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Implementation of Seven Quality Tools for Improving Bottled Drinking Water Product Quality

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Abstract
The bottled drinking water industry requires consistent product quality to maintain customer satisfaction, production efficiency, and consumer safety. However, production defects such as leaking bottles, loose caps, tilted labels, damaged packaging, and inconsistent filling volumes frequently occur and can negatively affect company performance. Therefore, effective quality control methods are needed to identify dominant defects and determine appropriate corrective actions. This study aimed to implement Seven Quality Tools to analyze product quality problems and propose improvement strategies in bottled drinking water production. This research used a quantitative descriptive approach. Data were collected through direct observation, interviews, and defect recording during 15 production days. The analysis was conducted using Seven Quality Tools, including check sheets, histograms, Pareto charts, scatter diagrams, control charts, fishbone diagrams, and flowcharts. These tools were used to identify dominant defects, analyze root causes, and evaluate process stability. The results showed that tilted labels and leaking bottles were the most dominant defects, contributing more than half of the total defect occurrences. The control chart analysis indicated that the production process was statistically under control, although fluctuations in defects were still observed during high production periods. The fishbone diagram revealed that defects were influenced by human, method, environment, material, machine, and policy factors. Improvement efforts such as routine operator training, regular machine maintenance, stricter implementation of standard operating procedures, and continuous quality improvement programs are recommended to reduce defect rates and improve product quality consistency.

Keywords: Seven Quality Tools; quality control; bottled drinking water; product defects; continuous improvement; manufacturing quality

1 Introduction

The bottled drinking water industry has experienced rapid growth due to increasing public awareness of the importance of clean and safe drinking water [1, 2]. Consumers not only expect products that are hygienic and safe for consumption, but also demand consistent quality in packaging, volume accuracy, labeling, and product appearance. In a highly competitive market, product defects such as leaking bottles, loose caps, tilted labels, damaged packaging, and inconsistent filling volumes can reduce customer satisfaction and negatively affect company reputation [3]. Therefore, maintaining and improving product quality has become a critical factor for bottled drinking water manufacturers to sustain customer trust and competitiveness [4].

Quality control is an essential activity in the manufacturing process because it helps companies identify, analyze, and reduce defects systematically [5]. One of the widely used approaches in manufacturing industries is the implementation of Seven Quality Tools [6]. These tools consist of check sheets, histograms, Pareto charts, fishbone diagrams, scatter diagrams, control charts, and flowcharts. The Seven Quality Tools provide a simple yet effective method for collecting data, identifying dominant problems, analyzing root causes, monitoring process stability, and supporting decision-making for continuous improvement [7]. Their practical nature makes them suitable for use in bottled drinking water production processes.

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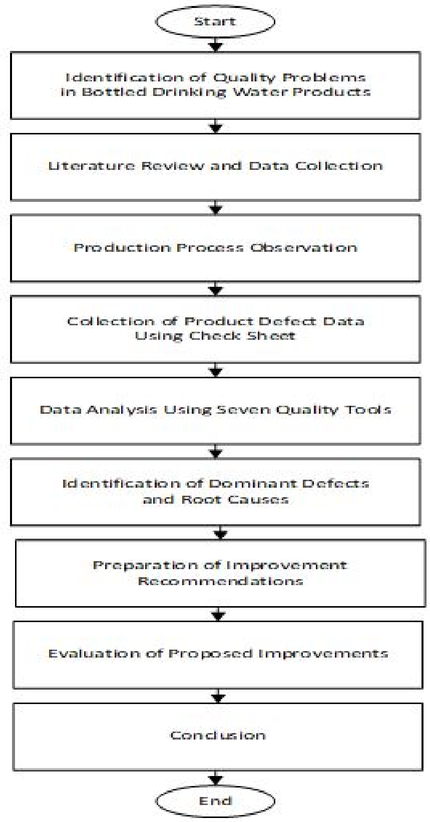

Figure 1. Flowchart Research

Several previous studies have shown that the implementation of Seven Quality Tools can improve production quality and reduce defect rates in manufacturing industries [3, 8]. However, many companies still experience difficulties in identifying the dominant causes of defects and determining appropriate corrective actions, especially in the bottled drinking water sector where product quality is closely related to consumer safety and packaging reliability. In addition, inconsistent production processes and inadequate monitoring systems often contribute to recurring defects and inefficiencies in production activities.

Based on these conditions, this study aims to implement Seven Quality Tools to analyze and improve the quality of bottled drinking water products. The study focuses on identifying the dominant types of defects, determining the root causes of quality problems, and proposing improvement strategies to reduce product defects and enhance production performance. The results of this research are expected to provide practical contributions for companies in improving product quality control systems and supporting continuous quality improvement in the bottled drinking water industry.

2 Material and Methods

2.1 Research Design

This study used a quantitative descriptive approach to analyze product quality problems in bottled drinking water. The research focused on identifying the dominant product defects, analyzing the root causes of quality problems, and proposing improvement recommendations using the Seven Quality Tools approach. Flowchart research can be shown in Figure 1.

2.2 Research Object

The object of this study was the production process of bottled drinking water products, particularly several common defects that frequently occur during production, including leaking bottles, loose bottle caps, tilted labels, dented packaging, and inappropriate filling volumes. These defects were selected because they significantly affect product quality, production efficiency, and customer satisfaction.

2.3 Data Collection

The data used in this research consisted of primary and secondary data. Primary data were obtained through direct observation of the production process, interviews with production and quality control personnel, and recording defect occurrences during production activities. Secondary data were collected from company production reports, quality inspection documents, and previous studies related to quality control and manufacturing improvement. The observation period was carried out over several production days to ensure sufficient and representative defect data.

2.4 Research Instrument

The main instrument used in this research was a defect data recording sheet based on the check sheet method. The collected data were then analyzed using Seven Quality Tools.

2.5 Data Analysis Method

The data analysis in this study was conducted using Seven Quality Tools, consisting of:

1. Check Sheet

   The check sheet was used to collect and record the frequency of defects occurring during the production process systematically [7].

2. Histogram

   Histograms were used to display the distribution and frequency of product defects visually [9].

3. Pareto Chart

   The Pareto chart was applied to identify the dominant defects based on the 80/20 principle, where a small number of defect types contribute to the majority of quality problems [10].

4. Cause-and-Effect Diagram

   The cause-and-effect diagram, also known as the fishbone diagram, was used to analyze the root causes of defects based on factors such as: man, machine, method, material, environment, and measurement [11].

5. Scatter Diagram

   Scatter diagrams were used to identify the relationship between production factors and defect occurrence [12].

6. Control Chart

   Control charts were utilized to evaluate whether the production process was statistically under control and to monitor process stability [13].

7. Flowchart

   Flowcharts were used to describe the overall bottled drinking water production process and identify stages with potential quality problems [14].

3 Results and Discussion

3.1 Result

Based on the production defect data collected over 15 observation days, several types of defects were identified in the bottled drinking water production process, including leaking bottles, loose

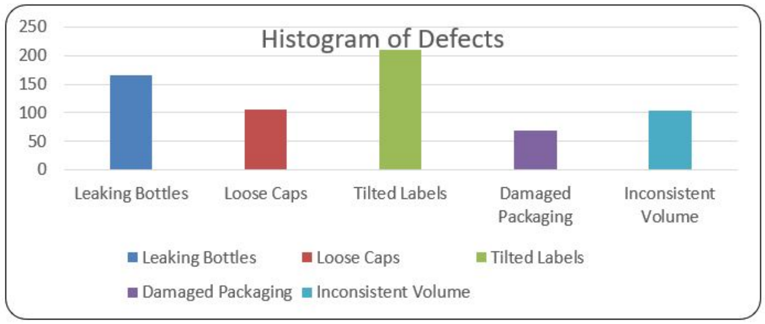

Figure 2. Histogram

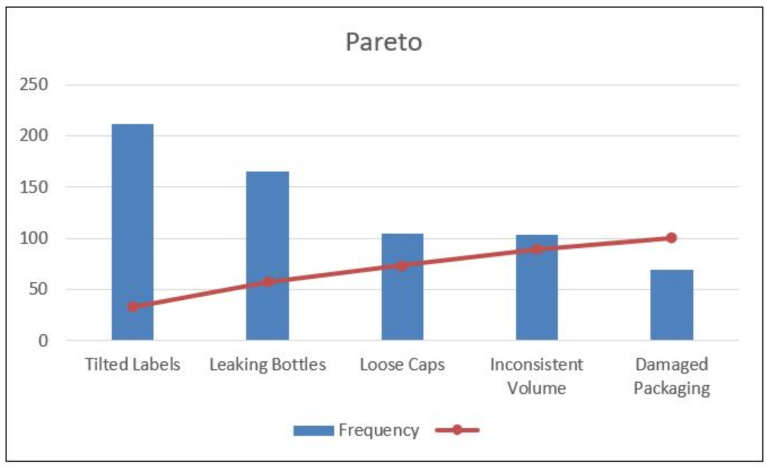

Figure 3. Pareto Chart

caps, tilted labels, damaged packaging, and inconsistent filling volume. The analysis was conducted using Seven Quality Tools to determine the dominant defects and identify their root causes.

3.1.1 Check Sheet Analysis

The check sheet results showed that the total number of defects recorded during the observation period was 653 defects. The defect with the highest frequency was tilted labels with 211 cases, followed by leaking bottles with 165 cases, loose caps with 105 cases, inconsistent filling volume with 103 cases, and damaged packaging with 69 cases. These results indicate that the labeling and packaging processes were the major contributors to product quality problems.

3.1.2 Histogram Analysis

The histogram analysis in Figure 2 illustrated the distribution of defect frequencies for each defect category [15]. Tilted labels had the highest occurrence among all defects, while damaged packaging had the lowest frequency. The significant difference between tilted labels and other defects indicates that the labeling process requires more attention and stricter quality control. Meanwhile, leaking bottles also showed a relatively high number of occurrences, indicating possible issues in the sealing or packaging process.

3.1.3 Pareto Chart Analysis

The Pareto chart analysis in Figure 3 revealed that tilted labels contributed 32.31% of total defects, while leaking bottles contributed 25.27%. Combined, these two defects accounted for 57.58% of all defects occurring during production. Loose caps contributed 16.08%, inconsistent filling volume contributed 15.77%, and damaged packaging contributed 10.57%. Based on the Pareto principle, improvement efforts should focus primarily on reducing tilted labels and leaking bottles because these defects represented the majority of quality problems.

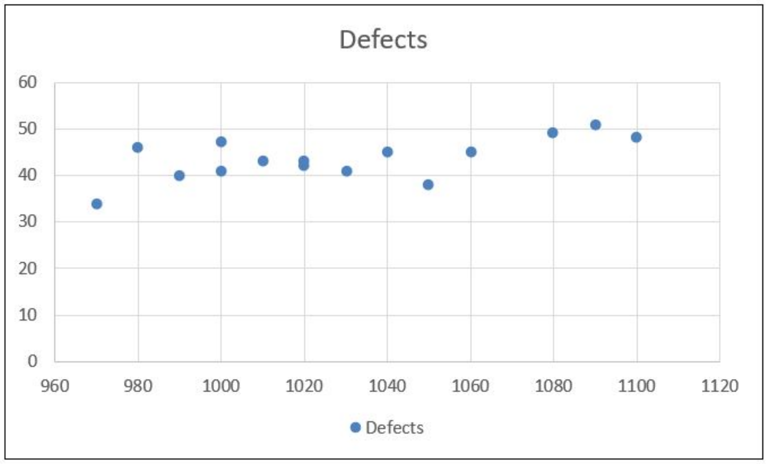

Figure 4. Scatter Diagram

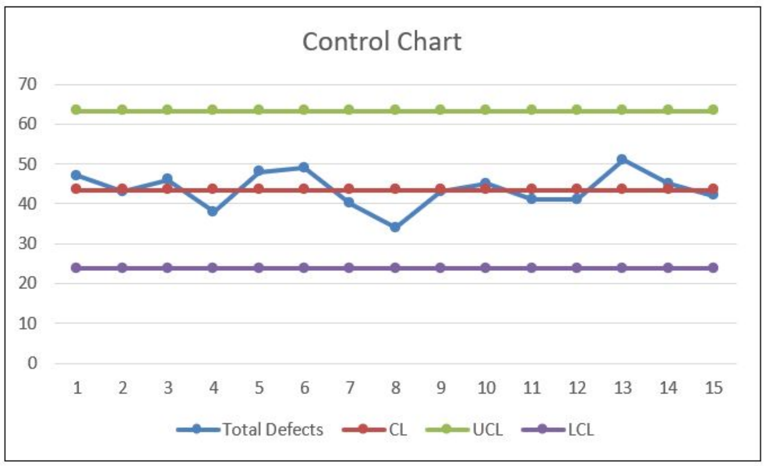

Figure 5. Control Chart

3.1.4 Scatter Diagram Analysis

The scatter diagram analysis in Figure 4 showed a relationship between production volume and total defects [16]. When production volume increased from 970 units to 1100 units, the number of defects also tended to increase from 34 defects to 49 defects. This relationship indicates that higher production activity may reduce process stability and increase the likelihood of defects occurring. Therefore, monitoring production performance during high-volume production periods is important to maintain product quality consistency.

3.1.5 Control Chart Analysis

The control chart analysis in Figure 5 showed that the average number of defects was 43.53 defects per day, with an Upper Control Limit (UCL) of 63.33 and a Lower Control Limit (LCL) of 23.74. All observed defect data remained within the control limits, indicating that the production process was statistically under control. However, fluctuations still occurred during several production days, especially on days with higher production volumes. Although the process was stable, continuous improvement is still necessary to reduce defect variation and improve production efficiency.

3.1.6 Fishbone Diagram Analysis

The fishbone diagram in Figure 6 identified several possible root causes of defects based on six main factors, namely human, method, environment, material, machine, and policy. Human factors included lack of operator attention, insufficient training, and operator fatigue. Method factors involved inconsistent implementation of standard operating procedures and poor inspection

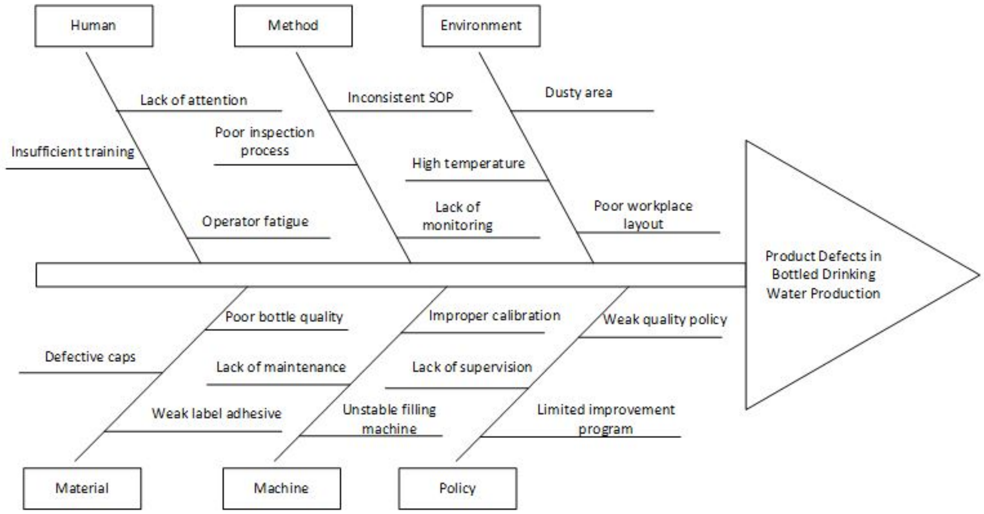

Figure 6. Fishbone Diagram

methods. Environmental factors included dusty production areas and poor workplace conditions. Material factors were related to poor bottle quality and defective caps. Machine factors included improper calibration and insufficient maintenance, while policy factors involved weak supervision and limited quality improvement programs.

3.2 Discussion

The implementation of Seven Quality Tools successfully identified the dominant defects and the root causes of quality problems in bottled drinking water production. The results indicated that tilted labels and leaking bottles were the most critical defects because they contributed more than half of the total defect occurrence. These problems were mainly associated with machine settings, operator performance, and inconsistent production procedures.

The control chart results showed that the production process was still statistically controlled because all defect values remained within the control limits. However, the relatively high number of defects indicated that process improvements were still required. The scatter diagram also confirmed that increased production volume could lead to higher defect rates, suggesting the need for stricter monitoring during peak production periods.

Based on the analysis results, several improvement actions are recommended, including routine operator training, regular machine calibration, stricter implementation of standard operating procedures, improved inspection processes, and better supervision during production activities. In addition, improving packaging material quality and implementing continuous quality improvement programs are important to reduce defect occurrence and improve overall product quality.

4 Conclusion

The implementation of Seven Quality Tools in bottled drinking water production was effective in identifying dominant defects and analyzing the root causes of product quality problems. Based on the analysis results, the most dominant defects were tilted labels and leaking bottles, which contributed more than half of the total defects during the observation period. The analysis using check sheets, histograms, Pareto charts, scatter diagrams, control charts, fishbone diagrams, and flowcharts provided a systematic approach for evaluating production quality and process performance. The control chart analysis indicated that the production process was statistically under control, although fluctuations in defect occurrence were still found during several production periods. In addition, the scatter diagram showed that increasing production volume tended to increase the number of defects, indicating the need for stricter supervision during high production activities.The root causes of defects were influenced by several factors, including human, method, environment, material, machine, and policy factors. Therefore, improvement efforts such as routine operator training, regular machine maintenance, stricter implementation of standard operating procedures, improved quality supervision, and continuous improvement programs are necessary to reduce defects and improve product quality consistency. Through the implementation of these improvements, bottled drinking water companies are expected to enhance production efficiency, minimize defect rates, and increase customer satisfaction.

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