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ANALYSIS AND CONTROL OF FILLING PROCESS DEFECTS USINGSEVEN QUALITY CONTROL TOOLS AT PT ABC

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Abstract

Quality control plays an important role in maintaining product consistency and improving production efficiency. A high level of product defects can lead to material waste, increased production costs, and decreased operational performance. This study aims to identify the dominant types of product defects and analyze the factors causing defects in the production process of cup and lid packaging for the rock Twist product at PT ABC. This research employed a quantitative descriptive method using the Seven Quality Control Tools, including flowchart, Check Sheet, histogram, Pareto diagram, scatter diagram, p-control chart, and cause-and-effect (Fishbone) diagram. The data used in this study were secondary data obtained from production reports and rejected product reports during the 2021 production period. The results indicate that the most dominant defect type is uncentered fill, with a total of 357,326 pieces, followed by overfill (53,672 pieces), underfill (52,481 pieces), and poor coding (3,602 pieces). Based on the Pareto analysis, uncentered fill contributes 76.50% of the total product rejects, making it the primary quality issue in the production process. The scatter diagram analysis shows a positive correlation between the number of cups and lids used in production and the number of rejected products. Furthermore, the p-control chart indicates that the production process is statistically out of control. The cause-and-effect diagram identifies human factors, machine conditions, work methods, and material quality as the primary contributors to product defects. The findings demonstrate that the Seven Quality Control Tools are effective in identifying major sources of quality problems and determining priority areas for process improvement. Improving control in the filling process is expected to significantly reduce product defects and enhance production quality and efficiency.

Keywords: Quality Control, Statistical Process Control, Product Defects, Pareto Analysis

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INTRODUCTION

The development of the Fast Moving Consumer Goods (FMCG) industry in Indonesia has shown increasingly fierce competition in recent years. This industry is characterized by fast product turnover, large production volumes, and relatively thin profit margins. These conditions require companies to maintain consistent product quality through effective production process control. In high-volume industries, small process variations can result in a large accumulation of defective products. Research shows that production process stability is a critical factor in maintaining the competitiveness of manufacturing companies (Antony, 2021; Sony et al., 2020). Therefore, quality is not only related to the final product but also to the company's ability to control process variations systematically.

One of the growing FMCG subsectors is the ice cream industry. The growth of frozen food consumption in Southeast Asia, including Indonesia, has continued to increase in recent years (Mordor Intelligence, 2023). This increase has intensified competition between producers and requires companies to maintain consistent quality standards. In the ice cream industry, product quality is determined not only by the composition of raw materials and flavor, but also by the quality of the packaging. Primary packaging, such as cups and lids, serves to protect the product and maintain its cleanliness and safety. Failures in the packaging system can reduce overall product quality and potentially cause losses for the company (Marsh & Bugusu, 2021). Therefore, primary packaging is a crucial part of the production quality control system. From a quality management perspective, quality is understood as conformity to established specifications. An unstable production process will result in defective products and indicate uncontrolled variation. In the FMCG industry, which produces large quantities, high reject rates reflect the need for systematic evaluation of the production process (Heizer et al., 2020).

Several studies since 2020 have shown that the implementation of the Seven Quality Control Tools is effective in identifying sources of defects and helping companies understand variation patterns in production processes (Gumelar et al., 2023; Pratanca & Wasesa, 2023; Rosyidi & Izzah, 2024; Sutartiah et al., 2024). These studies demonstrate that tools such as check sheets, Pareto charts, cause-and-effect diagrams, and control charts can systematically map dominant defect types and their causal factors. However, most of these studies have been conducted in the context of general manufacturing or food processing. Studies specifically examining primary packaging in the FMCG industry, particularly extruder-based production processes in the frozen food industry, are

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still relatively limited. Therefore, research is needed that specifically examines the dominant sources of primary packaging rejects in extruder production lines using the Seven Quality Control Tools approach.

Based on these conditions, this study focuses on the analysis of the use of Seven Quality Control Tools to identify the dominant sources of rejects in primary cup and lid packaging on the extruder production line at ABC Company. This study does not examine quantitative cost variance analysis, but focuses on mapping the types of defects, frequency of occurrence, and the main causal factors that influence the high reject rate. With this approach, the study is expected to provide a systematic overview of the root causes of quality problems in primary packaging in the context of the FMCG industry.

LITERATURE REVIEW

Seven Quality Control Tools

The Seven Quality Control Tools (QC Tools) are seven basic tools used to identify, analyze, and control variation in production processes. This concept developed rapidly in Japan as part of the quality control circle and total quality management (TQM) movements. According to Ishikawa (1985), most quality problems can be solved using simple statistical tools that are easily understood by all levels of the organization. These seven tools include: check sheets, histograms, Pareto charts, cause-and-effect diagrams, control charts, scatter diagrams, and flowcharts.

This approach emphasizes systematic data collection as a basis for decision-making. Recent literature shows that the Seven QC Tools remain relevant in the Industry 4.0 era due to their ability to simplify problem analysis in a visual and structured manner (Antony, 2021; Dahlgaard, 2022).

Framework

This study does not aim to test causal relationships between variables, but rather to apply the Seven Quality Control Tools as an analytical instrument in evaluating the quality of the production process. The framework is structured as a systematic flow in identifying, analyzing, and controlling process variations that have the potential to cause product defects. The initial stage is carried out by collecting and grouping defect data using a Check Sheet. Next, a Pareto chart is used to identify dominant types of defects that require priority improvement based on the principles introduced by Pareto (1896). Root cause analysis is conducted using a cause-and-effect diagram as developed by Ishikawa (1985), so that the factors causing process variations can be systematically identified. To

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evaluate the stability of the production process, this study uses a control chart introduced by Shewhart (1931). Through the Statistical Process Control approach, it can be determined whether the process is in statistical control or requires corrective action. Thus, this research framework describes the flow of implementing the Seven QC Tools as an evaluative method to increase the effectiveness of quality control and provide recommendations for improvement for the company.

RESEARCH METHOD

This study uses an applied descriptive research approach to analyze primary packaging quality issues in the production process at ABC Company. This approach was chosen because the study focuses on describing the actual conditions of the production process and identifying the causes of rejects in cup and lid packaging in the extruder line. This study is not intended to test statistical hypotheses, but rather to evaluate the company's operational conditions and formulate recommendations for process improvements based on empirical data. The descriptive approach is widely used in manufacturing quality control research because it can provide a systematic overview of production process variations and sources of product defects (John W. Creswell & J. David Creswell, 2018).

The research was conducted at ABC Company which operates in the Fast Moving Consumer Goods (FMCG) industry, specifically in ice cream production. The research object focused on the primary packaging of the product consisting of cups and lids produced on Extruder Line 1. The selection of the research object was based on the company's internal data on ice cream cups which showed that the reject rate of primary packaging on the line was relatively higher than other production lines, so it was considered a critical point in the company's quality control system.

The research data consisted of primary and secondary data. Primary data was obtained through direct observation of the production process, recording the type and frequency of defects using a check sheet, and visual documentation of the condition of damaged packaging. Meanwhile, secondary data was obtained from company documents, including production reports, packaging quality standards, and historical reject rate records maintained by the quality control department. The use of both types of data allows for a more comprehensive analysis of production process conditions and product defect patterns (Sony et al., 2020).

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To clarify the stages of the research carried out, the research methodology flow is presented in the form of a diagram in Figure 1. The flowchart describes the research process starting from problem identification, production data collection, analysis using Seven Quality Control Tools, to formulating recommendations for improving the production process.

Problem Identification
(Height of Reject Cup and Lid)
↓
Data collection
Observation and Check Sheet
↓
Classification of Defect Types
↓
Histogram Analysis
↓
Pareto Analysis
Determining the Dominant Defect
↓
Fishbone Diagram Analysis
Finding the Root Cause
↓
Control Chart
Process Stability Evaluation
↓
Recommendations for Improvement

Figure 1. Research Methodology Flowchart

In addition to the research methodology, this study also mapped the primary packaging production process to identify stages that could potentially lead to defects. The mapping was conducted using a production process flowchart that illustrates the production stages from raw material receipt to product packaging. The diagram is presented in Figure 2.

Plastic Raw Material Receipt
|

↓
Raw Material Quality Inspection
↓
Material Mixing
↓
*Feeding*to the Extruder Machine
↓
Plastic Melting Process
↓
Plastic Sheet Forming
↓
Sheet Cooling
↓
Thermoforming
Cup and Lid Formation
↓
Cutting / Trimming
↓
Quality Inspection
↓
Product Sorting
(Good / Reject)
↓
Packaging

Figure 2. Flowchart of the Cup and Lid Packaging Production Process

To ensure the validity of the research data, triangulation was conducted by comparing the results of field observations, company documentation, and the results of production data analysis. Furthermore, defect recording was carried out by a team experienced in quality control to minimize recording errors. Data reliability was also strengthened through observations over several production periods so that the analysis results could represent the production process

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conditions more consistently (Chiarini, 2020). Through these stages, this study aims to identify the dominant types of defects, evaluate the stability of the production process, and find the main root causes of rejects in primary packaging. The analysis results are then used as a basis for formulating recommendations for production process improvements to reduce reject rates and increase the company's operational efficiency.

RESULTS AND DISCUSSION

This study aims to analyze the quality control of cup ice cream packaging using the Seven Quality Control Tools method. The analysis was conducted on rejected data from cup and lid packaging during the 2021 production period. This method was used to identify dominant defects, evaluate the stability of the production process, and determine the root causes of product defects. The Seven Quality Control Tools used in this study include flowcharts, check sheets, histograms, Pareto diagrams, scatter diagrams, control charts, and fishbone diagrams. Each analytical tool was used systematically to obtain a comprehensive picture of the quality control conditions in the cup ice cream production process.

Production Process Flowchart Analysis

Flowcharts are used to systematically describe the stages of a production process, making it easier to understand the workflow and identify stages that could potentially lead to product defects. In the context of quality control, flowcharts serve as a visual tool for mapping the production process and assisting in analyzing critical points that can affect the quality of the final product.

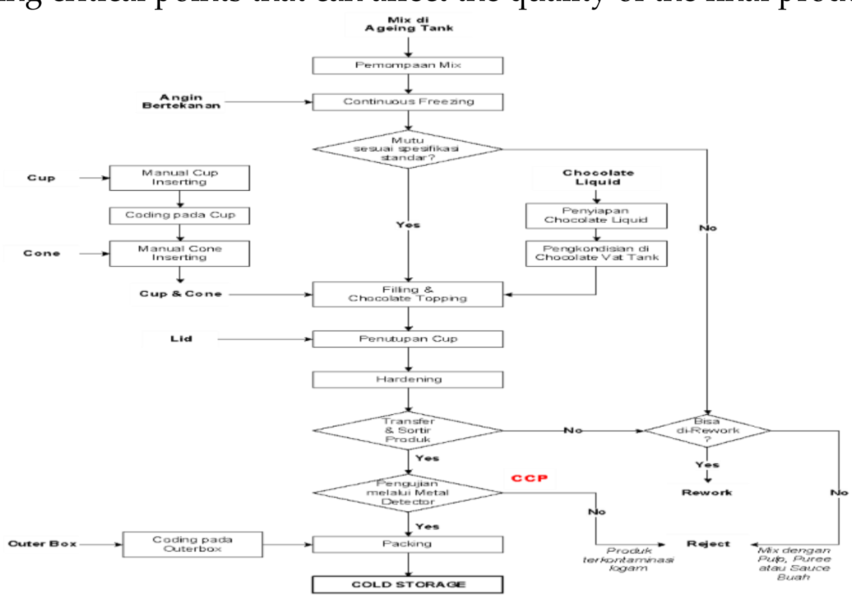

Figure 3. Flowchart of the Cup Ice Cream Product Filling Process

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Based on the production process flowchart, the filling stage is one of the most crucial processes in cup ice cream production because it directly interacts with the product, filling machine, and packaging. Inaccuracies in this process can lead to various product defects, such as uncentered fill, overfill, and underfill, which ultimately render the packaging unusable. One potential problem that often occurs during the filling stage is the inaccuracy of the product filling position into the cup. This condition can occur if the cup is not positioned at the correct point on the tray when passing through the filling machine. The lack of synchronization between the movement of the tray and the machine's filling system can cause the product to be unevenly printed in the cup, resulting in an uncentered fill defect.

Thus, based on the flowchart analysis, it can be concluded that the filling stage is a critical point in the cup ice cream production process, significantly impacting the product defect rate. Therefore, stricter process control at this stage requires operator supervision, regular machine maintenance, and standardized operational procedures to ensure the product filling process runs smoothly and consistently.

Check Sheet Analysis

Check Sheet is one of the Seven Quality Control Tools used to systematically collect, record, and classify product defect data during the production process. The use of Check Sheets allows companies to obtain accurate data on the frequency of defect occurrence, thus facilitating subsequent quality analysis, such as histograms, Pareto diagrams, and control charts. Data in this study were collected by recording the number of cup and lid packaging used and the number of rejects during the production period from January to December 2021. Recording is carried out periodically by the quality control department to determine the number of defects occurring during each production period and to identify the most dominant types of defects.

Table 1. Result Data
Check Sheet ice cream cup 2021

Month	Number of Units Used (Pcs)	Number of Rejects (Pcs)	(%)	Reject Type			
				Overfill	*Underfill*	*Uncentered fill*	*Coding*Bad
January	197,208	28,902	14.66	3,757	3,237	21,675	231
February	191,040	27,523	14.41	3.110	3,028	21,138	248
March	300,192	40,777	13.58	3,751	3,915	32,948	163
April	238,344	33,964	14.25	4.144	3,736	25,745	340
May	270,696	36,799	13.59	4.121	4,048	28,298	331

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June	308,040	41,896	13.60	4,692	4,650	32,176	377
July	248,184	38,366	15.46	5,064	4,259	28,698	345
August	251,880	33,893	13.46	2,779	3,728	27,148	237
September	319,344	48,507	15.19	5,530	5,336	37,205	437
October	254,976	36,134	14.17	4,408	4,481	27,101	145
November	375,048	51,444	13.72	6,791	6,688	37,657	309
December	321,936	48,876	15.18	5,523	5,376	37,537	440
Total	**3,276,888**	**467,081**	**14.25**	**53,672**	**52,481**	**357,326**	**3,602**
Average	**273,074**	**38,923**	**14.25**	**4,473**	**4,373**	**29,777**	**300**

Source: Primary Data (processed), 2026

Based on the data in Table 1, the total use of cup and lid packaging during 2021 reached 3,276,888 pieces, with 467,081 pieces rejected, or approximately 14.25% of total production. This percentage indicates that the product defect rate remains relatively high, potentially causing losses for the company, both in the form of wasted packaging materials and increased production costs. A more detailed analysis of monthly data reveals that the number of rejects fluctuates throughout the production period. The highest percentage of rejects occurred in July at 15.46%, followed by September at 15.19% and December at 15.18%. Meanwhile, the lowest percentage of rejects occurred in August at 13.46%. This variation in defect rates indicates that the stability of the production process is still not optimal and is still influenced by various factors that cause variations in product quality.

In addition to viewing the total number of rejects, Check Sheet data also provides important information regarding the distribution of defect types that occur in the production process. Based on the results of data processing, there are four main types of defects that occur in cup ice cream product packaging, namely overfill, underfill, uncentered fill, and poor coding. The uncentered fill defect type is the most dominant defect with a total of 357,326 pieces or approximately 76% of the total rejects. This condition indicates that most product defects are caused by inaccurate positioning of the product filling into the cup during the filling process. This inaccuracy can occur due to several factors such as a lack of synchronization between the filling machine and the tray, operator error in placing the cup, or variations in the position of the cup on the production line.

Thus, the use of the Check Sheet in this study provides a clear picture of the level of product defects and the most dominant types of defects in the cup ice cream production process. This information is crucial as a basis for further analysis using other quality control tools to determine more effective production process improvement strategies.

Histogram Analysis

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Histograms are used as a statistical analysis tool to visually depict the frequency distribution of a variable's occurrence, facilitating the identification of defect patterns occurring during the production process. In quality control research, histograms serve to demonstrate data variation and help researchers understand the most dominant types of defects in a production process (Montgomery, 2020). By using histograms, companies can obtain a clearer picture of the frequency distribution of defect types, making it easier to prioritize production process improvements. The histogram in this study illustrates the frequency distribution of defect types that occurred in cup and lid packaging for cup ice cream products during the 2021 production period. The data used are the results of a recapitulation of Check Sheets that have been classified into four main defect categories: overfill, underfill, uncentered fill, and poor coding. The visualization in the histogram shows a comparison of the frequency of each defect type, allowing the identification of the defect type that most dominantly affects the product rejection rate.

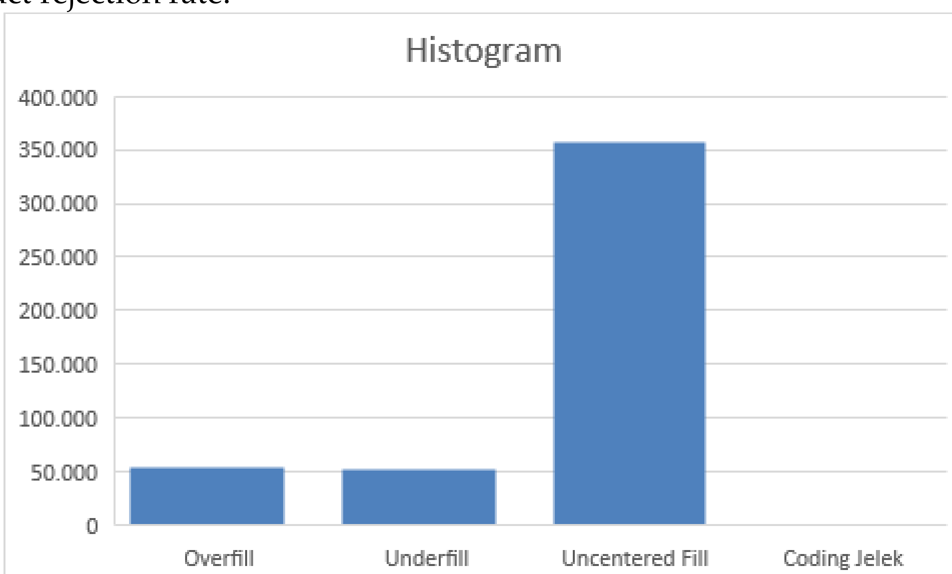

Figure 4. Histogram of Causes of Rejection of Cups and Lids of Ice Cream Cups

Based on the histogram analysis results in Figure 4, it can be seen that the uncentered fill defect type has the highest frequency of occurrence compared to other types of defects with a total of 357,326 pieces. This value indicates that most of the rejected products are caused by inaccurate product filling positions into the cup. This condition indicates that the filling process is not running stably or there is a mismatch between the position of the filling nozzle and the position of the packaging on the production line conveyor. This inaccurate filling position can

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cause the product distribution in the cup to be unbalanced and therefore does not meet the quality standards set by the company.

The dominance of uncentered fill defects in the histogram indicates that the product filling process is a critical control point in the cup ice cream production system. From a quality management perspective, process stages with the highest levels of variation are often the primary source of product defects and should be the primary focus of process improvement activities (Heizer et al., 2020). Therefore, improvements in the filling stage are a strategic step to significantly reduce packaging rejection rates.

Pareto Chart Analysis

The Pareto diagram is one of the Seven Quality Control Tools used to identify quality problem priorities based on their greatest contribution to total product defects. The basic principle of the Pareto diagram refers to the 80/20 rule, which states that most problems in a system are generally caused by a small number of dominant factors (Montgomery, 2020). By using Pareto analysis, companies can determine improvement priorities more effectively by focusing resources on the causes of defects that have the greatest impact on product quality. In this study, the Pareto diagram was used to analyze the distribution of contributions of each type of defect that occurred in the cup and lid packaging of cup ice cream products during the 2021 production period. The data used were the results of the Check Sheet recapitulation which had been classified into four main types of defects: overfill, underfill, uncentered fill, and poor coding. This analysis aims to determine the most dominant type of defect so that it can be prioritized in efforts to improve production quality.

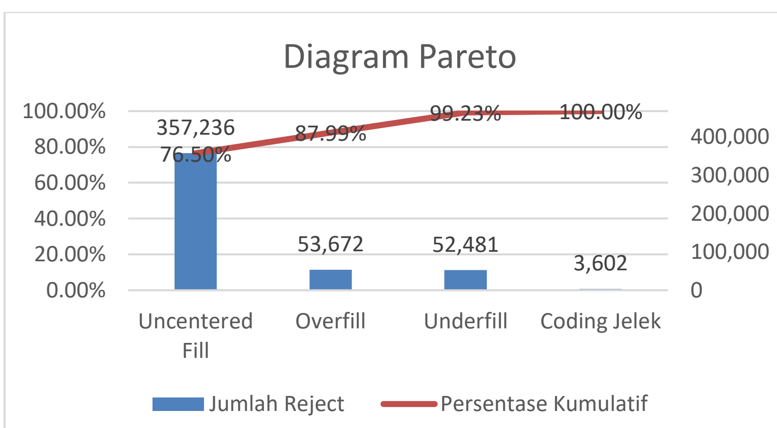

Figure 5. Pareto Diagram of Types of Rejected Ice Cream Cups

Based on the analysis results shown in Figure 5, it is known that the uncentered fill defect type has the largest contribution to the total rejections that

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occurred, namely 76.50% of all product defects. This percentage indicates that more than three-quarters of quality problems in the cup ice cream production process are caused by inaccurate product filling position during the filling stage. Meanwhile, overfill and underfill defects have a much smaller contribution, while poor coding defects only contribute very little to the total rejections. The dominance of uncentered fill defects indicates that the filling stage is a critical process point in the cup ice cream production system. This process is very important because it is directly related to the appropriate position and distribution of the product in the packaging before the closing process using the lid. Inaccurate filling position can cause the product to not be in the proper position in the cup, resulting in inappropriate product shape and potential failure at the packaging sealing stage.

Scatter Diagram Analysis

Scatter diagram is a statistical analysis tool used to identify the relationship or correlation between two variables in a production process. This diagram displays data pairs in the form of points on a coordinate plane, making it easier for researchers to observe the relationship patterns that occur between the variables being analyzed (Montgomery, 2020). In the context of quality control, scatter diagrams are often used to determine whether increased production activity has an impact on the increase in the number of product defects. In this study, a scatter diagram was used to analyze the relationship between the number of cup and lid packages used in the production process and the number of rejects that occurred during the 2021 production period. The variable number of packages used represents the level of production volume, while the variable number of rejects indicates the level of defects that occurred in the production process.

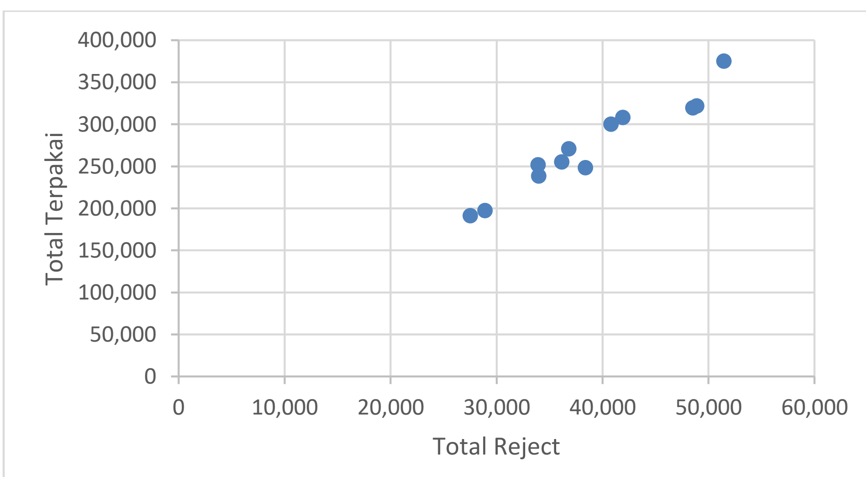

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Figure 6. Scatter Diagram of the Relationship between Used Cup Lid and Reject

Based on the analysis results shown in Figure 6, there is a tendency for a positive relationship between the number of packages used and the number of rejects that occur. The pattern of dots in the scatter diagram shows that as the number of packages used in production increases, the number of rejects also tends to increase. This relationship indicates that increases in production volume tend to be followed by an increase in the number of product defects. This condition indicates that the increase in production capacity carried out by the company has not been fully balanced by adequate production process stability. In a production system that is not yet fully stable, increased production volume often leads to increased process variation, thus increasing the potential for product defects.

Thus, the results of the scatter diagram analysis in this study indicate that increasing production volume needs to be balanced with improving the stability of the production process, particularly at the filling stage, which has been identified as the main source of product defects. Efforts that can be made include improving production process control, improving filling machine settings, and enhancing quality control at critical points in the production process.

Control Chart Analysis

A control chart is an important tool in Statistical Process Control (SPC) used to monitor the stability of a production process over time. This control chart consists of three main components: the central line (CL), which shows the average proportion of defects, the upper control limit (UCL), and the lower control limit (LCL).

Table 2. Recapitulation of P Control Chart Calculations

No	Number of Units Used (Pcs)	Number of Rejects (Pcs)	Reject Proportion	CL	UCL	LCL
1	197,208	28,902	0.147	0.143	0.145	0.140
2	191,040	27,523	0.144	0.143	0.145	0.140
3	300,192	40,777	0.136	0.143	0.144	0.141
4	238,344	33,964	0.142	0.143	0.145	0.140
5	270,696	36,799	0.136	0.143	0.145	0.141
6	308,040	41,896	0.136	0.143	0.144	0.141
7	248,184	38,366	0.155	0.143	0.145	0.140
8	251,880	33,893	0.135	0.143	0.145	0.140
9	319,344	48,507	0.152	0.143	0.144	0.141

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10	254,976	36,134	0.142	0.143	0.145	0.140	
11	375,048	51,444	0.137	0.143	0.144	0.141	
12	321,936	48,876	0.152	0.143	0.144	0.141	
Total	**3,276,888**	**467,081**					

Source: Primary Data (processed), 2026

Based on the calculation data in table 2, a p control chart can be created in figure 7.

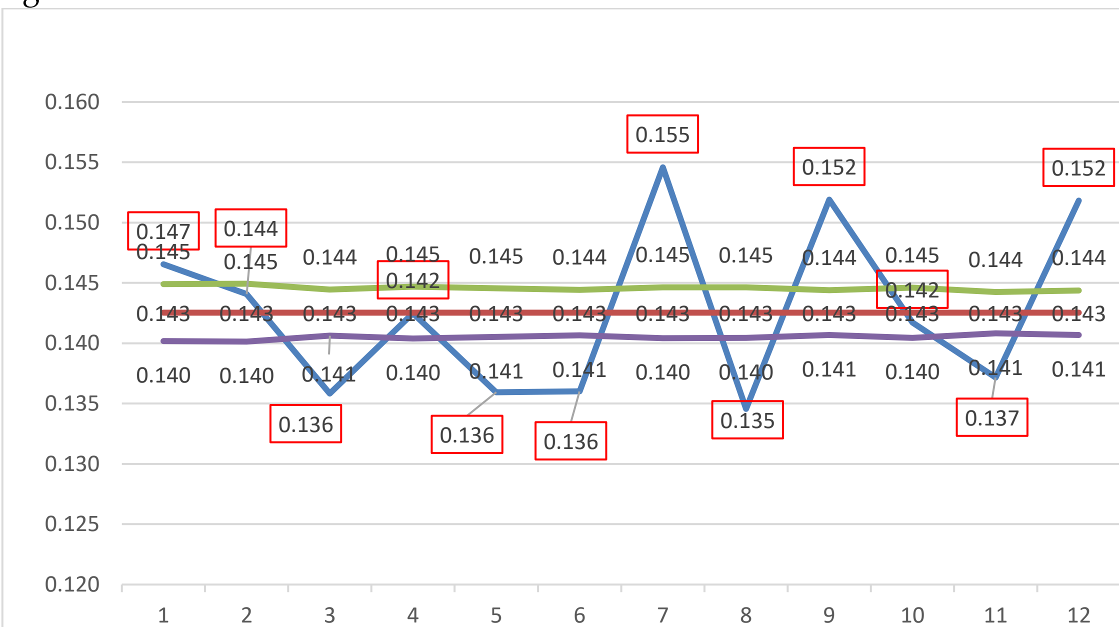

Figure 7. Control Chart of Reject Cup and Lid in 2021

Based on the calculation results presented in Figure 7, the Central Line (CL) value was obtained at 0.143, which indicates that the average proportion of reject products in the cup ice cream production process during 2021 was around 14.3% of the total cup and lid packaging used. This value reflects the average defect rate in the production system that occurred during the observation period. Furthermore, based on the calculation of the control limits, the Upper Control Limit (UCL) value ranged from 0.144–0.145 and the Lower Control Limit (LCL) value ranged from 0.140–0.141. The difference in control limit values was caused by variations in the number of production samples in each month. In the P control chart, different sample sizes can cause variations in control limit values because the standard deviation calculation is influenced by the number of production units in each observation period (Montgomery, 2020). The visualization of the calculation results is shown in Figure 7, which depicts the control chart for the proportion of reject cups and lids during 2021. Based on the control chart graph, it can be seen that most of the data points are outside the predetermined control

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limits. Of the twelve observation points analyzed, only three data points fell within the statistical control limits, namely in February, April, and October. Meanwhile, the other nine observation points fell outside the control limits, either above the UCL or below the LCL.

Thus, the results of the control chart analysis indicate that the cup ice cream production process still requires improvements to the process control system to achieve more stable and controlled production conditions. Several improvement efforts that can be made include regular calibration of the filling machine, increased operator supervision during the filling stage, improved synchronization between the conveyor system and the filling nozzle, and improved standard operating procedures (SOPs) in the production process. The implementation of better process control is expected to reduce variations in the production process so that the number of rejects can be significantly reduced and the efficiency of cup and lid packaging use in cup ice cream production can be increased.

Cause and Effect Diagram Analysis

A fishbone diagram, or cause-and-effect diagram, is an analytical tool used in the Seven Quality Control Tools method to identify and group various factors that have the potential to cause product defects in a production process. This diagram helps researchers systematically describe the relationship between a quality problem and its various causal factors, thus facilitating root cause analysis (Montgomery, 2020). In quality control practice, a fishbone diagram typically groups the causes of problems into several main categories such as man, machine, method, material, and environment. In this study, a fishbone diagram analysis was used to identify factors that cause defects in cup and lid packaging for cup ice cream products. Based on the results of previous analysis using check sheets, histograms, and Pareto diagrams, it was found that there were three main types of defects that were most dominant in the production process: uncentered fill, overfill, and underfill. Therefore, the fishbone diagram analysis focused on these three types of defects to identify the main causes that influenced the occurrence of product defects.

Reason of Uncentered fill

Uncentered fill is A mismatch occurs when the ice cream mixture is unevenly distributed within the cup, causing one side of the cup to be filled more than the other. This condition results in an unsymmetrical product and fails to meet the company's visual quality standards. Furthermore, uneven product distribution can also affect the sealing process, increasing the potential for product rejection.

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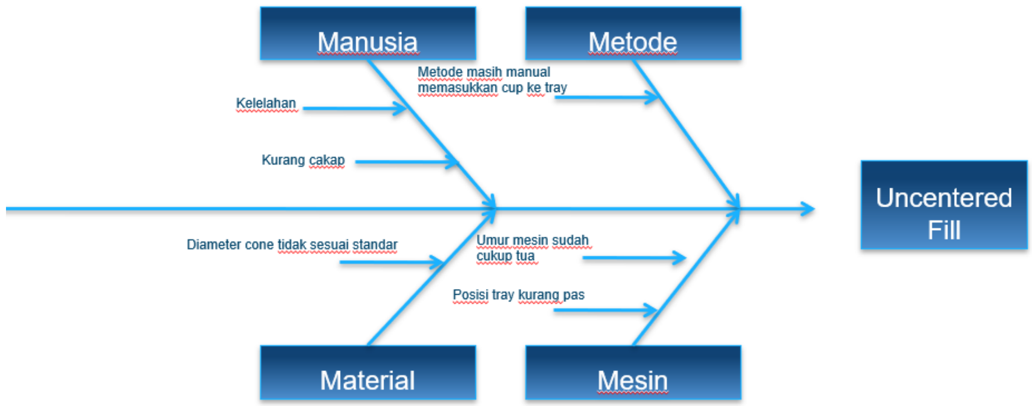

Figure 8. Fish Bone Uncentered fill diagram

The results of the analysis in Figure 8 show that uncentered fill defects are influenced by several main factors originating from machine, work method, human and material aspects:

In terms of machine factors, one of the main causes of uncentered fill is a lack of synchronization between the filling machine and the tray conveyor that carries the cup to the filling point. This lack of synchronization can cause the filling nozzle to be misplaced in the center of the cup, resulting in an unbalanced product flow into the package. In automated production systems, synchronization between conveyor movement and the filling system is a critical factor in determining the accuracy of product distribution within the package.

Regarding the method factor, the process of placing cups on production trays is still done manually by operators. This manual process can potentially lead to cups being positioned incorrectly, resulting in the cups being misplaced when moving to the filling machine.

In terms of human factors, operator performance also influences the stability of the production process. Operators who experience fatigue, lack of concentration, or limited experience can increase the likelihood of errors in the production process, including incorrect cup placement on the production tray.

Furthermore, regarding material factors, variations in cone diameter or cup packaging that do not meet standards can cause the packaging to become unstable on the conveyor tray. This mismatch in size can cause the cup to shift from its proper position, affecting the accuracy of the product filling process.

Reason of Overfill

Overfilling is a condition where the volume of product filled into a cup exceeds the standard capacity set by the company. This condition can cause

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product overflow during the packaging closing process, increasing the risk of lid sealing failure. Furthermore, overfilling can also lead to wasted raw materials because the amount of product used exceeds the standard. Based on the results of the Fishbone diagram analysis, there are several main factors that cause overfilling in the production process. One of the main causes comes from damage or instability of the freezer machine, which causes changes in the overrun value in the ice cream mixture. Overrun is an important parameter in the ice cream production process that indicates the amount of air mixed into the mixture during the freezing process. Changes in the overrun value can affect the volume of product exiting the filling machine, resulting in discrepancies in the volume of product filled into the cup.

Besides machine factors, operator errors in setting machine parameters can also lead to overfill. Parameter settings such as filling pressure and filling time that do not meet production standards can result in a higher product output than expected.

Another factor contributing to overfill is non-standard cup sizes. If the cup size used is smaller than the specified specifications, the product volume will appear excessive, leading to an overfill. This variation in package size can occur due to inconsistencies in the quality of the packaging materials supplied by the vendor.

Reason of Underfill

Underfill is a condition where the amount of product filled into a cup is less than the company's established standards. This can result in the product not meeting the established net weight specifications, potentially reducing customer satisfaction and harming the company in terms of product quality.

Based on the results of the Fishbone diagram analysis, the main causes of underfill are similar to those of overfill, particularly those related to the instability of the freezer and product filling system. One of the main factors is changes in the overrun value caused by freezer disruptions. An imbalance in the air composition in the ice cream mixture can cause the product volume exiting the machine to be smaller than the specified standard. Research by Kim and Lee (2022) shows that the stability of the overrun value is a crucial factor in maintaining product volume consistency in the ice cream industry.

Furthermore, operator error in air regulation in the ice cream mixture can also lead to underfill. Improper air regulation can affect the texture and volume of the mixture, resulting in less product coming out of the filling machine than expected.

Another factor that influences underfill is the variation in cup sizes used in the production process. If the cup size used is larger than the specified standard, the volume of product filled will appear insufficient, leading to underfill. This variation in packaging dimensions demonstrates the importance of quality control of the packaging materials used in the production process.

Based on the overall results of the Fishbone diagram analysis, it can be concluded that defects in cup and lid packaging of cup ice cream products are influenced by a combination of various factors originating from the aspects of machines, work methods, humans, and materials. However, when associated with the results of the previous analysis through the Pareto diagram, the most dominant factor in causing product defects is problems in the filling process, especially those related to the inaccuracy of the product filling position. The results of this study indicate that improvements in production quality need to be focused on optimizing the filling system, including improving synchronization between the filler machine and the conveyor system, improving the method of placing cups on the production tray, increasing operator competence, and controlling the quality of packaging materials used in the production process.

Ranking Problem Priority

Based on the results of the Pareto diagram analysis of cup and lid packaging defect data in the cup ice cream production process during the observation period, information was obtained regarding the contribution of each type of defect to the total number of rejects that occurred. Pareto analysis is used to identify the types of defects that contribute most to quality problems so that the company can determine improvement priorities more effectively and efficiently. The Pareto principle states that most quality problems are usually caused by a small number of dominant factors that contribute the most to the total number of product defects (Montgomery, 2020).

Table 3. Problem priority

Reject Type	Amount	Percentage	Priority
Uncentered fill	357,326	76.50%	Top priority
Overfill	53,672	11.49%	Second priority
Underfill	52,481	11.23%	Third priority
***Coding*Bad**	3,602	0.78%	Low priority

Source: Primary Data (processed), 2026

The data processing results show that the uncentered fill defect type has a total of 357,326 units or approximately 76.50% of the total reject products that occurred during the production period. This percentage indicates that more than three-quarters of quality problems in the cup ice cream production process are

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caused by inaccurate product filling positioning during the filling stage. With such a dominant contribution, the uncentered fill defect can be categorized as a top priority in efforts to improve the quality of the production process.

Meanwhile, overfill defects accounted for 53,672 units, or approximately 11.49% of total product defects, making them the second priority for quality improvement. These defects relate to product volume exceeding packaging capacity, potentially leading to packaging closure failures and wasteful production materials.

Underfill defects accounted for 52,481 cases, or approximately 11.23% of total product defects, making them the third priority for quality improvement. This defect involves product volume falling below established standards, resulting in the product not meeting the required net weight specifications.

Meanwhile, poor coding defects had the lowest frequency, with 3,602 occurrences, or approximately 0.78% of total product defects. This relatively small percentage indicates that the production code printing process on packaging is running relatively well and does not significantly contribute to the overall product reject rate. Therefore, this type of defect can be categorized as a low priority in production quality improvement efforts.

The dominance of uncentered fill defects in Pareto analysis indicates that the filling process is one of the production stages with the highest level of variation and has the potential to be a major source of product defects. From a quality management perspective, process stages that contribute the most to product failure should be the primary focus of production process improvement activities (Heizer, Render, & Munson, 2020). By focusing improvements on the root cause, companies can achieve more significant quality improvements than by improving all factors simultaneously.

Thus, the results of the Pareto analysis show that efforts to improve the quality of cup ice cream production should be focused on controlling and optimizing the filling process, especially in maintaining the accuracy of the filling position and the stability of the volume of the product put into the packaging.

Recommendations for Production Process Improvement

Based on the results of the previous fishbone diagram analysis, various factors contributing to product defects can be identified, including those related to machines, work methods, people, and materials. To address these issues, a series of corrective actions are required to improve production process stability and reduce the level of defects in cup and lid packaging for cup ice cream products.

Table 4. Recommendations for Production Process Improvements

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Factor	Problems	Recommendation
Machine	Filler machine is not synchronized	Regular machine calibration and maintenance
Machine	*Freezer breakdown*	*Preventive maintenance*
Method	Manual cup placement	Standardization of SOP for filling process
Man	Operator error	Operator training
Material	Cup diameter is inconsistent	Increased raw material inspection

Source: Primary Data (processed), 2026

Based on Table 4, one of the main problems identified in the machine aspect is the lack of synchronization between the filler machine and the tray conveyor that carries the cup packaging to the filling point. This lack of synchronization can cause the product filling position to be off-centered, resulting in an uncentered fill. To address this issue, the company needs to perform regular machine calibration and scheduled maintenance to ensure the product filling system operates precisely and consistently.

Furthermore, other machine-related issues include damage or disruption to the freezer, which can cause changes in the overrun value of the ice cream mixture. Changes in the overrun value can affect the volume of product exiting the filling machine, potentially leading to overfill and underfill defects. Therefore, companies need to consistently implement preventive maintenance programs to maintain optimal production machine performance. Research by Rahman and Yusuf (2023) shows that implementing preventive maintenance in the food industry can reduce machine failures and improve product quality consistency.

In terms of work methods, the process of placing cups on production trays is still carried out manually by operators. This manual process can potentially lead to imprecise cup positioning, which can impact filling accuracy. To address this issue, companies need to standardize operating procedures (SOPs) for the filling process and ensure that each production stage is carried out according to established procedures. Standardizing work processes is a crucial step in reducing variation in the production process and improving product quality consistency (Heizer et al., 2020).

From a human perspective, operator error in machine operation and packaging handling can also impact product defect rates. Therefore, companies need to improve operator competency through regular training and skills enhancement programs.

Furthermore, regarding materials, variations in cup diameters that do not meet standards can also affect the stability of the packaging position on the conveyor tray, leading to inaccurate product filling. To address this issue,

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companies need to improve their quality inspection systems for packaging raw materials before use in the production process. Material quality control is a crucial factor in maintaining production consistency and preventing product defects due to variations in packaging dimensions (Putra et al., 2023).

Overall, the implementation of the proposed improvement recommendations is expected to improve production process stability and reduce the level of cup and lid defects in cup ice cream products. By implementing integrated improvements across machinery, work methods, people, and materials, the company can increase production efficiency while maintaining consistent product quality.

CONCLUSION

Based on the results of research and discussion regarding quality control in the production process of cup and lid packaging for cup ice cream products at PT ABC using the Seven Quality Control Tools method, several conclusions can be drawn as follows.

First, the company's quality control implementation encompasses three main stages: quality control of raw materials and packaging materials, quality control of the production process, and quality control of the finished product. This quality control aims to ensure that each stage of production follows established operational standards, ensuring that the resulting product meets the required quality standards.

Second, the analysis using statistical tools in the Seven Quality Control Tools indicates that defects in cup and lid packaging still occur during production. Based on the flowchart analysis, it was found that the filling stage is the production stage with the greatest potential for product rejection. At this stage, inconsistencies often occur during the product filling process, resulting in incorrect filling positions or product volumes that do not meet established standards.

Third, based on the results of data processing using the Check Sheet, four main types of defects were obtained that occurred during the production process, namely overfill of 53,672 pieces, underfill of 52,481 pieces, uncentered fill of 357,326 pieces, and bad coding of 3,602 pieces. The results of the histogram analysis show that the most dominant type of defect is uncentered fill, while bad coding defects have the lowest frequency compared to other types of defects.

Fourth, the Pareto diagram analysis results show that the uncentered fill defect type contributes the most to the total product rejects with a percentage of

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76.50%, followed by overfill at 11.49%, underfill at 11.24%, and bad coding at 0.77%. These results indicate that most quality problems in the production process are caused by inaccurate product filling processes into packaging. Therefore, quality improvement efforts should be focused on controlling and stabilizing the filling process.

Fifth, the results of the scatter diagram analysis show a positive relationship or correlation between the number of cups and lids used in the production process and the number of rejected products produced. This indicates that an increase in production volume tends to be followed by an increase in the number of product defects if not balanced with optimal production process control. Sixth, based on the results of the p-control chart analysis, it is known that the cup and lid packaging production process is still in a statistically uncontrolled condition. This is indicated by the presence of several observation points that are outside the upper control limit (upper control limit) and the lower control limit (lower control limit). This condition indicates that variations in the production process are not only caused by natural process variations, but are also influenced by special factors originating from machine conditions, work methods, packaging material quality, and operator error. Seventh, the results of the cause and effect diagram analysis (Fishbone diagram) show that the main causes of product defects come from several main factors, namely human factors (operators), machine factors, work method factors, and raw material and packaging material factors. These four factors interact with each other in influencing the stability of the production process so that they have the potential to cause product defects if not controlled properly.

Overall, the results of this study indicate that the application of the Seven Quality Control Tools method can help organizations identify product defect patterns, determine the root causes of quality problems, and provide a basis for more systematic decision-making in efforts to improve production processes. With the implementation of more structured and data-driven quality control, it is hoped that the level of product defects can be minimized, thereby continuously improving production process efficiency and product quality.

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