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Quality Control on Packing Process of Willarine Margarine Products at PT. XYZ with FMEA and FTA Methods

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ABSTRACT

PT. XYZ is a company engaged in the crude palm oil processing sector, one of which is willarine margarine which is exported to various countries. In maintaining global competitiveness, the company strives to produce high-quality products. However, in practice there are still obstacles that need to be overcome. One of them is during the packing process there are three types of product defects identified, namely leakage in the pouch packaging, lack of margarine volume, and damage to the pouch carton. So this research uses the FMEA (Failure Mode and Effect Analysis) method used to determine and transfer the severity, occurrence, and detection levels, so that it is obtained with the highest total RPN, namely leaky pouch packaging of 904, and FTA (Fault Tree Analysis) as a clue with the root of the problem tree, so that it is known that the root causes are lack of rest time, lack of supervision, no concern for the importance of track setting instructions, and no worker concern for cleanliness. After the results are known, improvement proposals are given, namely providing sufficient rest time and always rechecking, providing track setting instructions, and always doing routine cleaning at the beginning and end of work.

INTRODUCTION

Industrial competition in the globalization period requires all industries, both in the service and manufacturing sectors, to improve the quality of product services (Dzikri et al., 2024). This is intended to face the challenges of an increasingly tight era. Quality is one of the main keys for an industry to survive to maintain the market, because good quality can describe an advanced industry (Wicaksono & Yuamita, 2022). Good quality control practices speed up the production process and reduce the number of defective products (Anwar et al., 2023). Quality is very important for businesses because it influences repeat purchase decisions (Hardianto & Nuriyanto, 2023).

The aspect of a product or service that affects the fulfillment of needs is called quality. As the global industry develops, customer satisfaction will be the top priority for every business to gain a competitive advantage in the industry (Yafi & Cahyono, 2024). The success of a product can be achieved by having good quality from the customer's perspective (Priyambada et al., 2024). This is in line with what is presented that the accuracy of the capital spent, the accuracy of the application time and the quality results in accordance with customer expectations and also

reveals that to improve the quality of human resources and the ability to utilize natural resources, one of the factors is the quality of the products produced (Kalid, 2022).

PT. XYZ is a company engaged in the crude palm oil processing sector, producing various derivative products, one of which is Willarine margarine which is exported to various countries. In maintaining competitiveness in the global market, PT XYZ always strives to produce high-quality products by implementing a strict quality control system. This strategy aims to minimize defective products, so as to optimize production efficiency and increase company profitability by reducing repair costs and utilizing resources more effectively. Although it has committed to producing high-quality products, in the production process quality control has been carried out so that it becomes a margarine product that is ready for packing, but in practice there are still several obstacles that need to be overcome. One of the indicators is that during the packing process, there are three types of product defects identified, namely leakage in the pouch packaging, lack of margarine volume, and damage to the pouch carton.

Analysis of product quality control is expected to identify the root of the problem and formulate effective solutions to improve product quality in accordance with the standards set by the company. FMEA and FTA are suitable methods to identify these problems, because they can improve the quality of margarine product packing. FMEA (failure mode and effect analysis) is a method for detecting a failure mode systematically and with the help of data collection tables for analysis (Wijaya et al., 2021), In its identification FMEA produces an RPN (Risk Priority Number) value which intends to determine the value that has the highest potential failure (Rahman et al., 2021), from the RPN value in the FMEA identification process there are severity (S), occurrence (O), detection (O) obtained from distributing questionnaires to related actors.

The results of the calculation of severity (S), occurrence (O), detection (D) will produce an RPN value which aims to evaluate activities that can cause disability. FTA (Fault Tree Analysis) is a method used to identify the causes of failure in the production process (Renosari et al., 2023). The depiction of this FTA method is in the form of a tree that breaks down the problem to the root cause of the failure. From the existing Fault Tree, the cause of the event can be broken down from the top event-basic event so that the cause can be known and can be evaluated by providing suggestions for improvement. The use of FMEA and FTA methods aims to determine the highest RPN value of the cause of failure and provide suggestions for improvement based on the highest RPN value and the results of the FTA chart.

RESEARCH METHODS

FMEA (Failure Mode and Effect Analysis)

A methodology used to evaluate potential failures in systems, designs, processes, or services (Abdurrahman & Al-Faritsy, 2021). This methodology involves scoring each failure mode based on three parameters, namely Occurrence rate, Severity rate, and Detection rate (Romadhoni et al., 2022). The score ranges from 1 to 10 and serves to identify potential failures that need to be prioritized in improvement efforts. Risk Priority Number (RPN) a numerical value used to measure the risk level of a failure mode, obtained by multiplying the severity, occurrence, and detection values (Bachtiar et al., 2021) (RPN = SxOxD).

Severity (S)

A quantitative assessment that reflects how much negative impact is felt by the customer or end-user due to a failure (Paquita & Laksono, 2022). This assessment is based on a numerical scale that represents the severity of the impact, ranging from mild to very severe.

Table 1. Severity

Rank	Criteria	Description
1	Negligible severity	Bad potential that can be ignored
2 and 3	Mild severity	Slight adverse potential
4,5, and 6	Moderate severity	Moderate adverse potential (still within the tolerance limit position)
7 and 8	High severity	High adverse potential (indicating out of tolerance limitations high repair cost)
9 and 10	Potential safety problems	Harm to user safety (related to violating government regulations related to safety)

Occurrence (O)

To provide an outcome of the potential frequency of a problem as a result of a potential source posed by the event and generate research with a score of 1-10 (Tanto et al., 2023).

Table 2. Occurrence

Rank	Failure Rate	Description
1	1 from 1.000.000	The degree of likelihood that the cause of the value resulting in the potential failure mode
2	1 from 20.000	The rate at which this failure is possible is rare
3	1 from 40.000	The rate at which this failure is possible is rare
4	1 from 1.000	The rate at which these failures are possible is often
5	1 from 400	The rate at which these failures are possible is often
6	1 from 80	The rate at which these failures are possible is often
7	1 from 40	The degree to which this failure is likely to occur
8	1 from 20	The degree to which this failure is likely to occur
9	1 in 8	At this level it is almost certain that potential failures will definitely occur
10	1 in 2	At this level it is almost certain that potential failures will definitely occur

Detection (D)

Used to detect potential causes, detection is a control tool (Berlyan et al., 2021). Identify the methods used to avoid or locate the failure source mode, using a scale of 1-10.

Table 3. Detection

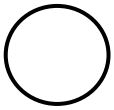
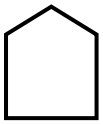
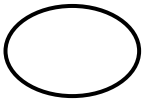
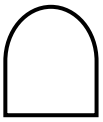
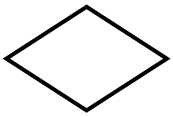
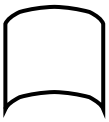
Rank	Failure Rate	Description
1	1 dari 1.000.000	A highly effective and productive prevention method
2 3	1 dari 20.000 1 dari 4.000	Allows that the cause will occur in low mode
4 5 6	1 dari 1.000 1 dari 400 1 dari 80	The probability of a cause occurring is moderate. In prevention or detection methods, sometimes the cause occurs repeatedly

7	1 dari 40	The likelihood of the cause occurring is very high and prevention or detection methods are less effective because the cause occurs repeatedly or continuously
8	1 dalam 20	
9	1 dalam 8	
10	1 dalam 2	

FTA (Fault Tree Analysis)

A method for finding risk factors that cause failure. This method uses a top-down approach (Krisnaningsih et al., 2021). Starting from the failure assumption of the peak event, then explaining the reason for the peak event to the source of the failure (Purba et al., 2022). Fault tree analysis identifies the relationship between causal factors and shows them in the form of a fault tree (Safira & Damayanti, 2022). One way that can be used to investigate the primary source of a failure or fault. The following is a symbol of fault tree analysis :

Table 4. Fault Tree Analysis Symbol

Symbol	Meaning	Symbol	Meaning
	Basic event: basic fault initiation that does not require further development		External event: event that is expected to occur
	Conditioning event: spectify conditions that can be applied to various logic gates		AND gate: manual error due to all problem inputs that occur
	Undevelopment event: An event that cannot be further developed because information is not available		OR gate: error arises due to one of the problem inputs occurring

RESULTS AND DISCUSSION

Data Collection

In collecting data on willarine margarine defects, interviews and observations at PT XYZ are carried out in the form of a check sheet to make it easier to analyze defects.

Check Sheet

Check sheets are useful instruments to simplify the data collection and analysis process. The data is presented in a table containing information on the number of items produced, the types of non-conformities, and the frequency of occurrence of each non-conformity. The data for the willarine margarine defect table is as follows :

Table 5. Defect Check Sheet

Year	Month	Amount of Packing Processes	Defective Production Type			Amount of Defective Products	Percentage (%)
			Leaky Packaging Pouch	Less Willarine Margarine Volume	Broken Pouch Carton		
2024	March	8000	270	260	250	780	10%
	April	8210	260	350	280	890	11%
	May	8200	350	320	310	980	12%
	June	8200	320	300	290	910	11%
	July	8200	240	370	260	870	11%
	August	8200	350	210	310	870	11%
	September	8230	350	330	240	920	11%
	October	8220	290	280	270	840	10%
	November	8540	300	300	350	950	11%
	December	8300	350	270	230	850	10%
2025	January	8100	250	250	250	750	9%
Amount		90400	3330	3240	3040	9610	11%
Average		8218				874	11%

(Source : PT. XYZ)

Based on the table above, it presents data on the number and types of defects that occurred during March to December 2024 and January 2025, with an average percentage of 11%. The data shows that there are three types of defects in general that occur in willarine margarine products at PT XYZ. The types of defects consist of leaking pouch packaging of 3330 pcs, insufficient volume of willarine margarine of 3240 pcs, and damaged pouch cartons of 3040 pcs.

Data Processing

Calculation of RPN Value Using FMEA Method

RPN (Risk Priority Number) is a criticality marker used to evaluate corrective actions or system failure mitigation efforts based on failure modes. The following is a table of RPN calculations on the defects of leaky packaging pouches, insufficient volume of willarine margarine, and damaged pouch cartons :

Table 6. RPN Value Calculation

Failure Type	Potential Causes of Failure	Potential Factors That Cause Failure	S	O	D	RPN	Total RPN	Priority
Leaky Packaging Pouch	Man	Employees who are not careful when packing pouches of margarine products	7	8	5	280	904	1
	Method	Product output trajectory setting is not correct	5	6	4	120		
	Environment	Sub-optimal conveyor hygiene conditions can cause contamination of the pouch, such as being exposed to small particles that have the potential to cause damage to the packaging.	7	9	8	504		

Less Willarine Margarine Volume	Man	Employees who are not careful when setting the volume of margarine willarine	7	5	5	175	723	3
	Method	Employees who do not understand the SOP for filling willarine margarine that has been given by the company, crank calibration and angel set setting have not reached the optimal level of precision	5	5	4	100		
	Environment	The location of the willarine margarine filling is less spacious so that it affects the time of the willarine margarine filling process which results in less willarine margarine. The position of the mintak hose that allows air to enter results in a lack of volume or inadequate oil supply.	8	7	8	448		
Broken Pouch Carton	Man	Employees who are not careful when selecting pallets or exposed to margarine willarine leaking in cartons	6	7	5	210	730	2
	Method	Employees who are not careful in sorting cartons, resulting in cartons that do not match the size or arrangement of cartons in product pallets is not good	6	4	3	72		
	Environment	There are two types of hazards at the packing workstation, namely the risk of being damaged by sharp objects found on the conveyor and the risk of being pinched by the fold back machine caused by improper timing during the carton folding process	7	8	8	448		

It is concluded in the RPN table 6 above that the failure type of leaking packaging pouch is caused by humans by 280, methods by 120, and the environment by 504. The volume of margarine willarine is less due to humans by 175, methods by 100, and the environment by 448. Cardboard pouch damage was caused by humans by 210, methods by 72, and the environment by 448. The results of the calculation of the highest total RPN are leaky packaging pouches with a total RPN of 904, followed by damaged pouch cartons with a total RPN of 730, and finally the volume of willarine margarine is less with a total RPN of 723.

FTA (Fault Tree Analysis)

FTA itself in this process is useful as a stage to find the root cause of each cause of failure from the top event-basic event, to make improvements in the future.

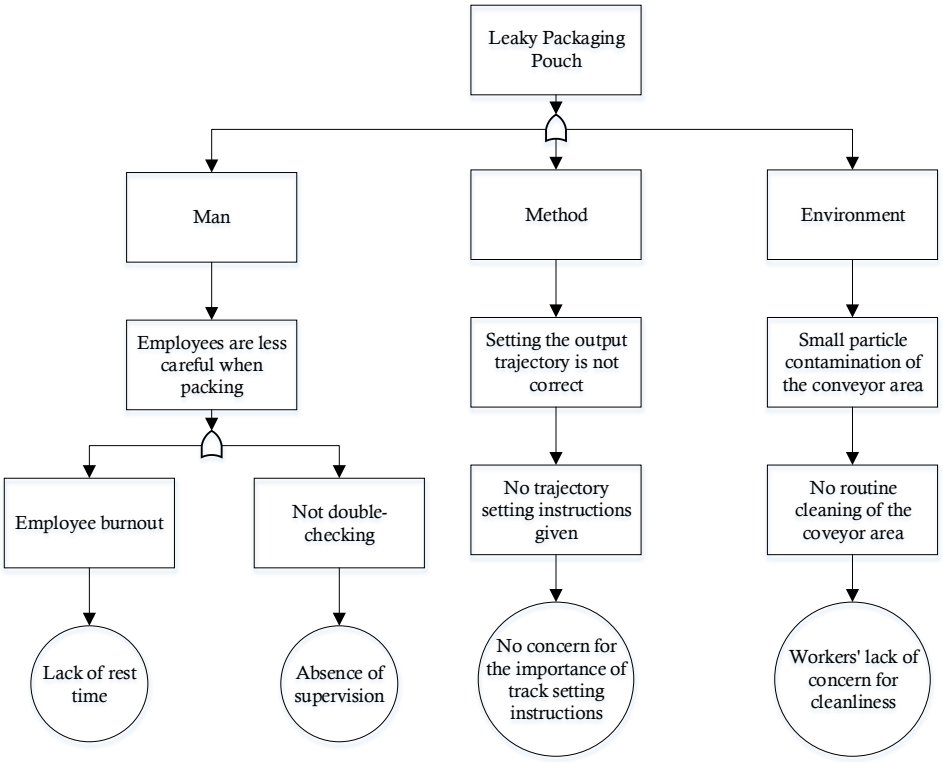


Figure 1. Leaky Packaging Pouch

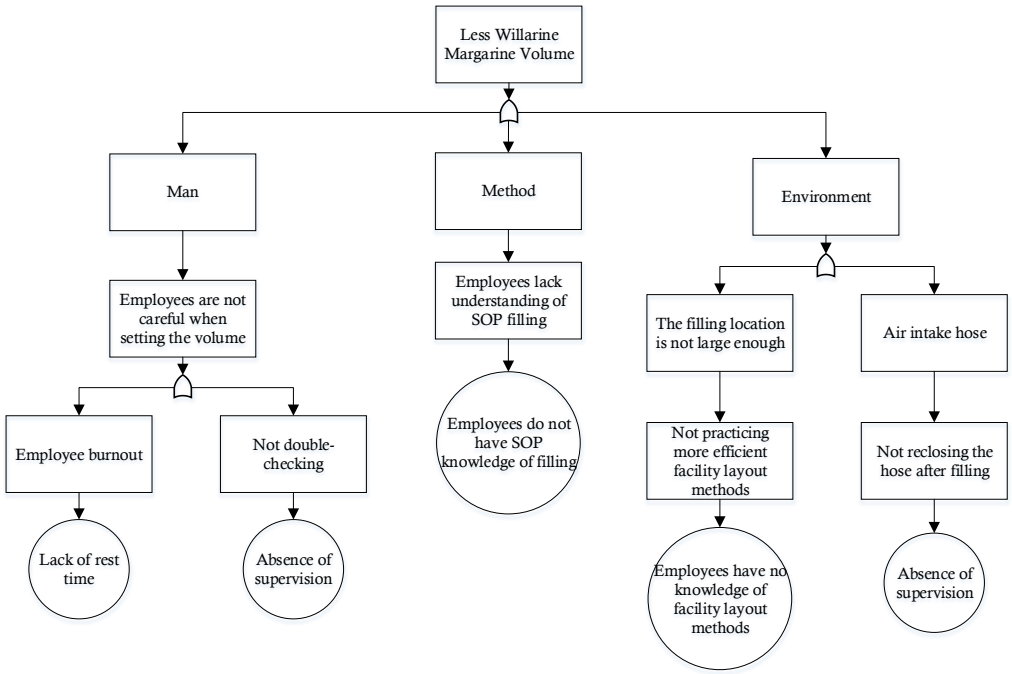


Figure 2. Less Willarine Margarine Volume

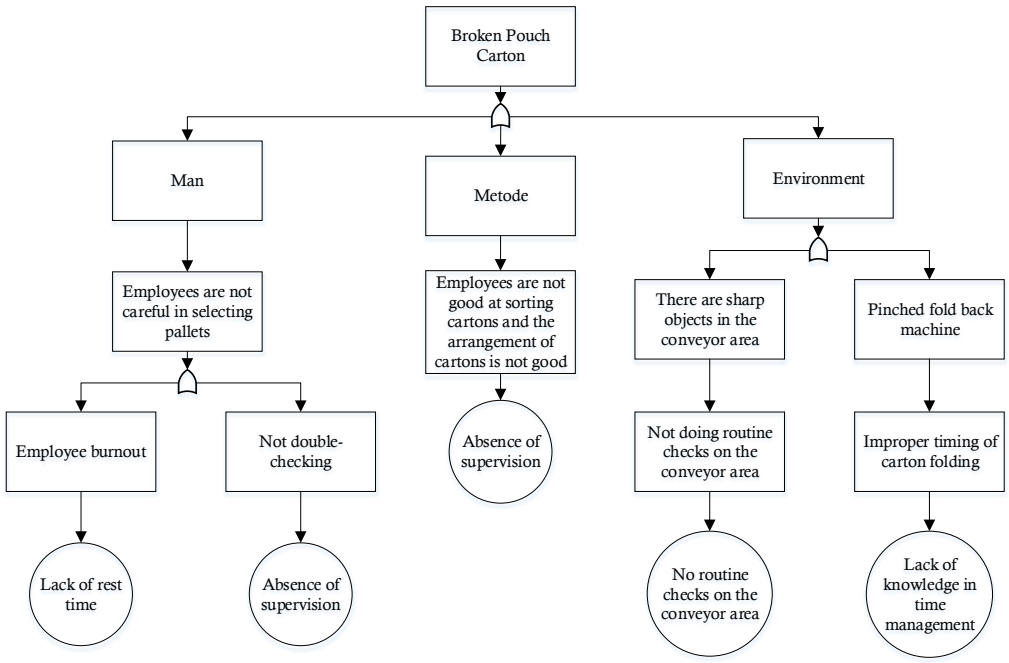


Figure 3. Broken Pouch Carton

The results of figures 1, 2, 3 above can be explained that from the defects of leaky packaging pouches, insufficient volume of willarine margarine, and damaged pouch cards have root causes or basic events including, lack of rest time, no supervision, no concern for the importance of track setting instructions, no worker concern for cleanliness, employees do not have SOP knowledge of filling, employees do not have knowledge of facility layout methods, no regular checks on the conveyor area, and lack of knowledge in time management.

Proposed Improvements

The following are proposed improvements that can be made by PT XYZ to overcome the failures that arise from FMEA identification, the highest RPN value, and FTA. Proposed improvements are made to the highest RPN value, as follows :

Table 7. Proposed Improvements

Failure Type	Causes of Failure		Proposed Improvements
Leaky Packaging Pouch	Man	Employees are tired and do not double check	Provide adequate rest time and always double-check
	Method	No trajectory setting instructions given	Providing trajectory setting instructions
	Environment	No routine cleaning of the conveyor area	Always perform routine cleaning at the beginning and end of work

From the results of table 7 above, it is known that the proposed improvements from the highest RPN value, namely leaky packaging pouches, are to provide adequate rest time and always recheck, provide track setting instructions, and always do routine cleaning at the beginning and end of work. That way PT. XYZ can reduce the impact that occurs such as losses due to products that must be wasted or replaced, if the packaging leaks to consumers it can result in decreased trust, difficult to distribute because of the risk of contaminating other packaging, and creating a negative perception of product quality.

CONCLUSION

The conclusion that can be drawn from the identification process at PT XYZ is that there are 3 defects, namely leaky packaging pouches, insufficient volume of willarine margarine, and damaged pouch cartons. after that FMEA identification was carried out by distributing questionnaires and obtained the highest RPN calculation, namely leaky packaging pouches with a total RPN of 904. The next process is FTA identification and produces basic events from the highest RPN total resulting in a lack of rest time, no supervision, no concern for the importance of track setting instructions, and no worker concern for cleanliness. After the results are known, improvement proposals will be given, namely providing sufficient rest time by arranging a work schedule with a clear division of rest time and in accordance with labor regulations and always rechecking by making standard operating procedure (SOP) on the packaging of each stage of production, providing track setting instructions by installing signs or guide labels on the conveyor machine to help workers make proper adjustments, and always doing routine cleaning at the beginning and end of work by scheduling routine cleaning according to standard operating procedure (SOP) and providing tools and cleaners that are suitable for the type of machine and product being processed.

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