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Risk Analysis Of The Raw Tofu Production Process With The FMEA Method at The Saudara Jaya Factory In Jember Regency

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ABSTRACT

This study analyses the risk of tofu production at the Saudara Jaya Tofu Factory using the Failure Mode and Effect Analysis (FMEA) method with the aim of identifying potential failures and calculating the Risk Priority Number (RPN) value based on severity, frequency of occurrence, and detection. The results of the study found 17 risks in the tofu production process with 5 highest priority risks, namely the mixing of good and bad quality soya beans, improper dosage of vinegar, negligence in managing soaking time, inappropriate tofu size, and less dense tofu. To minimise these risks, several mitigation measures are proposed, including the selection of quality raw material suppliers, the use of soybean sorting machines, the creation of written SOPs, the use of timers for soaking, and the replacement of cutting tools and presses with more efficient ones. The implementation of these mitigations is expected to improve the quality and efficiency of tofu production as well as customer satisfaction.

Keywords — FMEA method, tofu production, risk analysis, Risk Priority Number (RPN).

1. Introduction

Indonesia is known as a country with abundant natural resources, including beans that have great potential in improving the national economy. One of the most widely consumed legumes by the public is soybean, which can be processed into various food products such as tofu, tempeh, and soy sauce that are very popular with the public. However, soybean production in Indonesia has experienced significant challenges, mainly due to a decrease in the area of planted land. The average annual soybean demand is 2,953,022 tonnes from 2015 to 2020, which is not accompanied by soybean production, which only reaches around 674,843 tonnes in the same period (Setyawan and Huda, 2022). Meanwhile, domestic soybean consumption continues to increase every year, forcing Indonesia to import soybeans to meet national demand.

Soybeans have an important role in the food industry, one of which is tofu production. In Jember district, there are 720 tofu agro-industries that play a role in the local economy, including the Saudara Jaya Tofu Factory located in Patrang sub-district (Dinas Perindustrian dan Perdagangan Kabupaten Jember, 2010). The factory has been operating since 1991 and requires 300 kg of soya every day to produce raw and fried tofu. With a daily turnover of IDR 5,000,000, the factory is one of the main tofu producers in the area. The tofu production process at this factory involves several stages, from soaking, grinding, boiling, filtering, vinegar application, pressing and moulding, cutting tofu to packaging. The quality of the tofu produced is highly influenced by several factors, such as a chewy texture, not too dense but not easily broken, a non-sour taste, and a white but not flashy colour. However, this tofu factory also

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faces a number of challenges in maintaining the quality of its products. The main risks faced are poor soybean quality and labour operational errors, which have an impact on production output. Based on interview data with the factory owner, some of the problems that often arise in the production of tofu at the Saudara Jaya Tofu Factory include the size, density, aroma, colour and taste of the tofu that is not up to standard, which leads to consumer dissatisfaction.

To overcome these problems, this factory applies the Failure Mode and Effect Analysis (FMEA) method to analyse and minimise risks in the tofu production process. This method is used to identify potential failures at each stage of production, set priorities based on risk impact, and formulate improvement solutions that can improve the quality of tofu products and reduce consumer complaints. With this approach, it is expected that the factory can maintain better tofu quality standards and improve overall consumer satisfaction.

2. Method

This research design uses a quantitative description, aims to describe and analyse the risks in the tofu production process at the Saudara Jaya Tofu Factory. The analysis method used is the Failure Mode and Effect Analysis (FMEA) method, the selection of this method is used to identify, record, and calculate risks through the Risk Priority Number (RPN) value based on impact (Severity), frequency of occurrence (Occurrence), and detection (Detection). Data was collected through a total sampling technique covering the entire tofu production process, with a sample equal to the entire population.

The analysed variables consist of independent and dependent variables. FMEA and production process flow are categorised as independent variables, while risks in the production process are categorised as dependent variables. Data collection is done through observation, interviews with business owners and employees, questionnaires and supporting documents from the Company.

The tofu production process involves various stages, such as soaking soybeans, grinding and pressing, which have the risk of

causing product damage if not done properly. Risks that arise in the production process such as labour errors and raw materials that do not meet standards. The analysis technique uses FMEA, starting from identifying potential risks to determining mitigation steps based on risk priorities calculated from the RPN value. Through the results of the RPN calculation, it helps determine which risks need to be prioritised for mitigation, with the aim of preventing and reducing the frequency of failures in the tofu production process at the Saudara Jaya Tofu Factory.

3. Discussion

3.1. Flow of Tofu Production Process

The tofu production process at Saudara Jaya Tofu Factory begins with soaking the soybeans for 3-4 hours, this process aims to soften the soybeans and facilitate the separation of the epidermis. After soaking, the soybeans are drained and washed to minimise impurities that can affect the quality of the tofu. Then, the soybeans are ground using a dynamo grinding machine until the texture becomes soybean pulp. The dynamo grinding machine used has an advantage in sound speed so that it is not too noisy. The soybean porridge is then boiled for 10-15 minutes to remove the odour.

After boiling, the soya pulp is filtered with a special cheesecloth to separate the soya juice from the pulp. The next process is to mix the soybean juice with vinegar for 5-10 minutes to coagulate the soybean juice. The amount of vinegar varies depending on the type of tofu produced. The next stage is the pressing and printing of the tofu, this is done to obtain tofu that is in accordance with factory standards. The soya juice is placed in a square container and covered with cloth and stones as ballast/ this process lasts for 5-10 minutes until the tofu has a solid texture.

The last stage is cutting and packaging the tofu, the tofu is cut using a wooden ruler and knife according to the order and consumer needs. The cut tofu is then packed in containers filled with water to maintain freshness and last longer or in plastic bags for small orders. This entire process flow can ensure that the tofu produced is in accordance with factory standards.



3.2. Risk analysis with FMEA

The FMEA method is used to identify potential failures in tofu production operations at Saudara Jaya Tofu Factory, evaluate the effects that may arise,

and formulate actions to overcome these problems. The main purpose of FMEA is to look for possible failures of a process or product and determine the priority of risks that need to be taken more seriously.

Table 1. Identification, Assessment, and Mitigation of Tofu Production Process Risks

Process	Risk Code	Risk Occurrence	S	O	D	RPN (SxOxD)	Risk Level	Recommended Mitigation
Soaking Soybeans	R1	Negligence in setting the soaking time of soya beans.	7	7	4	196	High	Using a timer for soaking time control.
	R2	Mixing of good quality soya beans with poor quality beans.	7	9	9	567	Very High	Choose quality suppliers and use sorting machines.
Washing Process	R3	Slippery production area.	5	7	3	105	Currently	
	R4	The washing process is not clean enough.	6	6	3	108	Currently	
Soybean Milling	R5	The milling machine is broken.	6	5	3	90	Currently	
	R6	Milling machine noise	2	2	2	8	Very Low	
	R7	The mixing of foreign materials (impurities) with the soya beans.	4	5	2	40	Low	
	R8	Risk of exposure to hot water.	4	4	2	32	Low	
Boiling Process	R9	Risk of exposure to smoke and steam during the boiling process.	3	2	2	12	Very Low	
	R10	Soya porridge is not cooked.	6	1	1	6	Very Low	
Screening Process	R11	The filtration process is less than perfect.	6	5	3	90	Currently	
Vinegar Feeding Process	R12	The amount of vinegar is not correct.	7	7	5	245	Very High	Create a written SOP for vinegar dosing guidelines.



Printing Pressing Process	R13	Tofu is less dense.	7	5	4	140	High	Replace the tofu press with a more modern one.
	R14	The press is broken.	6	5	3	90	Currently	
Cutting Process	R15	The crumbling of tofu when cut.	6	6	3	108	Currently	
	R16	The size of the tofu does not match.	5	6	5	150	High	Replace tofu cutting tools with more precise tools.
Packaging Process	R17	Crumbling of tofu during packaging.	4	6	3	72	Low	

Source: Primary Data Processing, 2024

The table above illustrates the risks identified during the tofu production process at Saudara Jaya Tofu Factory. These risks appear at various stages, from soaking the soybeans to packaging. Each production process has certain risks that can affect the quality of the final product and production efficiency.

In the identification stage, potential risks in tofu production were identified through direct observation of the production process and brainstorming. As a result, 17 risks were found that could affect the quality and smoothness of tofu production. These risks cover various stages of the production process, from soaking, washing, grinding, boiling, filtering, vinegar application, pressing and moulding, cutting, to packaging. For example, at the soaking stage, there are risks such as negligence in setting the soaking time (R1) and mixing good quality soya beans with bad ones (R2). Meanwhile, other risks such as broken milling machine (R5) and machine noise (R6) arise at the soybean milling stage.

Risk analysis is performed by assessing the impact, frequency of occurrence, and detectability of risks using three parameters: Severity (S), Occurrence (O), and Detection (D). Each risk is given a score based on these three parameters. For example, risk R1 (omission of soaking time) has a Severity score of 7, indicating that this risk greatly affects the production process. In addition, R2 (mixing of soya beans) has an Occurrence value of 9 because this risk occurs once in three production processes. After the S, O, and D values are obtained, the Risk Priority Number (RPN) is calculated by multiplying the three values. The

RPN is then sorted from largest to smallest to determine the priority of risk handling.

The calculation results show that the risk with the highest RPN is R2 (mixing of good quality soya beans with bad ones) with an RPN value of 567, which is included in the very high risk category. The next risk is R12 (incorrect dosage of vinegar) with an RPN of 245. There are also several other risks with high RPN levels such as negligence in adjusting the soaking time of soybeans (R1) and inappropriate tofu size (R16). These high RPN risks need to be prioritised in the implementation of mitigation actions to minimise their impact.

The next step is to provide mitigation proposals for each prioritised risk. For R2, for example, the proposed solution is to choose the best supplier of soybean raw materials and use a soybean sorting machine to separate beans based on quality. For risk R12, a written SOP (Standard Operating Procedure) is suggested as a guide for employees in carrying out the production process. As for risk R1, the proposed mitigation is to provide a timer in the production room of the soybean soaking section to ensure proper soaking duration. These mitigation proposals are expected to minimise risks and maintain the quality of tofu products in accordance with the desired standards.

By applying this FMEA analysis, Saudara Jaya Tofu Factory can identify and handle risks in its production process effectively. This will help maintain product quality and improve the overall efficiency of the production process.

4. Conclusion



Based on the risk analysis of raw tofu production using the FMEA method at the Saudara Jaya Tofu Factory, 17 risks were found in the production process, such as negligence of soaking time, mixing of good and bad quality soya beans, slippery production areas, and risks during packaging. From the assessment of severity, frequency of occurrence, and detection, there are 5 highest priority risks based on the RPN value, namely the mixing of good and bad quality soya beans with RPN 567, improper dosage of vinegar with RPN 245, negligent soaking time of soybeans with RPN 196, inappropriate tofu size with RPN 150, and less dense tofu with RPN 140. To minimise these risks, the proposed mitigation measures include selecting a quality soybean supplier, investing in a soybean sorting machine, creating written SOPs for production procedures, using a timer for soaking soybeans, and replacing the cutter and tofu press with more efficient and modern versions.

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