	103,540 ml
Cooling	2 days	3 hours	103,540 ml
Mixing	30 minutes	7.5 hours	103,540 ml
Filling/Bottling	6 hours	2 hours	166 bottles
Packaging	2.5 hours	5.5 hours	166 bottles

D. Phase 4: Corrective Action Development

Phase 4 engages in the application of risk management theories by identifying corrective action plans aimed at controlling or mitigating the high-priority risks delineated. This involves harnessing insights regarding CCP processes, the correlated high-priority risks, and prevailing control measures to craft a tailored corrective action plan for the company. The process commences with an assessment of the limitations posed by current controls concerning high-priority risks, juxtaposed with the anticipated outcomes of the proposed corrective action plan. This critical evaluation step determines whether the corrective action plan effectively rectifies the deficiencies inherent in existing control measures. Table IV below provides insights into the existing control activities and facilitates the assessment of the corrective action plan.

Table IV. Existing Control and Corrective Action Plan Assessment

Hazard	Existing Control Activities	Downside	Corrective Action Plan	Expectation
Blackout	Switching To Manual Produce SOP	Manual production is time-consuming, necessitating overtime pay for employees. Additionally, quality consistency issues are likely to arise since the process is manually managed by humans.	Backup Generator	In the event of a blackout in the Rembang area, a backup generator will be utilized to ensure continuous operation during production hours. This generator will remain active, preventing any downtime in the production process.
Water Shortage	Several Inhouse Water Sources	As the source remains in-house, there's no assurance of consistent availability and quality, potentially resulting in variations among the different water sources.	Additional Water Supply from Neighbor City	Water supply will be systematically scheduled year-round to ensure its availability for the production process. This strategy guarantees consistent access to water while maintaining its quality at all times. Pati, being the closest city

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				to Rembang, boasts better water quality compared to Rembang due to its greater distance from the sea.
Defect Product	1. Temperature Indication 2. Control Checklist	While both the temperature indication and control checklist can assist in ensuring that the liquid sugar maintains the correct temperature, manual monitoring by a human is still necessary, posing a risk of human error.	Installing Homogenizer	The homogenizer, a machine integrated into the mixing process, eliminates the dependency of mixing on the temperature of the ingredients. It enables the blending of liquid sugar and other components regardless of their temperature, mitigating the risk of producing defective products. Additionally, it facilitates the mixing of water and oil at any temperature, further minimizing potential risks.

As stated in Table IV above, proposed corrective measures include installing backup generators for blackout scenarios, securing additional water supply from neighbouring cities to address water shortages, and implementing homogenizers to tackle defective products. Subsequently, a CBA is conducted to determine the feasibility of these proposed actions. Essential inputs for this analysis include the average downtime per year (from 2018 to 2022), potential risk impacts/costs, and the costs associated with implementing the corrective actions. The analysis aims to ascertain whether the proposed corrective actions offer a net benefit to the company. Table V below shows the cost/benefit analysis for the suggested corrective action plan.

Table V. Cost/Benefit Analysis

Hazard	**Corrective Action Plan**	**Average Downtime per year (2018-2022)**	**Risk Impact/Cost (1,333 bottles per day x IDR 37,000)**	**Corrective Action Cost**	**Beneficial?**
Blackout	Backup generator	7 days (56 hours)	IDR 345,247,000	IDR 107,996,800 **Price breakdown:** - Genset (100 kVa): IDR 100,000,000 (one time purchase) - Diesel fuel (21 liter per hour) (21 x 56 x IDR 6,800): IDR 7,996,800 per year	Beneficial
Water Shortage	Additional water supply from neighbor city	5 days	IDR 246,605,000	IDR 10,000,000 per year	Beneficial
Defect Product	Installing homogenizer	10 days	IDR 493,210,000	IDR 350,000,000 (one time purchase)	Beneficial

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This analysis demonstrates the execution of CBA with the objective of maximizing the financial advantages for the company. Based on the calculation in Table V above, the CBA revealed that all three proposed corrective actions yield a positive outcome for the company, indicating their feasibility and potential benefits.

VI. CONCLUSION AND RECOMMENDATION

This study details an ERM combined with HACCP analysis for a small and SME beverage manufacturing company. It illustrates how the combination of critical assessment, process mapping, HVA, and HACCP principles should be utilized to conduct a comprehensive ERM analysis. The approach taken in this study highlights that a fundamental step in the ERM process is to identify risks and critical control points to determine which risks should be prioritized to prevent production downtime.

During the period covered in this study, the highest risks for the production process are power outages, water shortages, and defective products occurring at CCPs of boiling, cooling, mixing, filling/bottling, and packaging. Corrective actions found to be most beneficial for mitigating these risks include installing backup generators, securing an additional water supply from a neighboring city, and introducing homogenizers, respectively.

Future work at the company should include establishing a robust monitoring protocol. This procedure is essential for the ongoing assessment and maintenance of all identified risks at acceptable levels. Such proactive measures ensure the company's preparedness when identified risks occur while also verifying the presence of necessary controls. Ultimately, this approach will minimize production downtime, thereby aiding in the consistent attainment of production targets.

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