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Total Quality Control (TQC) Analysis in Identification of Damage to Coffee Production at PT XYZ

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ABSTRACT

PT XYZ is a coffee processing company with a production process involving five stages: sorting, drying, peeling, selecting, and packaging coffee beans. This study applies the Total Quality Control (TQC) approach to identify factors causing product defects. Methods include p-control charts to monitor quality variations statistically and fishbone diagrams to analyze root causes. Data were collected through interviews, observations, and company documents. The analysis revealed seven data points exceeding the upper control limit (UCL) and 11 below the lower control limit (LCL). Human errors, inadequate training, and machine-related issues were identified as the primary causes of defects. Environmental factors, such as inconsistent humidity levels, were also found to affect product quality. The findings provide actionable insights for PT XYZ to implement Kaizen-based improvements, focusing on minimizing defects, enhancing production quality, and maintaining product consistency. These measures are expected to support the company in achieving better control over quality processes and ensuring the stability of its coffee product standards.

Keywords: *Coffee, Total Quality Control, Quality Control.*

A. INTRODUCTION

Indonesia is one of the largest coffee-producing countries in the world and has a very strong coffee culture [1]. Coffee has become an important part of people's lives, both as an export commodity and a favorite daily beverage [2]. With high demand, the quality of the coffee produced is also a major concern, especially to meet the expectations of consumers at home and abroad [3]. The vast diversity of coffee variants, influenced by Indonesia's unique geography, adds value to its coffee industry. Furthermore, the traditional cultivation methods passed down through generations enrich the cultural and historical significance of Indonesian coffee. Maintaining this heritage while integrating modern quality standards is crucial for sustaining the industry's growth.

Good quality coffee can increase the competitiveness of Indonesian products in the global market, while maintaining a reputation as one of the world's best coffee producers [4]. However, the quality challenges in the coffee industry are quite complex, especially due to variations in the production process that can lead to defects in the final product. At PT XYZ, one of the coffee-producing companies in Indonesia, it was found that there were product defects that affected quality and competitiveness in the market. These defects often result in higher production costs and delayed fulfillment of customer orders. Additionally, inconsistent product quality can damage customer trust and reduce brand loyalty over time. Addressing these issues requires an integrative approach that combines advanced quality control techniques with continuous workforce training.

This obstacle requires an in-depth analysis of the cause of the defect and systematic improvement so that the resulting product can meet the desired quality standards. In this context, effective quality control is the main key to overcoming the problem of product defects in the company. To answer this challenge, the research uses a Total Quality Control (TQC) approach, which focuses on comprehensive quality control, from the process to the final product [5]. This method emphasizes not only corrective actions but also preventive measures to avoid future defects. The integration of TQC tools fosters a structured framework for identifying potential risks in the production process. By leveraging data-driven insights, companies can create actionable strategies to ensure long-term quality improvements.

A P control map will be applied to monitor defects in the product, while a fishbone diagram will be used to identify the factors causing defects [6]. Through the application of this TQC method, it is hoped that systematic improvement measures can be found to reduce the level of product defects at PT XYZ. The research also aims to identify the interrelation between different factors such as machine efficiency, operator skill levels, and raw material quality. Combining statistical tools with root cause analysis ensures a holistic view of the production challenges. Ultimately, these findings will serve as a foundation for developing an optimized production workflow that aligns with quality standards and market demands.

Previous research conducted by Nugraha et al., (2023) on the Sariwangi tea beverage industry shows that the application of TQC can reduce the defect rate by up to 15% by monitoring critical control points in the production process. This study aims to identify and analyze the causes of coffee product defects at PT XYZ and formulate improvement proposals to improve the quality of the products produced. It is hoped that the results of this research can provide practical benefits for companies and theoretical contributions to research in the field of quality control in the food and beverage industry. In addition, implementing TQC at PT XYZ can serve as a benchmark for other companies in similar industries. Future studies could explore the adaptation of these methods to different types of products and operational scales. This research also underlines the importance of collaboration between academia and industry to address real-world production challenges.

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B. LITERATURE

Risk management is a systematic process for identifying, measuring, and controlling risks within a project or company to ensure the achievement of organizational goals [8]. This process is essential for mitigating uncertainties that can impact operations, finances, or project timelines. In construction companies, risk management is typically implemented through proactive measures such as prevention and risk reduction strategies. These include identifying potential risks early, transferring risks through insurance or contracts, and establishing contingency plans. Furthermore, improvement measures such as enhancing response mechanisms when risks occur can reduce the impact of unforeseen events. By integrating risk management into decision-making processes, companies can ensure resilience and sustainability while achieving their objectives efficiently. Therefore, risk management serves as a foundation for maintaining stability and operational success in dynamic business environments.

Quality is a critical element of a company's performance, emphasizing the need to meet or exceed customer expectations [10]. It encompasses various dimensions, including performance, durability, aesthetics, and reliability, all of which contribute to overall customer satisfaction. Achieving high-quality standards requires a structured approach, including quality control measures. Quality control is the process of ensuring that products or services adhere to predetermined standards, minimizing errors, reducing inspection costs, and maintaining consistent quality [12]. It involves regular monitoring and assessment of production processes, allowing companies to identify and address defects before products reach customers. As with risk management, a proactive approach to quality control strengthens a company's ability to meet market demands while sustaining long-term business success.

Total Quality Control (TQC) is an integrated quality management approach involving all employees in monitoring and improving quality using statistical tools and methods [13]. TQC fosters a culture of continuous improvement by engaging employees across all organizational levels, from frontline workers to top management. For employees, TQC enhances skills through training and encourages better communication, fostering a collaborative work environment. For companies, it boosts competitiveness by delivering consistent, high-quality products and reducing production costs associated with defects or inefficiencies. For consumers, TQC ensures access to products that meet strict health and safety standards, aligning with market demands for reliability and quality assurance [14]. By implementing TQC alongside strong risk management practices, organizations can create a structured and sustainable approach to operational excellence.

Quality control is influenced by multiple factors, each playing a vital role in ensuring the production of high-quality products [15]. Key factors include human resources, machinery, materials, and methods. Employee skill levels and adherence to standard operating procedures directly impact the quality of outputs. Similarly, the condition and efficiency of machinery can affect production consistency and minimize downtime. The quality of raw materials also plays a critical role, as poor input quality often leads to defects in the final product. Lastly, production methods, including process design and quality monitoring techniques, significantly influence the ability to meet established standards. Addressing these factors comprehensively through Total Quality Control (TQC) ensures that quality management becomes an integral part of organizational operations, contributing to better customer satisfaction and market competitiveness [16]. Ultimately, the integration of risk management and quality control allows businesses to mitigate challenges, optimize processes, and sustain long-term growth. .

C. RESEARCH METHOD

This research was conducted at PT XYZ in January 2022 using a quantitative approach. Secondary data from the company, such as production volume and defective product counts, were analyzed. The independent variables include raw materials, machines, and methods that influence product quality, while the dependent variable is the quality of coffee production. Data collection methods comprised interviews, direct observations, and document analysis, ensuring a comprehensive understanding of the production process and associated issues.

Data processing employed a Total Quality Control (TQC) approach, beginning with collecting production and defect data using a check sheet. A P-chart was constructed to statistically analyze the proportion of defects, including calculations for the percentage of damage, center line (CL), upper control limit (UCL), and lower control limit (LCL). The fishbone diagram method was used to identify the main factors causing defects through categorization, brainstorming, and evaluation. Recommendations for quality improvement were developed using the Kaizen 5W+1H method, aimed at reducing defects and enhancing production quality. The problem-solving steps included field studies, formulation of problems and objectives, identification of operational variables, data collection, analysis, and concluding findings with actionable recommendations for future improvements..

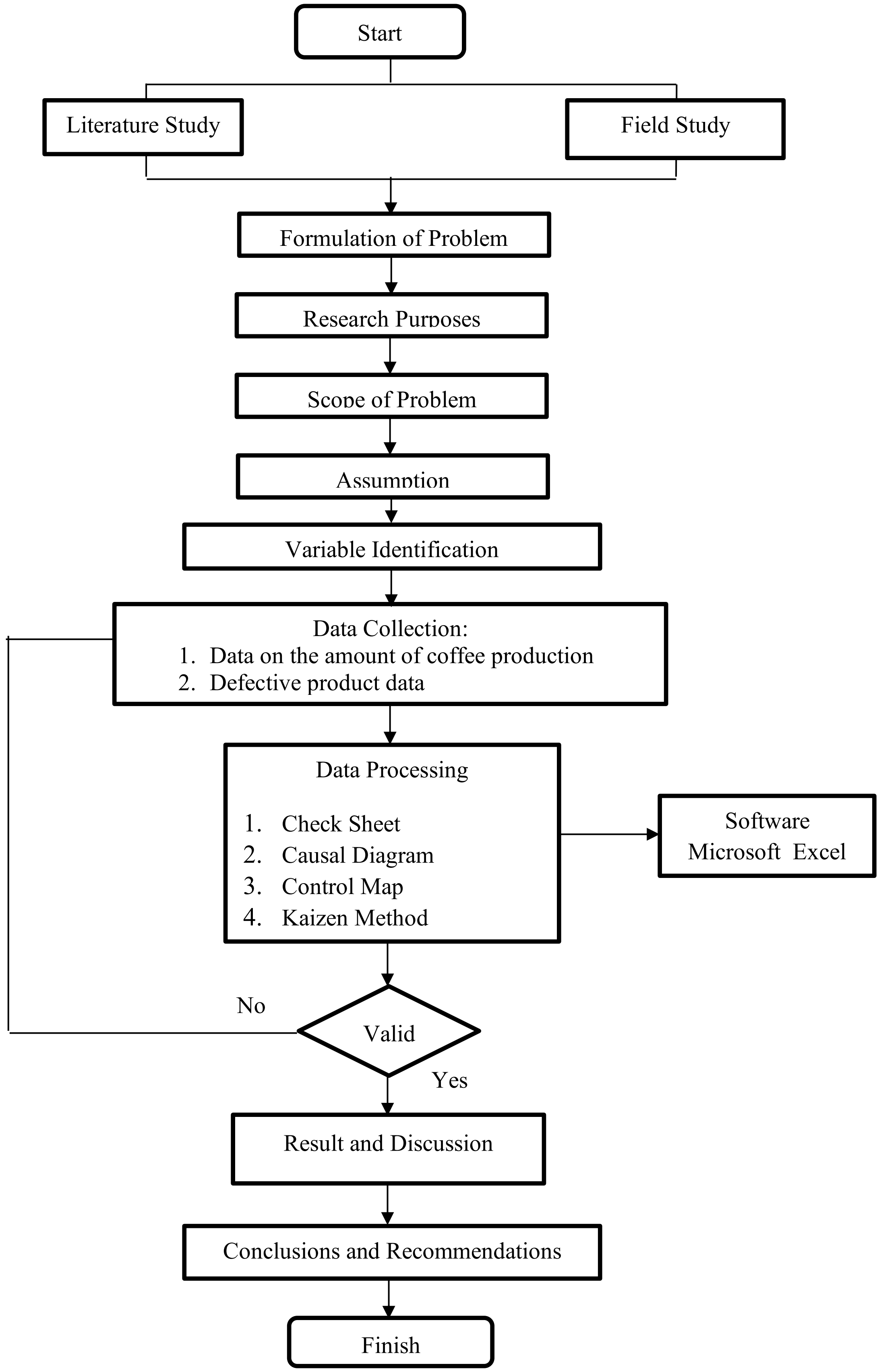

Figure 1. Flowchart
Source : Data Processing

D. RESULT AND DISCUSSION

D.1. Data Collection

TABLE 1
DATA ON NUMBER OF DEFECTS AND NUMBER OF COFFEE PRODUCTS

Day to	Sample	Damaged Packaging	Coffee Color	Coffee Flavor	Burnt Coffee Beans	Defects	Percentage
1	30	2	2	1	1	6	20%
2	28	2	1	2	0	5	18%
3	27	2	1	0	1	4	15%
4	30	2	1	2	0	5	17%
5	30	3	1	0	1	5	17%
6	30	2	2	1	1	6	20%
7	28	2	1	1	1	5	18%
8	29	3	1	1	0	5	17%
9	26	2	1	0	1	4	15%
10	27	0	1	1	0	2	7%
11	27	1	2	2	1	6	22%
12	30	2	0	0	0	2	7%
13	28	3	1	0	2	6	21%
14	30	3	1	2	0	6	20%
15	27	1	0	1	0	2	7%
16	26	0	1	2	1	4	15%
17	30	2	1	0	0	3	10%
18	27	1	0	1	0	2	7%
19	28	2	1	0	0	3	11%
20	28	2	1	0	0	3	11%
21	29	1	1	0	1	3	10%
22	30	2	1	1	0	4	13%
23	27	0	1	1	0	2	7%
24	26	1	0	0	1	2	8%
25	27	1	1	0	0	2	7%
26	28	2	1	0	2	5	18%
27	27	1	2	1	1	5	19%
28	29	3	1	1	2	7	24%
29	28	2	2	2	0	6	21%
30	28	1	2	1	1	5	18%
Total	845	51	32	24	18	125	15%
Aver age	28.1667	1.88889	1.23077	1.33333	1.2	8.0645 2	29%

Source : Data Processing

Table 1 presents data on the number of defects in coffee production over a 30-day period, including sample sizes for each day and recorded defects categorized into damaged packaging, coffee color issues, coffee flavor inconsistencies, and burnt coffee beans, along with the total defects per day and the corresponding percentage relative to sample size. The data show fluctuations in the occurrence of defects, with the daily total defects ranging from as low as 2 to as high as 7, and the percentage values varying between 7% and 29%, highlighting inconsistencies in production quality. The total number of samples during the period was 845, with an average daily sample size of approximately 28.17, while the total number of recorded defects was 125, leading to an average defect rate of 15%. A breakdown of defect types shows that damaged packaging was the most frequent problem, followed by coffee color and flavor inconsistencies, while burnt coffee beans occurred less frequently. These observations emphasize the need for quality control measures to reduce defects and ensure consistent coffee product standards.

D.2. Analysis Using P Control Map

Quality analysis at PT XYZ was conducted with a p control map to monitor coffee production defects during January 2022, with a defect tolerance of 20% per day. The defect percentage (p) is calculated daily, while the center line (CL) is taken from the average daily defect percentage.

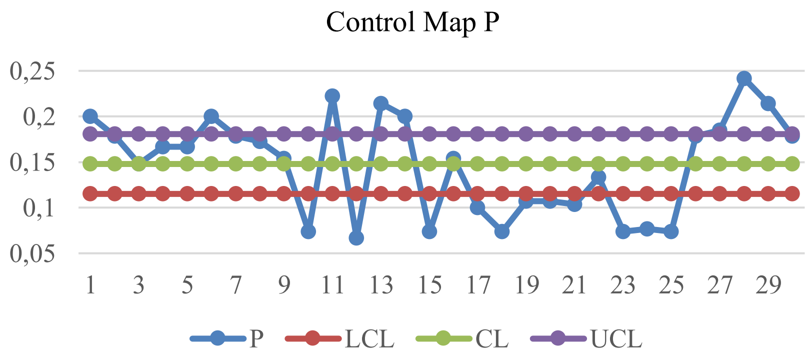

Figure 2. Control Map P
Source : Data Processing

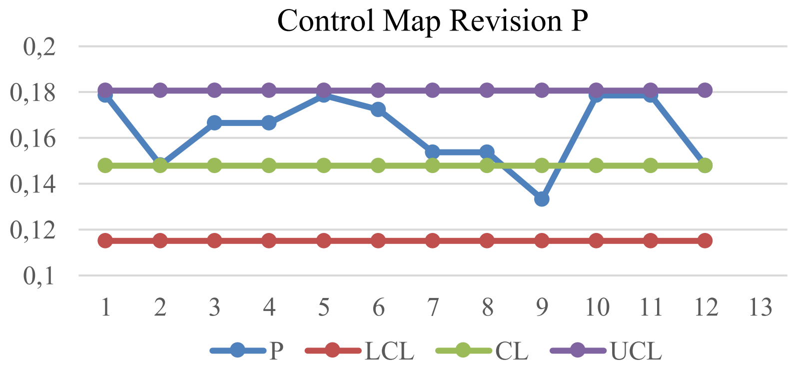

Figure 3. Control Map Revision P
Source : Data Processing

Based on the results of data processing on the p-control diagram in Figure 2, it can be seen that the quality discrepancies of PT XYZ's production results during January 2022 are mostly within the statistical tolerance limits. However, there are 7 data points that cross the upper limit (UCL) and 11 data points that cross the lower limit (LCL), indicating a significant variation in quality. This indicates the need for further improvement to achieve the quality standards set by the company. A revision map, as shown in Figure 3, was also created to address these 7 data points by utilizing a fishbone diagram analysis, allowing the identification of root causes and the formulation of targeted corrective actions to improve quality consistency.

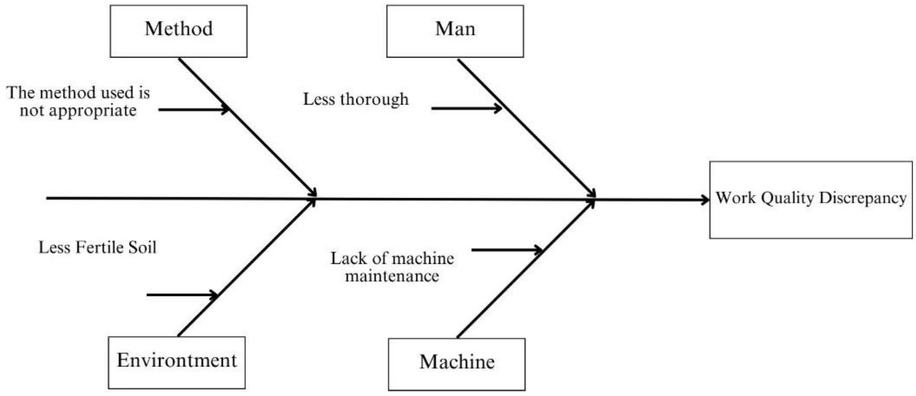

Figure 4. Fisbone Diagram Analysis
Source : Data Processing

After reprocessing the data as shown in Figure 4 using fishbone diagram analysis, the statistical limits were updated, and no more data was found that crossed the specified threshold. This shows that with proper analysis and improvement, the production quality can be stabilized to the expected standard.

D.3. Analysis Using Cause and Effect

Cause-and-effect diagrams are used to identify the relationship between quality problems and factors that may be the cause of nonconformities in coffee products at PT XYZ.

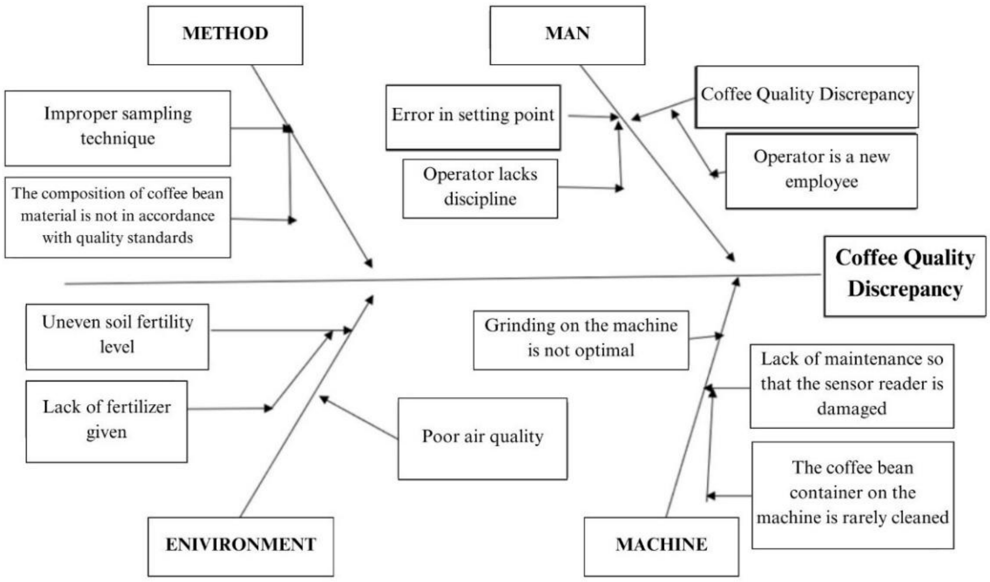

Figure 5. Cause and Effect Diagram
Source : Data Processing

Based on the analysis of Figure 5, there are several main factors, namely people, methods, machines, and environment. Human factors include setting errors due to rushing, lack of instruction mastery, low discipline, and the presence of new employees. Method factors relate to sampling techniques that are not up to standard. Machine factors include sensor inaccuracies, lack of maintenance, and machine cleanliness. Finally, environmental factors involve air quality, soil fertility, and inadequate fertilization of coffee plants.

D.4. Analysis Using the Kaizen Method

After knowing the factors that cause non-conformity in the quality of portland cement production that occurs at PT XYZ, the next step is to propose general corrective actions using 5W+1H (What, why, Where, When, Who, How). The following are the results of the quality improvement planning made based on the identification results using the Kaizen 5W+1H method.

TABLE 2
PROPOSED ACTIONS FOR FACTORS CAUSING NONCONFORMITY IN PRODUCTION QUALITY

No	Factor	Dominant Causes	Countermeasures					
			What	Why	Where	When	Who	How
1	Man	Error in setting point	Conduct periodic training make a record of the type of error	Reduce the occurrence of errors	PCMD Section	Productio n Stoppage	Head of controlli ng and monitori ng section	Supervise operator performance and create operator worksheets
		Lack of Discipline	Supervise and improve operator discipline.	So that operators are more careful and disciplined at work	PCMD Section	When the productio n process is in progress	Head of productio n	Make clear work instructions and check operator performance
2	Machin e	Grinding on the machine is not optimal	Checking the grinding machine and addressing the causes	So that coffee beans can be ground perfectly	Product ion section	After the productio n process is complete	Staff helper	Replace the blades and clean the blades regularly
		Damaged Reader Sensor	Damage to the coffee bean grinder sensor reader causes ignorance when the grinding process is complete	In order to know when the grinding process is complete	Product ion Section	After the productio n process is complete	Staff helper	Repair the read sensor
3	Method	Improper sampling technique	Sampling obtained and taken does not meet the needs of the method to be used	Sampling taken less at least requires 2 months of sampling to compare	PCMD Section	During the coffee bean harvesting process	Head of Producti on	Change the method used to get good analysis and maximum results
4	Enviro nment	Uneven soil fertility levels	The uneven level of soil fertility causes some coffee beans to not grow properly	To check the level of soil fertility and divide it into several soils that are and are not fertile so that it is easy to provide nutrients for the soil	PCMD Section	When you want to plant coffee	Staff Helper	Checking the level of soil fertility in each area before planting coffee seedlings

Table 2 outlines the proposed preventive actions for the causal factors of nonconformity in production quality, categorized into four factors: Man, Machine, Method, and Environment. The table details the dominant causes such as operator error, machine inefficiency, improper sampling, and uneven soil fertility, along with the appropriate corrective actions, responsible personnel, time, and method of application to improve production quality.

D.5. Interpretation of Results

PT XYZ, as a coffee manufacturer, is responsible for maintaining consistent and on-target product quality every day. To ensure this, PT XYZ implements a quality control program at every stage of the production process, from receiving raw materials to finished products. Every year, the company sets quality objectives and SOPs as guidelines so that the risk of product damage can be minimized. Based on analysis using the P control map, the average product non-conformity (CL) is 0.1479, the upper control limit (UCL) is 0.18066, and the lower control limit (LCL) is 0.1151. The data shows that there are 7 points that cross the upper limit and 11 points that cross the lower limit, indicating that the company's quality control has not fully met the set standards.

Further analysis using cause-and-effect diagrams identified factors affecting quality, such as human factors (e.g. lack of operator discipline), inappropriate sampling methods, machine problems (lack of maintenance and cleanliness), and environmental factors (such as uneven soil quality). Improvement efforts through Kaizen methods were suggested, including increased operator supervision, regular machine maintenance, and soil nutrient management. Overall, there is still data showing product non-conformity at PT XYZ, which if left unchecked could negatively impact the company. Therefore, statistical-based quality control as applied in Total Quality Control (TQC) is important to control the number of nonconformities, identify root causes, and maintain production quality.

E. CONCLUSION

Based on the results of observations and analysis carried out, it can be concluded that the quality control system at PT XYZ on coffee products during January 2022 is still within statistical tolerance limits, although there are several points that cross the upper control limit (UCL) and lower control limit (LCL). This indicates that product quality still needs improvement to maintain quality consistency. The main causes of quality discrepancies were found through cause-and-effect diagrams, with human and machine factors as the dominant factors in the emergence of defective products, such as mismanagement by operators or poorly maintained machine conditions.

In addition, the current quality control system is very simple, involving manual inspections for packaging, color, taste, and condition of the coffee beans. In an effort to improve, recommended measures include increased operator supervision and training, regular machine cleaning and maintenance, and the development of clearer work instructions so that product non-conformance can be minimized on an ongoing basis.

As a suggestion, PT XYZ is advised to update the quality control system with a more comprehensive Total Quality Control approach. The company also needs to form a special team to oversee the production process and quality inspection, as well as increase employee awareness about the importance of quality through training and socialization programs..

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