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Dear Author(s)
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It's my pleasure to inform you that, after the peer review, your paper ***Analysis of Tofu Quality Control Using the Failure Mode and Effect Analysis (FMEA) Method at Tahu Gunung SME has been ACCEPTED with content unaltered to publish with International Journal of Health, Economics, and Social Sciences (IJHESS) in Volume 7 Issue 2 (April 2025).***

Thank you for making the journal a vehicle for your research interests

With regards
Yours sincerely

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Analysis of Tofu Quality Control Using the Failure Mode and Effect Analysis (FMEA) Method at Tahu Gunung SME

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ABSTRACT

Business competition that is increasingly dynamic, complex, and uncertain emphasizes company managers to think creatively and innovatively. Product quality plays an important role in maintaining customer trust and loyalty, so companies must focus on developing and controlling product quality to increase competitiveness and achieve competitive advantage. This study aims to analyze the factors that cause product failure and examine strategies in improving quality at SMEs Tahu Gunung. The research method uses the Failure Mode and Effect Analysis (FMEA) method by identifying and reducing potential failures to improve product quality through RPN values. The results of the analysis show the calculation of the highest RPN value of 210 is in the soybean soaking process with the risk of failure due to soaking carried out less or more than the specified time and the water in the soaking tub is not replaced with new water, then obtained the second highest RPN value of 192 in the tofu delivery process. From the results of the RPN calculation, improvements are focused on the soaking and tofu delivery stages, by emphasizing to employees to drain the water reservoir regularly and install a cover for the water tank. In the tofu delivery process, improvements that can be made are checking the tofu before the tofu is sent, using a cover box for the tofu container, and routinely cleaning the mold and box after use.

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INTRODUCTION

In the era of globalization, businesses must enhance efficiency and quality to remain relevant in the global market. One such example is small and medium enterprises (SMEs), which need to adapt to market changes and improve product quality to increase competitiveness (Apriyan, J,dkk, 2020). Enhancing the quality of products and services is an effective strategy for SMEs to compete with larger companies (Anthony, M. 2023). As business competition becomes increasingly fierce, SMEs are required to focus on product and service quality to differentiate themselves from competitors. Businesses that prioritize quality will have a greater ability to evaluate the market and enhance their competitive advantage (Goyal, M., & Kumar, A. 2018).

Quality control is an effort to determine whether quality will ensure the final outcome. Important factors that influence quality control activities are highly needed, as they can reduce the likelihood of problems,

facilitate improvements, help ensure that quality meets standards, and minimize customer complaints (Kumar, V., & Sharma, R 2015).Quality monitoring in SMEs has the potential to improve the quality of life within the SME community, deliver better work quality than other companies, and serve as an effort to reduce the cost of labor rework. (Zhao, X., & Wang, Y, 2017)

Tahu Gunung SME was established by Mr. Tarigan in 2008 and is located on Ketaren Street, Kaban Jahe District, Karo Regency, North Sumatra. The products are distributed to market traders and even to areas outside Mr. Tarigan's hometown. However, there have been frequent occurrences of product rejects, which have significantly decreased the productivity level of Tahu Gunung SME (Sinha, R., & Kumar, S. (2019). Rejected products are those that do not meet the quality standards set by the company or industry, and therefore cannot be sold or used (Hardianto RD et al., 2023).

This study aims to identify the factors contributing to product defects in the production process and to evaluate strategies to improve the quality of Tahu Gunung SME, in order to reduce the occurrence of defective products and minimize product rejects (Susanto, H., Salma, S. A., & Rahmani, H.2025). The product defects that lead to rejections include tofu that has an unpleasant odor, a hard or overly soft texture, the presence of foreign objects, and improper cutting (Singh, R., & Singh, S. P.2016).

Failure Mode and Effect Analysis (FMEA) is a method that can identify potential causes of product malfunction, prioritize what needs to be improved by using the Risk Priority Number (RPN), and conduct experiments to minimize the likelihood of functional failure (Apriyan J, 2020). By using the FMEA method, businesses can reduce the number of defective products, as it has been proven that customer returns and damaged or defective products can be addressed in a way that makes the production process more efficient, effective, and capable of meeting customer satisfaction (Chen, Y., Daraba, dkk 2021)

METHODOLOGY

The research was conducted at Tahu Gunung SME, established by Mr. Tarigan, an SME engaged in food processing and manufacturing, operating as a home industry. The business is located on Ketaren Street, Kaban Jahe District, Karo Regency, North Sumatra. The production process begins with the main raw material, soybeans, and ends with tofu products ready to be served as a meal side dish. The research was carried out from September to October 2024.

Data collection methods included both primary and secondary data. Primary data were obtained through interviews and direct observation at Tahu Gunung SME, along with documentation to strengthen the data. Secondary data were sourced directly from the SME's management, including information such as monthly production levels, annual sales growth, records of rejected products, and so on. Secondary data were used to support and reinforce the primary data and provide a more comprehensive understanding of the conditions at Tahu Gunung SME. (Szczyrba, A., & Ingaldi, M.2024).

The method used in this study is the Failure Mode and Effect Analysis (FMEA) method. FMEA is a systematic approach used to analyze and limit potential problems, issues, and other risks resulting from systems, processes, designs, and services—from the beginning of a product's development to the end of its consumer journey. FMEA can be used to identify and reduce errors in production activities that result in product defects, and to determine the root causes and contributing factors of potential quality issues (Gaspersz, 2002). The steps in the process consist of four stages, namely:

Severity Value (S)

Severity is the initial step in risk analysis, identifying several critical points or the intensity of a process that significantly affects the final outcome.

Table 1. Severity Value (S)

Rating	Criteria
1	No effect on the product
2	Component can still be processed with a very minor effect
3	Component can be processed with a minor effect
4	There is an effect on the component, but no repair is required
5	Moderate effect is present, and the component requires repair
6	Component performance is reduced, but it can still be processed
7	Component performance is severely affected, but it can still be processed
8	Component cannot be processed for the intended product, but can still be used for another product
9	Component requires repair in order to proceed to the next process
10	Component cannot be processed for the next stage

Source: Gaspersz, 2002

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Occurrence Value (O)

Occurrence refers to the likelihood of a problem arising and manifesting in a specific form during the product manufacturing process.

Table 2. Occurrence Value (O)

Degree	Based on the Frequency of Occurrence	Rating
Remote	0 – 10 per 100 item	1

Degree	Based on the Frequency of Occurrence	Rating
Low	11 – 20 per 100 item	2
	21 – 30 per 100 item	3
Moderate	31 – 40 per 100 item	4
	41 – 50 per 100 item	5
	51 – 60 per 100 item	6
High	61 – 70 per 100 item	7
	71 – 80 per 100 item	8
Very High	81 – 90 per 100 item	9
	91 – 100 per 100 item	10

Source: Gaspersz, 2002

Detection Value (D)

Detection functions as a tool to monitor the production process and reduce the threshold of failure within the process.

Table 3. Detection Value (D)

Detection	Description	Rating
Almost impossible	No control tools are capable of detecting the failure	10
Very rare	Current control tools find it very difficult to detect the form or cause of failure	9
Rare	Current control tools have difficulty detecting the form and cause of failure	8
Very low	The ability of control tools to detect the form and cause of failure is very low	7
Low	The ability of control tools to detect the form and cause of failure is low	6
Moderate	The ability of control tools to detect the form and cause of failure is moderate	5

Source: Gaspersz, 2002

RPN Value Calculation

Calculating the RPN to prioritize corrective actions based on the obtained RPN value

$$RPN = Severity\ (S) \times Occurrence\ (O) \times Detection\ (D)$$

The results of the RPN calculation can determine its critical limits once identified as a Critical Control Point (CCP), followed by improvement recommendations for the critical paths in the tofu production process, (Agustina, A., Telan, A. B., & Mboro, F. 2018). It also helps identify failures caused by potential hazards and assess the risks resulting from those hazards. The research data flowchart is shown in Figure 1.

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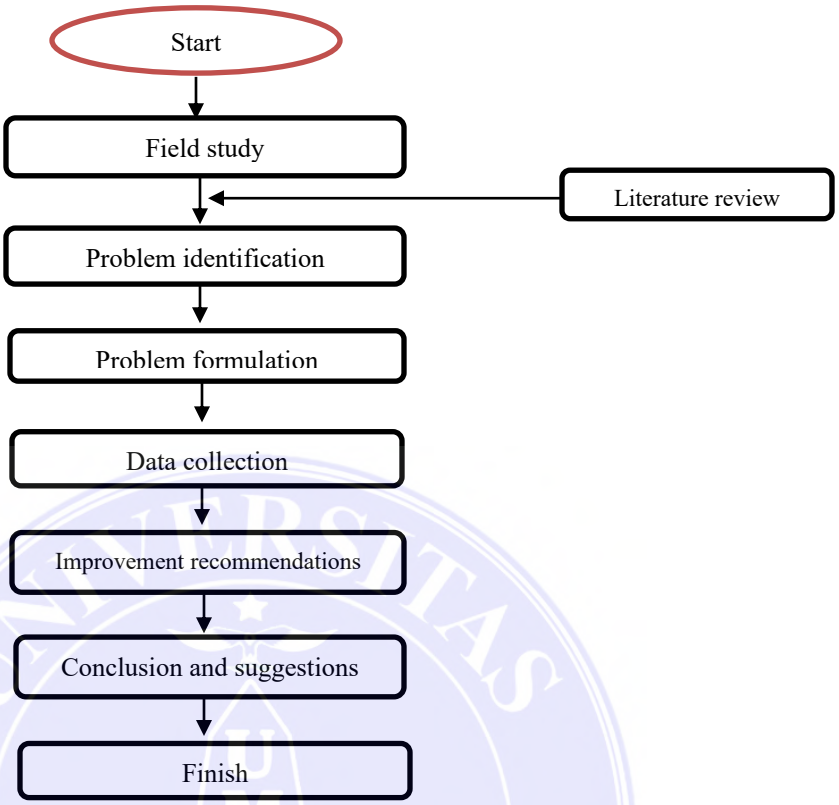

Figure 1. Research Flowchart
Source: Research Data, 2024

RESULTS

Based on the research method used, the identification of types of damage in the tofu production process was obtained from interview data and observations during the period of March – August 2023, as shown in Table 4.

Table 4. Production Reject Data

Month	Total Production (Pieces)	Type of Defect					Total Defects (Pieces)
		Smelly Texture	Hard Texture	Soft Texture	Presence of Foreign Matter	Incorrect Cutting	
March 2023	350.000	150	155	145	80	70	600
April 2023	400.000	175	180	160	90	95	700
May 2023	400.000	200	160	180	50	60	650
June 2023	390.000	190	200	190	60	60	700
July 2023	360.000	150	90	80	80	100	500
Agust 2023	420.000	150	150	80	80	90	550
Total	**2.320.000**	**1015**	**935**	**835**	**440**	**475**	**3700**
Average	**386,667**	**169,167**	**155,833**	**139,167**	**73,333**	**79,167**	**616,667**

Source: intern company

Based on the data above, there are five types of defects in the tofu production process that result in product rejection, namely smelly texture, hard texture, soft texture, presence of foreign matter, and incorrect cutting. These defects are caused by several production stages that do not fully comply with standard operating procedures (SOP), whether in terms of providing quality equipment and raw materials, or due to

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employee negligence, which needs to be addressed in the tofu production process (Kurniawan, A., & Yuliana, R. (2023).

Stages of Failure Mode and Effect Analysis (FMEA)

Failure Mode and Effect Analysis (FMEA) is used to examine the parts of the process that cause failures, focusing on those with the highest RPN values (Sharma, A., & Gupta, P.2015).The first step in identifying failure modes in production is to determine the potential effects of failure, the causes of failure, and the severity, occurrence, and detection thresholds (Weeden, M. M. 2015). This is done by inspecting each stage of the tofu production process.

Table 5 shows the identification of several potential risks in tofu production.

No	Process	Potential Failure Mode	Potential Effect of Failure
1	Soybean delivery	Low-quality soybeans mixed with high-quality soybeans	The quality of the tofu may affect taste, texture, and food safety
		Presence of foreign materials such as gravel and sand in the raw soybeans	Presence of contaminants in the resulting tofu
2	Soaking soybeans (3 hrs)	Soaking for less or more than the specified time and water not replaced	The resulting tofu may have a soft or hard texture
3	Washing soybeans	Waste mixed with soybeans due to worker negligence	Presence of contaminants and odor in the resulting tofu
		Spillage of raw materials due to worker negligence	Reduced raw materials will affect the quantity of tofu produced
4	Grinding soybeans	Grinding machine malfunction	Soybeans are not finely ground, resulting in hard tofu
		Excessive water added	Tofu becomes soft
5	Cooking soybeans	Cooking tank is unclean	Tofu becomes smelly
		Soy milk is not properly cooked	Tofu has a soft or hard texture and an unpleasant odor
6	Filtering	Filtering cloth is dirty	Causes odor in the tofu
		Filtering cloth is torn	Residual pulp remains in tofu
7	Settling soy milk	Foreign matter in soy milk due to an open tank	Presence of contaminants in the resulting tofu
8	Tofu molding	Damaged molding tool	Tofu will fall apart when cut
9	Tofu cooling	Inadequate or excessive cooling time	Tofu may have a soft or hard texture
10	Tofu cutting	Cutting is too large or too small	Incorrect tofu portion sizes
11	Tofu frying	Inadequate or excessive frying time	Tofu is undercooked or burnt
12	Tofu delivery process	Failure to inspect defective products	Tofu gets damaged during packaging

Source : Research Data, 2024

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The analysis results show that the highest risk of product failure occurs during the soybean soaking stage, with an RPN value of 210. The second highest risk is found in the tofu delivery process, with an RPN value of 192.

DISCUSSION

Based on these failure data, the researcher can propose improvements by focusing on these two critical stages. Improvement recommendations were determined through a brainstorming discussion with the owner of Tahu Gunung SME, Mr. Tarigan.

Soybean soaking stage for 3 hours

a. The process of filling the basin with water and soaking the soybeans requires improvements in the water storage area and the soaking basin. The recommended improvement is to regularly drain and clean the water storage container. Previously, Tahu Gunung SME under Mr. Tarigan only performed this cleaning once every six months; however, it is advisable to do it once a week. Routine draining can prevent the growth of moss, dirt accumulation, and mosquito larvae, which can cause contamination and health issues.
b. Installing a water tank cover — Currently, the water storage tank at Tahu Gunung SME, owned by Mr. Tarigan, is left uncovered, allowing dirt, dust, and microbes to enter the water. To prevent this, it is recommended to install a stainless steel lid that can be easily opened and closed. With this cover, the entry of dirt and dust can be minimized, keeping the water clean and safe for soaking soybeans.
c. Regular cleaning of the soaking basin — Washing the basin is essential to prevent contamination of the soybeans. Routine cleaning should be carried out after each use to remove any dirt or residue. For the first and second uses, the basin should be washed with clean water. After the third use, it should be cleaned with dishwashing soap suitable for kitchen utensils. Once cleaned, the basin should be air-dried.
d. Conducting water quality testing — Water quality testing is crucial to ensure that the water used in the production process meets quality standards. According to the Indonesian Ministry of Health Regulation No. 32 of 2017, water must meet physical, biological, and chemical parameters. Therefore, the SME should carry out periodic water quality testing at a certified laboratory or authorized agency.

Tofu Delivery Process Stage

a. Perform product inspection before delivery and before placing tofu into the container. It is recommended to carry out the inspection at the final stage to ensure that the tofu being delivered meets quality standards and is in good condition.
b. Use sealed box containers to maintain the cleanliness of the tofu during transportation.
c. Clean the tofu molds and wash the containers after use to avoid dirt and dust accumulating on the molds during transport. This helps prevent mold growth, which can cause unpleasant odors

To make it easier for workers to understand and remember, use a poster with simple and easy-to-understand language, based on the solutions above (Patel, M., & Desai, T. 2015). The poster should include the tofu delivery procedure: first, inspect the tofu; then, use a box with a tight-fitting lid; and finally, clean the molds and boxes after use.

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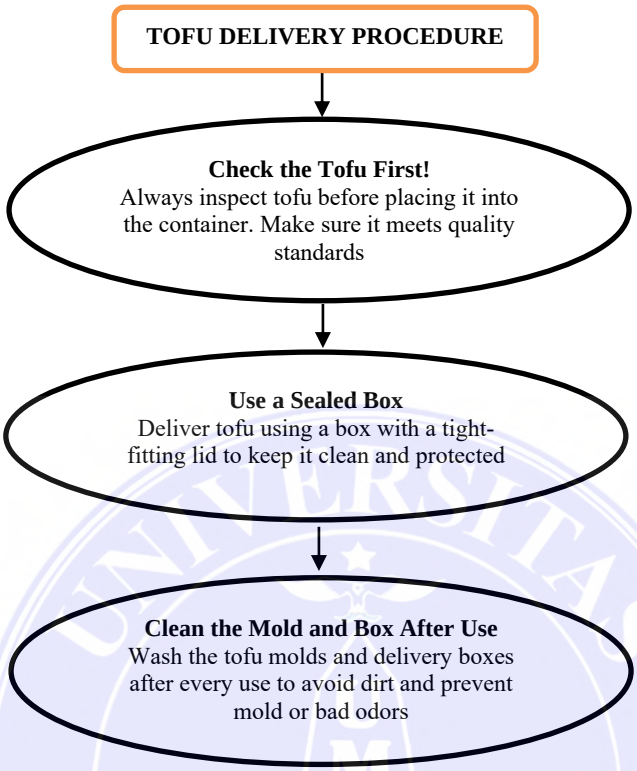

Figure 2. Tofu Delivery Process
Source : Research Data, 2024

CONCLUSION

Based on the analysis conducted by the researcher, several factors were identified that contribute to product defects at Tahu Gunung SME. These include improper soaking time (less or more than the specified duration) and failure to replace the soaking water with fresh water. In addition, failure to inspect defective products also contributes to product defects.

Quality control at Tahu Gunung SME is focused on the soaking and delivery stages. Quality control efforts include instructing employees to regularly drain the water storage tank using a schedule checklist to help them remember tasks, installing a lid on the water tank, cleaning the soaking basin regularly, and conducting water quality tests. For the tofu delivery process, the recommended solutions are to inspect the tofu before delivery, use sealed boxes as containers, and always clean the molds and wash the boxes after use

From the measurement results using the Failure Mode and Effect Analysis (FMEA) method, efforts to minimize defective products can be seen through the Risk Priority Number (RPN) values:

- The highest RPN value is 210, found in the soybean soaking process (3 hours), due to soaking for too long or too short a duration and failure to replace soaking water, resulting in defective tofu texture (hard or soft) and an unpleasant odor.
- An RPN value of 192 is found in the tofu delivery process, where the failure to inspect defective products leads to the tofu being damaged during packaging.

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