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Analysis Quality Control of Creamer Product Packaging using DMAIC and RCA Methods

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ABSTRACT

***Objective**: This study aims to analyze the types of defects in the packaging process of creamer products and propose improvements for the company based on data processing results. **Method**: The analysis utilizes a sigma index calculation supported by tools such as Pareto diagrams, fishbone diagrams for cause-and-effect evaluation, and failure tree diagrams to identify the root causes. The 5Whys method is also employed to analyze the underlying issues. **Results**: The findings indicate that while productivity remains stable, several factors contributing to a high percentage of packaging defects require evaluation and optimization. The analysis highlights specific areas for improvement in the packaging process. **Novelty**: This study introduces a comprehensive approach combining statistical tools and root cause analysis to optimize the packaging process in the creamer production industry, offering valuable insights for improving operational efficiency.*

INTRODUCTION

PT. XYZ is a company engaged in the manufacturing of food and beverage products, specifically non-dairy creamer, which serves as an additive for food and beverages. The non-dairy creamer is in powdered form, made from vegetable fats and other food additives. The product is also referred to as a milk substitute due to its milk-like taste characteristics. As a result, the creamer produced by this company is classified as a non-dairy creamer because its primary ingredient is hydrogenated vegetable oil, mixed with glucose syrup and other food additives. The product is packaged in a bag made of two types of materials: the inner layer is made from PET plastic, in compliance with food standards, and the opening is sealed using a heat-sealing process. The outer layer is a bag made of recycled paper, which is sewn shut (seawing) as an external seal for the product.

By utilizing a product quality control system, a company has the potential to improve its output. This is because each product will meet the quality criteria that have been set, reducing the number of defective items produced during the manufacturing process [1]. To ensure that all operations within the company are carried out according to the predetermined plan, it is crucial to establish a strong Quality Control (QC) system [2]. The main goal of quality control is to perform all operations to prevent or eliminate faulty goods.

Quality improvement is an ongoing task aimed at enhancing overall quality. This process is related to improving the effectiveness and efficiency of procedures to increase customer satisfaction. Quality assurance is a vital effort to instill confidence in customers that the products they receive align with their specific requirements. Consequently, many tools are essential in ensuring quality, including compliance with process standards, procedural manuals (which outline standard operating procedures), work instructions, and other related documents [3].

In terms of production, over the last 6 months, the company produced 17,600 bags, each weighing 25 kg, which totals 440,000 kg. During this period, the monthly defect rate resulted in 371 defective bags, equivalent to 9,275 kg. The types of defects are categorized with the following percentages: filling at 20%, sealing at 26%, seawing at 30%, and coding at 23% over the last six months. To analyze these issues effectively, this study has chosen to apply the DMAIC method from Six Sigma.

DMAIC is used systematically to achieve continuous improvement in meeting objectives. It relies on scientific principles and factual evidence [4]. The five stages of DMAIC form the basic approach of the Six Sigma method [5]. This method is a roadmap used for continuous improvement. DMAIC stands for Define, Measure, Analyze, Improve, and Control [6]. Additionally, this research uses the Root Cause Analysis (RCA) method as a quality control technique in processes that can be managed effectively. By using this method, the company can statistically identify the number of defective products according to their types and determine the root causes of these defects [6].

Root Cause Analysis (RCA) is a method used for problem-solving by identifying the factors that cause an issue or an unexpected event. This method helps answer questions such as what happened on the packaging production line in the company, how it happened, and why it occurred. Its main goal is to identify the factors expressed in terms of form, size, location, and timing, resulting from habits, actions, and specific conditions that need to be changed to avoid unnecessary mistakes [7]. In this research, the method is used to ensure that the issues in the early stages are properly identified. The goal is to determine the source of the problem by applying a series of appropriate actions, supported by suitable methods, to identify the root cause [8].

Several previous studies have been referenced to support this research, including Supriyadi's study [9], which discusses methods for improving production productivity in flexible packaging and reducing product defects using Six Sigma. Ramadhan's research [10] discusses proposals for improvements to minimize defects in cement bag packaging by applying Six Sigma. Sirine's study [11] on quality control in companies to reduce product defects, which ranged from 0.34% to 1%, demonstrates how companies incurred additional production costs and losses when applying the DMAIC method from Six Sigma. Wibowo's study [7] analyzes the root causes of material cost overrun on construction projects, which ranged from 12.40% to 14.50%, using Root Cause Analysis and Fault Tree Analysis methods.

This research differs from previous studies by using two methods: the DMAIC concept from Six Sigma to analyze defect causes and the RCA method, incorporating

Fault Tree Analysis (FTA) and 5 Whys, to find the root cause and provide improvement suggestions. This study is expected to provide insight for the company to reduce product defects. Previous research explained the theories used, including the definitions and formulas for the calculations in Six Sigma and RCA methods.

Quality control is carried out to analyze whether products meet expectations, and corrective actions are taken if there is any non-compliance to ensure the best quality standards are maintained [3]. Quality is a key aspect considered by consumers when making purchasing decisions. With all efforts, business owners strive to meet consumer needs by providing quality products [4]. Product quality is essential for every company to maintain its competitiveness in a tight business environment. High-quality products are a business's primary goal to maintain products that meet customer expectations. Therefore, companies need to engage in intensive quality control activities [3]. Quality is one of the main parameters for a company to succeed amid the competition in the industry. The term "quality" has various meanings and interpretations. Different people may interpret it differently. Many interpret quality as the holistic characteristics and features of a product or service that can satisfy both stated and implied needs [5].

Defect refers to products that do not meet the company's specifications and cannot proceed to the next stage. However, by incurring costs, time, and effort in the repair process, the product can be processed again through repair or correction [6].

Research objectives: (1) To identify the causes of packaging defects in the non-dairy creamer product at PT. XYZ. (2) To provide improvement suggestions and identify the root causes of the packaging process to minimize product defects.

RESEARCH METHOD

This research was conducted over a period of six months at PT. XYZ. The research method used is an observational method, where direct observation, recording, and identification of the research objects are carried out to obtain the necessary data. This includes data from the packaging process, inspection, defect data from the process, and direct data collection by analyzing worker behavior, tools, and observing products that have defects. Interviews were conducted through oral questioning with the production supervisor, production staff, quality control staff, engineering team, production operators, as well as involving an external expert from CV. RGB with the assistant plant manager as the source. This study refers to the application of the Six Sigma (DMAIC) method and Root Cause Analysis (RCA) using problem-solving techniques with the Fault Tree Analysis (FTA) and 5Whys concepts.

1. Six Sigma (DMAIC)

Six Sigma is a comprehensive and adaptable framework that facilitates the achievement, assistance, and optimization of company operations [12]. Six Sigma has five stages, which are used to improve business performance. These stages include: defining goals (define), measuring performance (measure), analyzing data (analyze), improving (improve), and controlling the process (control). During this process, it is crucial to verify and update the issues or opportunities, processes, and customer requirements at each step [13].

1. **Define** is the initial step that aims to identify and formulate the existing problems. In this stage, the goals to be achieved are also established. Aspects such as cost, benefits, and impact on customers are important considerations at this stage. Common tools used in this phase include the Pareto chart, SIPOC diagram (Suppliers, Input, Process, Output, and Customer), and relationship diagrams [14].
2. **Measure** is the second step in the Six Sigma quality improvement process. There are three things that need to be done in this phase: determining quality characteristics or CTQs (Critical to Quality) that are directly related to the specific needs of the product's customers, developing a data collection plan through process output/outcome measurements, and measuring current performance to establish a baseline for the application of this method [4].
3. **Analyze** in this phase is carried out to find the root cause of the problems. Root cause analysis is done by analyzing the Pareto diagram to identify defects that require immediate action and conducting brainstorming sessions with the relevant parties [15].
4. **Improve** is the fourth step in the DMAIC cycle, where creative ideas and solutions are developed and evaluated. After the problems are identified, measured, and analyzed, various potential solutions are generated to address the issue.
5. **Control** is the final phase of the DMAIC method, where after the solutions are implemented, continuous measurements are performed to ensure the stability of the improvements and predictability of the process [16].

In Six Sigma methodology, the performance evaluation of a process in a company is measured by the sigma level. When the sigma value approaches six, the process performance is considered excellent. The sigma level calculation is based on the use of Defects Per Million Opportunities (DPMO) for attribute data. The calculation of DPMO and sigma level for attribute data can be done by following these calculation steps [16]:

a. **Defect Per Unit (DPU)**

$$DPU = \frac{D}{U} \quad (1)$$

Source [16]

Where:

D = The number of defects or defects occurring in the production process

U = The number of units inspected

a. *Defect Per Opportunity* (DPO)

$$DPO = \frac{D}{U \text{ x } OP} \quad (2)$$

Source [16]

Where:

OP (Opportunity) = A characteristic that has the potential to become a defect.

b. *Defect Per Million Opportunity* (DPMO)

$$DPMO = DPO \text{ x } 1.000.000 \quad (3)$$

Source [16] [17]

c. Sigma level calculation using Microsoft Excel

= NORMSINV (1 – DPMO / 1.000.000) + 1,5 (4)

Source [16]

d. Classification based on sigma level

Table 1. Sigma Level

Sigma Level	Defects Per Million Opportunities (DPMO)	Category
6	3.4	World Class
5	233	
4	6,210	Industry Average
3	66,807	
2	308,538	Non-Competitive
1	691,642	Highly Non-Competitive

Source: [4]

In Table 1, it can be observed that the higher the sigma level achieved, the better the performance of production in an industry. A 6-sigma level is better compared to 4-sigma or 3-sigma levels. Six Sigma is a tool used in quality control that is based on high-level statistics and a comprehensive discipline, aimed at eliminating the root causes of problems through the DMAIC approach [18].

2. Control Chart

The P-chart, also known as the control chart for proportions, is a tool used to control attributes in a process. These attributes are related to the characteristics of goods that are evaluated based on the proportion of certain events, such as whether goods are accepted or rejected in the production process [16]. After data is collected during the define and measure phases, the third stage is to identify the root causes of quality issues. To do this, P-charts are often used to help determine whether any products exceed control limits or not [19]. The steps in creating a P-chart (proportion of defective units) are as follows [20]:

a. Calculate the proportion of defective units for each subgroup to determine the average defect percentage using the formula:

$$\bar{P} = \frac{np}{n} \quad (5)$$

Source [20]

Explanation:
np: The number of failures in the subgroup
n: The number of items inspected in the subgroup
a. Next, the center line can be calculated using the following equation

$$CL = \bar{P} = \frac{\Sigma np}{\Sigma n} \quad (6)$$

Source [20]

Explanation:
$\bar{P}$ = The average percentage of product defects
Σnp = Total number of defective products
Σn = Total number of product inspections

Next, calculate the upper control limit (UCL) and lower control limit (LCL), which serve as reference limits for the graph line representing the proportion that will be displayed on the P-chart.

Calculating the Upper Control Limit (UCL)

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}\,(1-\bar{P})}{n}} \quad (7)$$

Source [20]

Explanation:
$\bar{P}$ = The average percentage of product defects
n = Number of products

Calculating the Lower Control Limit (LCL)

$$LCL = \bar{P} - 3\sqrt{\frac{\bar{P}\,(1-\bar{P})}{n}} \quad (8)$$

Source [20]

Explanation:
$\bar{P}$ = The average percentage of product defects
n = Number of products

3. Root Cause Analysis (RCA)

Problem-solving requires tracing the issue back to its root causes, which hinder the flow of a process. This is achieved through the application of the Root Cause Analysis (RCA) method. Root Cause Analysis (RCA) is a structured investigative process used to identify the true sources of problems in an event. The goal of this analysis is to identify the root causes of underlying issues. RCA is a method used to identify and rectify the sources of problems with the aim of designing and implementing solutions that can prevent the recurrence of the problem [6]. RCA is used in analysis to identify the primary cause of a problem by focusing on the most common or visible aspects, which are then linked to the root cause [7].

In this study, the use of this method is to ensure that the issues occurring at the initial stages are identified. The goal is to determine the source of the problem by using a series of appropriate actions, along with suitable methods, to ensure the root cause of the problem [8]. The RCA technique in problem-solving helps the team recognize the cause-and-effect relationships of failures to eliminate or reduce the potential for future repetition. One method that complements the RCA process is Fault Tree Analysis (FTA), which is often used for reliability analysis in critical systems [21] This technique is widely used to perform deductive investigations into embedded facts. FTA is a systematic technique that is appropriate for assessing the failure probabilities of various systems in a visual diagram known as a fault tree, allowing for both quantitative and qualitative project assessments [22]. A fault tree [23].

A Fault Tree (FT) is a deductive graphical method used to identify potential causes of undesirable events, often referred to as the top event (TE). The graphical representation of FTA is based on Boolean logic, which shows the logical relationships between various faults and their causes. The top event typically represents a system failure that can result in safety hazards or economic losses. As a deductive method, the development of the fault tree begins by considering the TE as the root of the tree and then building the tree downward until the basic events (BEs) that lead to the top event are identified [23].

The entire process of this study can be seen in the research flow diagram in Figure 1 below:

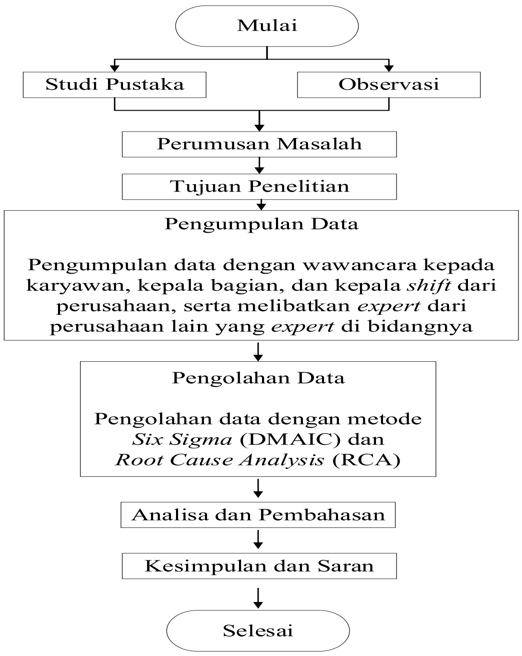


Figure 1. Research Flowchart

From Figure 1, it can be seen that this research was conducted directly in the field to formulate the problems and collect the necessary data. This data was then processed using the Six Sigma method in the DMAIC concept by determining the values of CL, UCL, and LCL. The next step involved calculating the values of DPU, DPO, and DPMO through data processing using Microsoft Excel to obtain the sigma level of the company. This was followed by the Root Cause Analysis (RCA) method to develop a corrective action plan to reduce the defects, and finally, a conclusion was drawn from all the research objectives.

RESULTS AND DISCUSSION

The data collected was processed using the Six Sigma method and Root Cause Analysis (RCA) as methods to analyze the sigma level and the root causes of defects in the creamer product packaging process. The types of defects that occurred in the packaged products are as follows:

1. Define Phase

PT. XYZ is a manufacturing company in the food additives industry that produces plant-based creamers, commonly known as non-dairy creamer. The creamer production process undergoes several stages, including packaging. During this stage, several categories of defects were identified, including underfilled or overfilled products (filling), improperly sealed plastic packaging (sealing), incorrect stitching (seawing), and unreadable or faded production code prints (coding).

1. Determining Critical to Quality (CTQ) Values

Table 2. CTQ (Critical to Quality)

No.	CTQ	Description	Impact
1.	Filling	The product filling exceeds or falls short of the standard net weight.	1. The product fails the quality checker and is categorized as Not-Good Product (NGP).
			2. The product cannot be distributed to the market and consumers in general.
			3. Products that accidentally pass and reach the market have a 96% chance of being returned.
			4. The company experiences losses in time and materials due to having to repeat the production process from scratch, and packaging materials are increased as the materials used cannot be reused.
			5. A decline in production quality due to suboptimal process capability.
2.	Sealing	Heat sealing results in leaks and improper closure.	
3.	Seawing	The stitching at the product packaging ends is not neat and improperly positioned.	
4.	Coding	The production code and product information are	

No.	CTQ	Description	Impact
		either unreadable or faded.	

In the study, the development of CTQ, as explained in Table 2, was based on interviews and observations with the production manager, shift leader, and packaging machine operators. In addition to internal company personnel, interviews were also conducted with sources from CV. RGB, a company in the food industry and a consumer of a similar product to the one produced by PT. XYZ. The interview was conducted with the assistant production manager of CV. RGB.

2. Defect Data Table for Product Packaging from July – December 2023

From Table 3, the product defect data can be observed as follows:

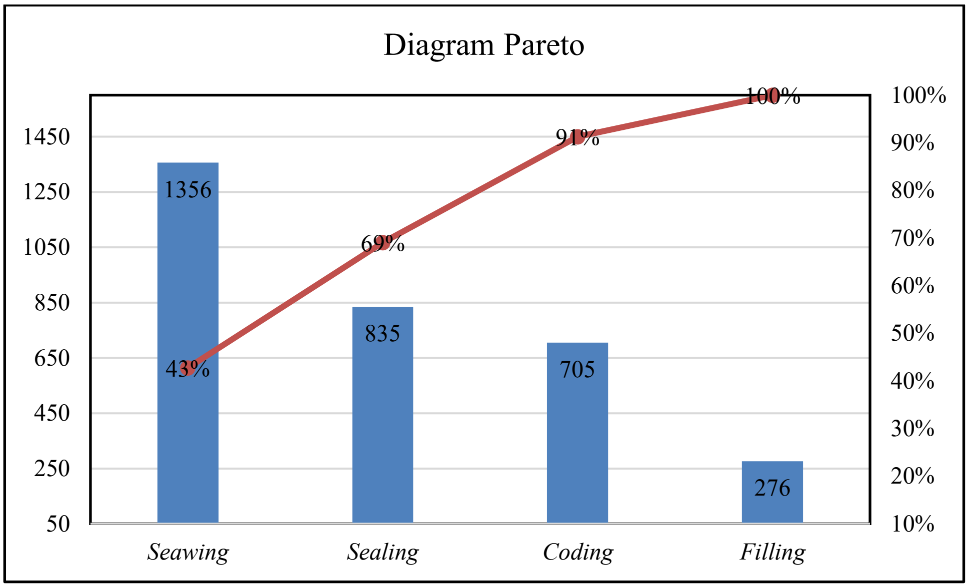
Table 3. Types and Number of Defects in the Packaging Process

Period	Filling	Sealing	Seawing	Coding
July	56	140	225	110
August	45	141	235	120
September	45	141	222	120
October	45	141	214	120
November	45	141	235	120
December	40	131	225	115
TOTAL	276	835	1,356	705

Table 3 explains the product defect data, showing that seawing defects hold the largest share, with a total of 1,356 bags, followed by sealing defects with 835 bags, coding defects with 705 bags, and filling defects with 276 bags. The total number of defective products over the data collection period from July to December 2023 is 3,172 bags.

3. Creating a Pareto Chart

A Pareto chart will be created to visualize the packaging defect data as an indication of the main issues.



In Figure 2, the root causes of the issues can be identified and addressed by making improvements in the product defect categories that account for approximately 80% of the total defects [24]. From the Pareto chart in Figure 2, it is evident that among the four product defect categories, three categories dominate: seawing, sealing, and coding. These categories should be prioritized for immediate improvement plans.

2. Measure Phase

The measure phase is conducted to determine the sigma level. Measurements are taken from the defect data of the packaging process over a 6-month period, with a total production of 184,708 bags and 5,888 defective bags. The next step involves calculating the number of defects per month (np) and the proportion of defects by performing calculations based on the obtained data using the following formula:

1. Calculating the Average Defect Percentage

$$\bar{P} = \frac{np}{n}$$

Where:

$\bar{P}$= Average defect percentage

np = Number of defects

n = Total number of units inspected

2. Calculating the Center Line (CL)

$$CL = \bar{P} = \frac{\Sigma np}{\Sigma n}$$

Where:

$\bar{P}$= Center Line

Σnp= Total number of defects

Σn= Total number of units inspected

3. Calculating the Upper Control Limit (UCL)

$$UCL = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

Where:
UCL = Upper Control Limit
$\bar{P}$= Average defect percentage
n = Number of units inspected

4. Calculating the Lower Control Limit (LCL)

$$LCL = \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

Where:
LCL = Lower Control Limit
$\bar{P}$= Average defect percentage
n = Number of units inspected

Table 4. Measurement Results for P, CL, UCL, and LCL Values

Month	Production Volume	Number of Defects	Proportion	UCL	CL	LCL
July	32,000	531	0.0166	0.0192	0.0171	0.0149
August	31,000	541	0.0175	0.0193	0.0171	0.0148
September	30,000	528	0.0176	0.0193	0.0171	0.0148
October	30,000	520	0.0173	0.0193	0.0171	0.0148
November	33,000	541	0.0164	0.0192	0.0171	0.0149
December	30,000	511	0.0170	0.0193	0.0171	0.0148
Total	186,000	3,172				

After the calculations in Table 4, it is observed that the average value of P is 0.0171, the average value of CL is 0.0171, the average value of UCL is 0.0180, and the average value of LCL is 0.0162. Based on the data processing, a P control chart is then created, as shown in the following figure.

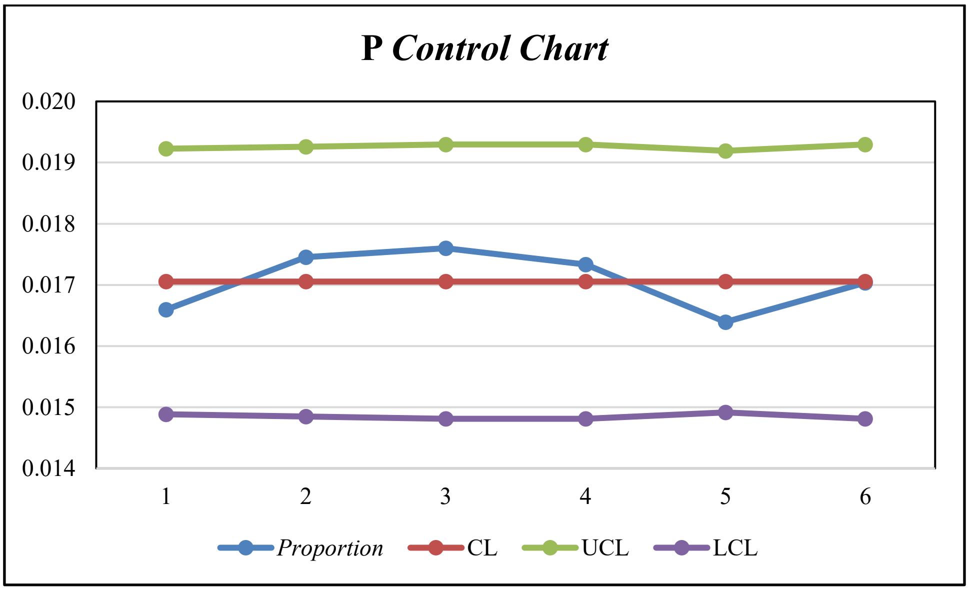


Figure 3. Control Chart for P Process in Packaging

In Figure 3, the control chart for the P process in packaging indicates that to emphasize zero defects, improvements are necessary to optimize production. By prioritizing zero defects, the company can achieve its target of improving the sigma level for enhancement. With this improvement, the company expects overall performance to increase, and every department within the company will experience positive impacts.

5. Calculation of DPU (Defects Per Unit)

Table 5. DPU Calculation for the Packaging Process

Period	Production Units	Defects	Opportunities	DPU
July	32,000	531	4	0.0166
August	31,000	541	4	0.0175
September	30,000	528	4	0.0176
October	30,000	520	4	0.0173
November	33,000	541	4	0.0164
December	30,000	511	4	0.0170

As shown in Table 5, the highest DPU value is found in September with a value of 0.0176, while the lowest DPU value is found in November with a value of 0.0164.

6. Calculation of DPO (Defects Per Opportunity)

To calculate the DPO for the period from July to December, see Table 6 below:

Table 6. DPO Calculation for the Packaging Process

Period	Production Units	Defects	Opportunities	DPU	DPO
July	32,000	531	4	0.0166	0.00415
August	31,000	541	4	0.0175	0.00436
September	30,000	528	4	0.0176	0.00440

Period	Production Units	Defects	Opportunities	DPU	DPO
October	30,000	520	4	0.0173	0.00433
November	33,000	541	4	0.0164	0.00410
December	30,000	511	4	0.0170	0.00426
Total	186,000	3,172			

Table 6 shows the calculated DPO values for the packaging process. The highest DPO value of 0.00440 is found in September with 30,000 bags produced and 528 defective bags, while the lowest DPO value of 0.00410 is found in November with 33,000 bags produced and 541 defective bags.

7. Calculation of DPMO and Six Sigma Level

The DPMO value is converted into the sigma value using Microsoft Excel with the conversion formula: Nilai DPMO = NORMSINV ((1.000.000-DPMO)/1.000.000)) + 1.5 [13].

The following table (Table 7) shows the DPMO and sigma level calculations for the packaging process from July to December:

Table 7. DPMO and Sigma Level Calculation for the Packaging Process

Period	Production Units	Defects	Opportunities	DPU	DPO	DPMO	Sigma Level
July	32,000	531	4	0.0166	0.00415	4148.438	4.14
August	31,000	541	4	0.0175	0.00436	4362.903	4.12
September	30,000	528	4	0.0176	0.00440	4400.000	4.12
October	30,000	520	4	0.0173	0.00433	4333.333	4.12
November	33,000	541	4	0.0164	0.00410	4098.485	4.14
December	30,000	511	4	0.0170	0.00426	4258.333	4.13
Total	186,000	3,172					

Based on the DPMO and sigma level calculations from Table 7, the quality control for packaging at PT XYZ shows a total production of 186,000 bags with 3,172 defective bags. The average DPMO is calculated to be 4266.915, meaning that there are 4,266.915 defective products per million units produced, with an average sigma level of 4. This indicates that quality control is still not optimal, as it is far from the 6-sigma level, which requires a DPMO of only 3.4. To compete with world-class companies, improvements in defect reduction are necessary.

3. Analyze Phase

The analysis phase of the problem can be performed after identifying facts and data. By analyzing the core issues, evaluating possible solutions, and assessing the process capabilities, the problem-solving approach becomes clearer 【25】. The steps to be taken include Pareto analysis and Fishbone diagram analysis. The Fishbone diagram (also known as the Ishikawa diagram) is used to categorize the causes of defects and to provide alternative solutions as a corrective action plan. The Fishbone diagram is shown below.

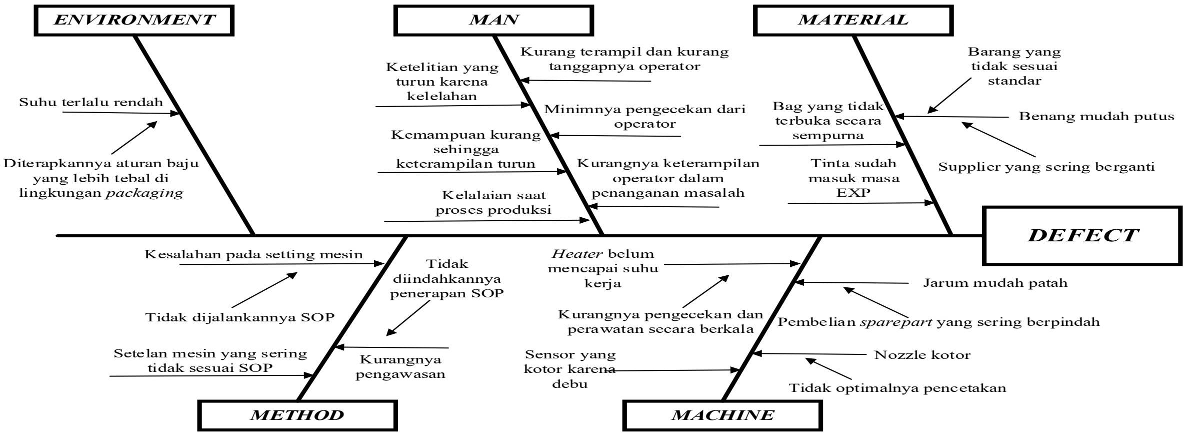


Figure 4. Fishbone Diagram for Sealing Product Defects

From the Fishbone diagram in Figure 4, an analysis of the product sealing defects reveals that the causes of defects are influenced by five main factors: material, machine, man, method, and environment.

1. Material: Issues with the material include threads that easily break due to the use of items that do not meet standards, as well as a frequent change of suppliers. There are also instances where the bag does not open properly and ink that has passed its expiration date.
2. Machine: The machine-related issues include dirty nozzles, which affect the optimal performance of the coding print, and needles that are prone to breakage due to not meeting the standards. The heater does not reach the required working temperature, leading to sealing failure, which is caused by insufficient preventive maintenance. Additionally, the sensor is dirty due to dust from the product, which also affects the machine's performance.
3. Man: The human-related factors are largely influenced by operator negligence and insufficient supervision. Operators who have undergone training tend to take standards lightly, which is due to a lack of awareness among employees. The company should emphasize its commitment to rules and standards for the company’s progress.
4. Method: The method-related issues involve incorrect machine settings and, in general, the failure to adhere to company standards by employees, along with a lack of punishment for not following the standards.

4. Improve Phase

In this phase, improvements are proposed to reduce failures in the packaging process of the creamer product at PT. XYZ. After identifying the root causes of the problems through analysis using the Six Sigma method and determining the highest percentage of defects, the next step is to perform a root cause analysis using the FTA

(Fault Tree Analysis) method to identify the most influential factor contributing to the defects.

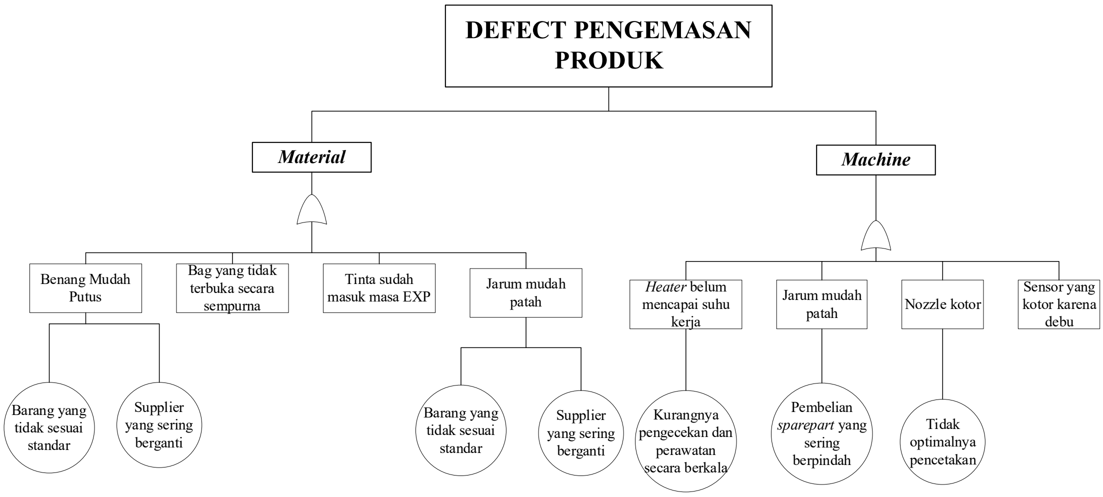


Figure 5. Fault Tree Analysis Diagram of Product Packaging Defects - Machine and Material Factors

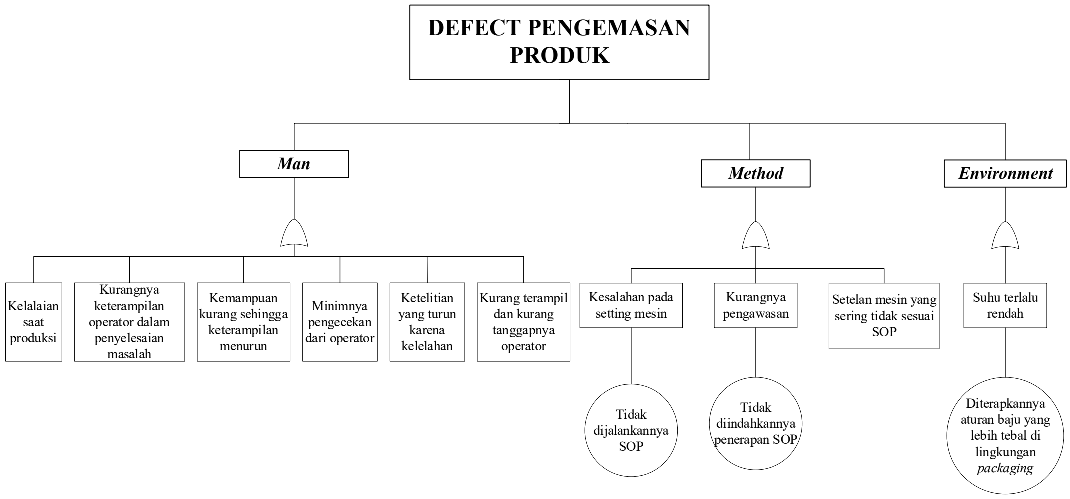


Figure 6. Fault Tree Analysis Diagram of Product Packaging Defects - Man, Method, and Environment Factors

Based on the fault tree analysis diagram in Figures 5 and 6, it can be concluded that a quality control plan is necessary to address these issues. The primary factors causing product failures, as identified in the fault tree analysis, are machine and material-related issues, where regular machine maintenance is crucial, and procuring materials through quality suppliers is also essential. Additionally, three other factors contribute to failures in the process, including the workers' lack of understanding of the standards while operating the machines, the methods that are not being applied, and the environment having low temperatures.

Table 8. 5 Why's Method for the Packaging Process

Defect	Why 1	Why 2	Why 3	Why 4	Why 5
Man	Operator is careless	In a hurry while working	Focus declines due to fatigue	Focus on target output instead of quality	Limited number of operators
	Continuing with defective products	Not considering the condition of the product	Not comparing with previous shift results	Lack of self-checking	No checks every 15 minutes
	Operator skills are lacking	Lack of operator experience	No improvements from operators	Training was not implemented properly	Ignoring standards after training
Machine	Heat sealer is not hot enough	No routine maintenance	Maintenance schedule not available	Maintenance done by third-party vendors	Maintenance not performed by the company
	Shift change often causes issues	Needle holder often shifts	Needle material often changes due to supplier differences	Needle brand often changes	Needle breakage slows the process
	Expired ink used	Lack of maintenance on coding equipment	Nozzle often clogs due to dry ink	Sensor blocked by dust	Spare parts for coding are not replaced regularly
Environment	Always low temperature	Low temperature causes workers to move sluggishly	Room temperature affects workers	Room temperature and humidity fluctuate	Worker clothing thickness affects performance
Method	Production method not implemented in the field	Different treatments across divisions	Lack of understanding about the importance of standards	Lack of strict punishment for mistakes	No follow-up socialization after training
Material	Packaging material	Suppliers frequently change	Delivered items often do	Supplier selection	Material procurement

Defect	Why 1	Why 2	Why 3	Why 4	Why 5
	quality often varies		not meet standards	needs tightening	must adhere to standards

Based on Table 8, the root cause analysis (RCA) using the 5 Why's method identifies that defects in the packaging process are influenced by five factors: man, machine, method, material, and environment. The most dominant factor is related to the human element, such as the operator being careless, not considering whether the product is in good condition, and failing to perform regular checks every 15 minutes to ensure that the output meets the required standards.

5. Control Phase

In the control phase, this research provides proposals for immediate corrective actions to address the defects. During this phase, all strategic steps are planned and then implemented to reduce defect rates. The improvements aim to deliver high-quality output, with the corrective action plan based on interviews with the head of the production department, production staff, and quality control personnel, as well as literature reviews from previous studies. The proposed corrective actions are as follows:

1. Human Factors

   a. Provide periodic training and continuous briefings [9].

   b. Conduct checks at every process stage to ensure the results align with company standards [10].

   c. Implement work schedule adjustments, such as shift work or increasing rest breaks twice daily, to improve concentration and attention to detail [10].

2. Machine Factors

   a. Perform regular checks on all machines after production, with daily performance logging and creating reports [10].

   b. Provide catalogs detailing machine specifications and operational procedures for each machine.

   c. Ensure routine machine maintenance is performed, not just when the machines break down (preventive maintenance) [15].

3. Method Factors

   Conduct checks and create reports for each material collection, maintenance, and purchase to ensure proper inventory control and prevent the accumulation of expired materials [15].

4. Material Factors

   a. Prioritize supplier selection based on quality. The quality of materials directly impacts the finished product.

   b. Improve coordination among departments for better communication and to align perceptions about the quality standards to improve overall departmental performance [9].

5. Environment Factors

a. Regulate air circulation in material storage areas to prevent excessive humidity, maintaining standards of 20°C and 35%-60% humidity to avoid material damage [10].

b. Continuously remind and emphasize during briefings and display posters as reminders.

c. Apply penalties for workers who fail to comply with the standards.

CONCLUSION

Fundamental Finding : This study identifies that the dominant causes of defects in the creamer product packaging process at PT XYZ are material and machine-related factors, including low-quality thread and insufficient machine maintenance, which contribute to defects such as seawing, sealing, coding, and filling. **Implication** : The findings suggest that addressing material quality, ensuring regular machine maintenance, and enhancing employee awareness through proper training could significantly reduce defects and improve the packaging process. Implementing these improvements will likely enhance product quality and operational efficiency. **Limitation** : The study faced several limitations, including insufficient monitoring of the night shift, a lack of involvement from policy-makers, and limited access to primary data, which may have impacted the comprehensiveness of the findings. **Future Research** : Future studies should focus on conducting more comprehensive shift monitoring, involving management in the data collection process, and obtaining broader access to company data to gain a more holistic view of the production process and its challenges.

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