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Analysis of Dyeing Process Quality at PT XYZ

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Abstract

This study investigates the root causes of the "inconsistent color" defect in the dyeing process at PT XYZ and evaluates the effectiveness of corrective actions undertaken to address the issue. Pareto analysis revealed that inconsistent color accounted for over 50% of total production defects, indicating it as a critical quality concern. Root cause analysis using the Fishbone diagram and 5 Why method identified human and method-related factors as primary contributors, particularly inaccurate dye mixing due to uncalibrated measurement tools and the absence of standard operating procedures (SOPs). To address these issues, corrective actions were implemented using the Plan-Do-Check-Act (PDCA) cycle, including the development of SOPs, the introduction of quality control checklists, and targeted operator training. Following implementation, the defect rate decreased by 22.6% over a six-month period, demonstrating the effectiveness of structured quality improvement methods. While the study confirms the value of systematic interventions in enhancing product consistency, it is limited by its focus on a single defect type and a short observation period. Future research should investigate a broader range of defects and consider the integration of advanced quality management frameworks such as Six Sigma or Total Quality Management (TQM). The findings underscore the critical role of continuous process control, regular calibration, and workforce competence in achieving and sustaining high-quality standards in textile manufacturing.

Keywords: Dyeing Process; Inconsistent Color Defect; Fishbone Analysis; 5 Why; PDCA; Quality Improvement

INTRODUCTION

Quality refers to the overall characteristics and appearance of a product or service that aim to meet customer needs and ensure satisfaction. According to Heizer and Render (2020), quality can be defined from three main perspectives. First, from the customer's point of view, high quality is associated with superior performance, better features, and continuous improvement that adds value. Second, from the manufacturing perspective, quality means conforming to standards and doing things right the first time. Third, from the product perspective, quality is considered a measurable and objective variable. These definitions emphasize that quality encompasses not only the final outcome but also the process and the perceived value by the user (Kurniawan et al., 2024).

The textile and garment industry has become one of the strategic sectors in supporting national economic growth. The increasingly dynamic fashion trends, especially among the middle-income population, have driven demand for products with unique designs, high quality, and strong brand identity (Simanjuntak et al., 2024). A consumerist lifestyle that treats clothing as a tertiary need has shifted market orientation from merely fulfilling functional needs to expressing identity and lifestyle (Rusandi & Sulistiyowati, 2019).

In response to these conditions, the national textile industry has shown positive performance. In the first quarter of 2024, this sector contributed 19.28% to the non-oil and gas processing industry's GDP, an increase from 18.57% in the same period of 2023 (Indonesia.go.id, 2024). This growth is also reflected in the rising investment value, which increased from IDR 24.6 trillion in 2022 to IDR 27.9 trillion in 2023 (Alamin et al., 2023).

However, amid this growth, challenges related to product quality remain a major obstacle, particularly for small and medium-sized enterprises. One example is PT XYZ, located in Baros, Cimahi City. The company operates in fabric dyeing services for partner clients but frequently experiences color discrepancies between the final product and customer specifications. Based on data from January to November 2024, the defect rate ranged from 7.14% to 25%, with the primary cause being failures in the dyeing process (Fithri et al., 2023).

This issue not only leads to increased rework activities but also reduces production efficiency, raises operational costs, and lowers customer satisfaction (Andriani, 2023). In a competitive industry, product quality is a key factor in maintaining customer loyalty and strengthening market position. Therefore, companies need to adopt a structured approach to managing production risks and ensuring the quality of the final output (Putri et al., 2022).

Previous studies have discussed the application of FMEA in identifying process failure risks in the textile industry. However, most of these studies are limited to the identification and risk analysis stages, without being followed by the implementation of systematic and sustainable improvement strategies (Hanum, 2022). The novelty of this research lies in the integration of the FMEA method with the PDCA cycle not only identifying potential failures but also directly designing and implementing structured corrective actions. Thus, this study not only provides a diagnosis of quality issues but also offers practical and applicable solutions for continuously improving process quality in small to medium-scale textile industry settings.

One approach that can be utilized is Failure Mode and Effect Analysis (FMEA), a systematic method for identifying, analyzing, and prioritizing potential failures in the production process based on severity, occurrence frequency, and detection capability (Pascu et al., 2020). Through FMEA, companies can identify critical points in the dyeing process that pose a high risk of producing defective products (Fithri et al., 2018).

Furthermore, to ensure that solution implementation is consistent and sustainable, the Plan-Do-Check-Action (PDCA) method can be used as a quality management framework. The PDCA cycle enables companies to carry out continuous improvements through stages of planning, implementation, evaluation, and corrective action (Yun & Kurniawan, 2023). The combination of FMEA and PDCA provides a strong foundation for companies to improve production process quality in a systematic manner (Chuenyindee & Prasetyo, 2020).

Thus, this study aims to analyze the quality of the fabric dyeing process at PT XYZ using the FMEA approach to identify key risks and the PDCA cycle as a strategy for continuous improvement. The findings of this research are expected to serve as a basis for managerial decision-making in reducing product defect rates and enhancing the company's operational efficiency.

METHODS

This study employs a descriptive qualitative approach to explore in depth the phenomenon of product non-conformity in the textile dyeing process at PT XYZ. Its primary goal is to comprehensively analyze the causes, impacts, and improvement efforts related to this issue through the integration of two quality management methods: Failure Mode and Effect Analysis (FMEA) and the Plan–Do–Check–Act (PDCA) cycle. A naturalistic approach was chosen to allow the researcher to understand the phenomenon within its natural context, without manipulating variables, and to objectively capture the dynamics occurring in the field (Andriani, Ananto, et al., 2023). The research site is PT XYZ, located at Jl. Mahar Martanegara No.169, Baros, Cimahi Tengah District, Cimahi City, West Java a dyeing service company with intensive production activities and high complexity in quality control.

The research subjects were selected using the concept of a social situation, with the primary unit of analysis being the textile dyeing process and the quality control of non-conforming products. The main informant in this study is the Head of Production Operations, who holds strategic authority in decision-making related to operations and quality control. Data collection was conducted using a triangulation technique, including participatory observation, in-depth interviews, and documentation (Aprila et al., 2023). Observations were carried out directly in the production area to record actual activities and instances of product non-conformity. Semi-structured interviews were conducted to explore the perspectives, experiences, and improvement strategies of key informants. Meanwhile, documentation focused on collecting secondary data such as Standard Operating Procedures (SOPs), inspection forms, and Non-Conformance Reports to support empirical findings (Yentifa et al., 2023).

Data analysis was conducted using the interactive model of Miles and Huberman, which includes three stages: data reduction, data presentation, and conclusion drawing and verification (Andriani, Rosalina, et al., 2023). Data reduction was carried out by filtering out important information relevant to the research focus, while data presentation was done through tables, matrices, and process flow diagrams to help identify patterns and cause-and-effect relationships. The process of drawing conclusions was done iteratively and verified through member checking with informants to ensure its validity. Data credibility was maintained through source triangulation, method triangulation, and time triangulation, and was further supported by techniques such as peer debriefing and audit trails to ensure transparency in the analysis process (Andriani et al., 2022).

This research was conducted from October 2024 to January 2025, covering stages of problem exploration, field data collection, analysis, and validation of findings. The entire research process was aimed at generating systematic recommendations based on PDCA and FMEA that are not only descriptive but also applicable in enhancing the effectiveness of quality control in the textile dyeing service industry.

RESULTS

Fabric Dyeing Production Flow at PT XYZ

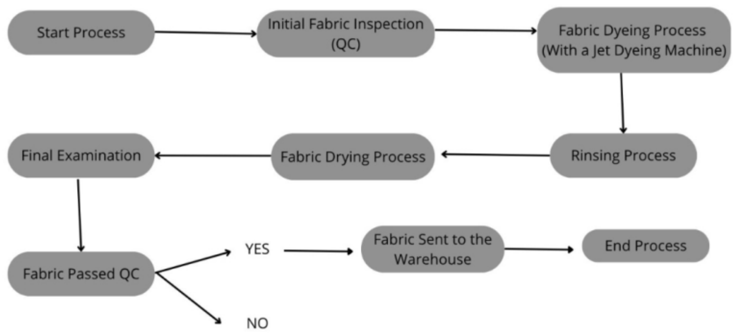

Figure 1. Fabric Dyeing

Figure 1 illustrates the flowchart of the fabric dyeing process at PT XYZ, starting from the initial inspection to the final distribution of products to the warehouse. The process begins with "Start Process," where raw fabrics undergo an Initial Fabric Inspection (QC) to ensure that the materials meet the required quality standards before proceeding to the dyeing stage. Fabrics that pass the inspection are then processed through the Fabric Dyeing Process (using a Jet Dyeing Machine). The use of jet dyeing machines enables efficient and uniform coloring, especially for synthetic or blended fabrics. After dyeing, the fabrics go through the Rinsing Process to remove any excess dye and chemical residues, ensuring the fabric is safe to use and colorfast.

The next stage is the Fabric Drying Process, which ensures the fabrics are properly dried before undergoing the Final Examination. This final quality control step determines whether the fabric meets the standards. The outcome of this examination classifies the fabric into two categories: Passed QC or Failed QC. If the fabric passes QC, it is sent to the warehouse for storage or distribution. On the other hand, if the fabric fails QC, it is either rejected or returned for reprocessing, depending on the company's internal policies. This flowchart reflects the systematic and stringent quality control procedures implemented at PT XYZ. Such a structure is crucial to ensuring product consistency, maintaining customer trust, and enhancing operational efficiency in the textile manufacturing process.

Identification and Analysis of Product Defects in the Dyeing Process

The dyeing process is one of the crucial stages in the textile industry, as it significantly determines the final product's quality. At PT XYZ, this process is highly complex due to the interactions between materials, machines, methods, and human skills. Based on direct observations and interviews with the production management team, several types of defects were consistently identified throughout the dyeing process during 2024. Defect data were collected and analyzed based on monthly production reports, which are summarized in the table below.

Table 2. Product Defect Data During the Dyeing Process at PT XYZ (2024)

Month	Defect Type	Defects (Rolls)	Total Production (Rolls)	Defect (%)
January	Incorrect Width	261	11,200	2.33%
February	Uneven Setting	218	8,200	2.66%
March	Incorrect Color	250	14,700	1.70%
April	Fabric Needs Reversal	259	11,000	2.35%
May	Incorrect Color	223	9,600	2.32%
June	Incorrect Width	249	10,200	2.44%
July	Incorrect Color	198	7,800	2.54%
August	Uneven Color	221	8,200	2.70%
September	Incorrect Color	298	15,500	1.92%
October	Color Too Dark	209	8,700	2.40%
November	Incorrect Color	203	9,800	2.07%
December	Incorrect Color	271	8,200	3.30%
Total		**2,860**	**123,100**	**2.40%**

From the table, it can be identified that the average defect percentage is 2.40%, which exceeds the company's maximum tolerance limit of 2%. The most dominant defect type is "incorrect color," which appeared consistently throughout the year, particularly in months with high production volumes such as March, May, September, and December. The presence of this defect not only affects rework costs and material waste but also impacts product credibility in the eyes of consumers and overall production line efficiency. Therefore, a deep analysis of the root causes of these defects is necessary.

To identify the root causes of defects, a cause-and-effect diagram (fishbone diagram) was used, categorizing the causes into four main categories: human, material, machine, and method factors. In the human category, it was found that the lack of operator skills in controlling the dyeing temperature and time was a crucial factor. Additionally, the absence of regular training and strict standard operating procedures (SOPs) led to frequent errors in dye measurement. From the material side, the varying quality of fabric raw materials caused differences in dye absorption, compounded by inconsistencies in dye quality and chemical contamination, which led to uneven coloring. Machine factors were also significant, such as improper settings of temperature and pressure on the dyeing machines, slow handling of machine breakdowns, and automatic control systems that still required considerable manual intervention from operators.

Meanwhile, from the method perspective, it was found that the dyeing procedure lacked standardized protocols. This resulted in inconsistent coloring between one batch and another. The lack of standardization in controlling dyeing temperature and time, as well as the use of ineffective dyeing techniques, contributed to the high defect rate. These findings suggest that the root cause is not only technical but also systemic, requiring a structured managerial approach to address the issue comprehensively.

Thus, mapping the types of defects and analyzing the root causes becomes a crucial foundation in designing a continuous improvement strategy at PT XYZ. The integration of the Failure Mode and Effect Analysis (FMEA) approach for risk prioritization and the Plan-Do-Check-Act (PDCA) cycle for improvement processes will be the next step in reducing defect rates towards the company's ideal quality standards.

Fishbone Diagram: Analysis of Defects in the Dyeing Process

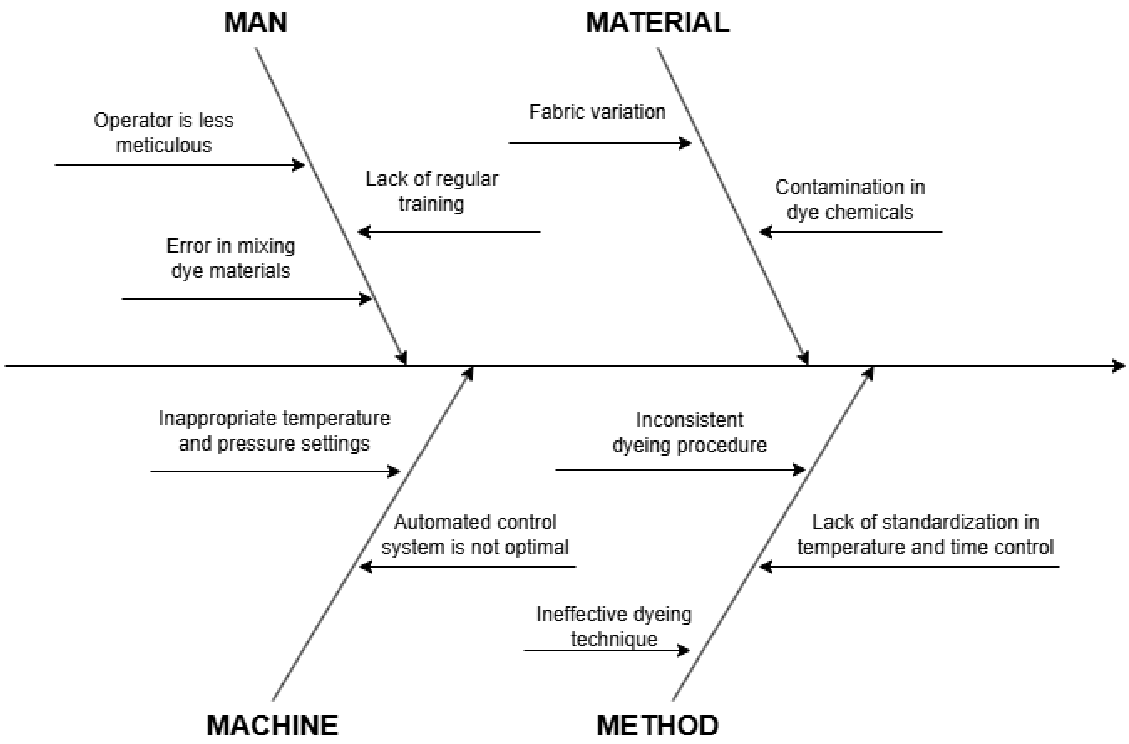

Figure 2. Diagram Fishbone

Based on the Fishbone Diagram presented in Figure 2, the causes of product defects in the dyeing process at PT XYZ can be categorized into four main interconnected factors: Human, Material, Machine, and Method. Each of these factors significantly contributes to the low quality of the final product and the inefficiency of the dyeing process.

In the Human factor, the operator's skills are a critical element. The lack of mastery in accurately controlling the temperature and dyeing time often leads to inconsistencies in the final results. This is further exacerbated by the absence of regular training that aligns the operators' knowledge with the company's desired standard operating procedures. Additionally, inaccuracies in the measurement of dye mixture, which heavily rely on the operator's precision, contribute to color variations that do not meet expectations. Without adequate skill development, the potential for human error in this process will continue to increase, affecting the quality of the produced products.

The Material factor plays a significant role in determining the success of the dyeing results. The varying quality of raw fabric can lead to differences in dye absorption, causing some areas of the fabric to absorb more color than others. Variations in the quality of dye materials, such as differences in concentration or the formulation of chemicals used, also have a direct impact on the final dyeing outcome. Contamination in the dyeing materials, often undetected at the early stages, causes stains or uneven coloration on the fabric. The instability in material quality, both in terms of fabric and dye, highlights the importance of stricter material quality control to ensure optimal dyeing results.

The Machine factor is a technical aspect that cannot be overlooked in this analysis. Inconsistent machine settings, such as improper temperature and pressure control, can significantly affect the dyeing process. Suboptimal temperature and pressure prevent the dye from evenly penetrating the fabric, ultimately resulting in products with colors that do not meet the required standards. Additionally, machinery breakdowns that are not addressed promptly add to the complexity of the issue. The automatic control system, which is not yet fully optimized, also poses a challenge because the machine cannot operate efficiently without the operator's intervention. As a result, operators are forced to make numerous manual adjustments, which not only consumes time but also increases the likelihood of human error.

Finally, the Method factor indicates that inconsistent and insufficiently standardized dyeing procedures are the root cause of ensuring consistent results. Without clear standards for temperature settings, dyeing time, and dyeing techniques, variations in product outcomes are difficult to avoid. Additionally, the use of ineffective dyeing techniques to ensure even color distribution further exacerbates this issue. The lack of uniformity in dyeing procedures creates variability in the final results, which in turn affects the product defect rate. The absence of standardized procedures to guarantee the quality of the dyeing results makes it challenging for the company to achieve optimal results consistently.

By delving deeper into these four factors causing defects, PT XYZ can take more targeted corrective actions. Improvements in operator training, raw material and dye quality control, more proactive machine maintenance, and the standardization of dyeing procedures are essential solutions to reduce product defect rates. Therefore, this analysis not only identifies the problems but also paves the way for improvements that will enhance both the quality and efficiency of the dyeing process in the future.

PDAC Analysis

1) Plan

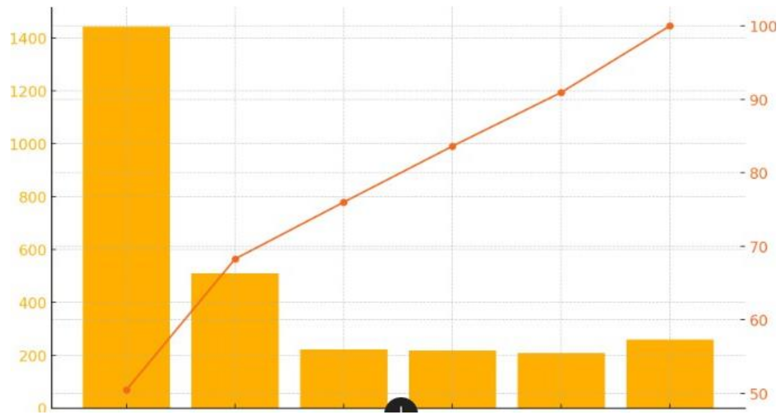

Figure 3. Pareto chart analysis

Based on the results of the Pareto chart analysis, it is evident that the most dominant defect in the dyeing process at PT XYZ is incorrect color, which contributes to more than 50% of the total defects that occurred. The dominance of this figure indicates that color mismatch is a critical issue that must be addressed systematically and comprehensively. To identify the root cause of this problem, a 5 Why analysis was conducted, illustrating the cause-and-effect chain in-depth until the main cause was discovered.

The analysis begins with the first question: why is the color incorrect? The answer is that the dye mixture was not prepared accurately. This inaccuracy arose from inconsistent dye dosing, which was traced further back to the discovery that the dye measuring equipment used was not accurate. The inaccuracy of the measuring tool was caused by the infrequent calibration process, and the root cause of all this was the absence of a Standard Operating Procedure (SOP) for routine calibration of the equipment. This cause-and-effect chain clarifies that the root problem lies in the weakness of the quality management system, particularly in the areas of equipment maintenance and control of the dye mixing process.

Therefore, the strategic solutions offered must not only be technical but also encompass system improvements. First, the calibration of dye measuring equipment should be scheduled regularly, at least once a month, to ensure the accuracy of measurements, which is crucial for successful color dyeing. Second, training for dye mixing operators is essential so that each individual involved understands the importance of accuracy in the mixing process and can identify color deviations early on. Third, the development and implementation of a new SOP, which specifically regulates the procedure for checking color before the dyeing process begins, must be carried out immediately. This SOP will serve as an operational guide to ensure consistent quality and prevent the occurrence of color mismatches during dyeing.

By consistently implementing these three solutions, PT XYZ can eliminate the root causes of color mismatch defects. Not only will this improve product quality, but these steps will also strengthen a work culture based on process control and continuous improvement, thereby promoting operational efficiency and enhancing the company's long-term competitiveness.

2) Do

As a strategic step to address the dominance of color mismatch defects in the dyeing process at PT XYZ, the company has taken a series of corrective and preventive actions, both technical and systemic. The first action implemented was the creation of a Quality Control (QC) Checklist, which serves as a monitoring tool to ensure that the dyeing process meets the required standards before the dyeing begins. This checklist not only includes color matching checks but also involves critical parameters such as temperature, time, and the condition of raw materials, allowing for early detection of potential quality deviations.

The second action taken was the establishment of a specific Standard Operating Procedure (SOP) for the color mixing process and controlling color variation between production batches. This SOP serves as a mandatory reference for all operators and the production team during the dyeing process, aiming to minimize color inconsistencies, which have been the primary source of product defects. The SOP includes technical instructions ranging from the measurement of materials, the sequence of mixing steps, to visual inspection techniques and the use of tools such as a spectrophotometer, if available.

The third equally important step is technical training for operators, particularly those responsible for dye mixing and the use of measuring instruments. This training aims to enhance the technical competence of operators in ensuring the accuracy of the mixing process and fostering awareness of the importance of regular calibration of measuring tools. With this training, it is expected that each operator will not only follow procedures mechanically but will also be capable of critically assessing potential process deviations.

The combination of these three actions is not only aimed at reducing the frequency of product defects but also at strengthening the overall quality system in the dyeing process. These steps reflect a proactive approach focused on continuous improvement and position quality as a shared responsibility across the entire production line. As a result, PT XYZ is expected to improve color consistency, reduce rejection rates, and strengthen customer trust in the quality of the products produced.

3) Check

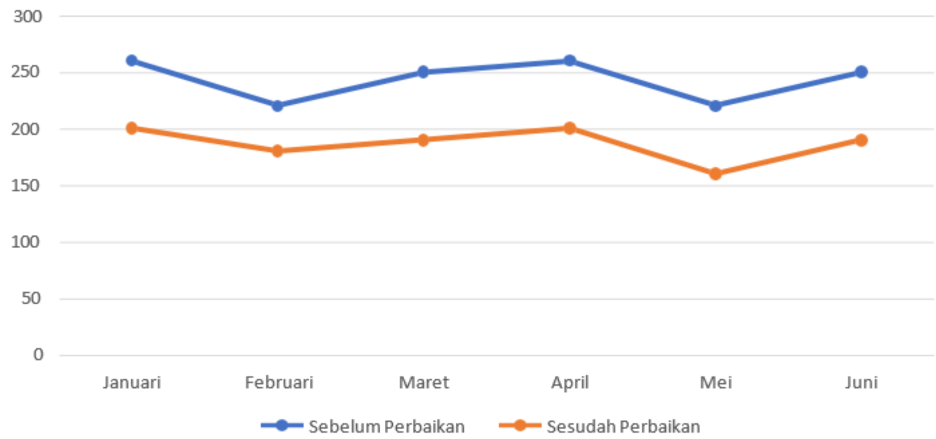

Figure 4. Trend of Defect Reduction

The evaluation of the effectiveness of the corrective actions implemented in the dyeing process at PT XYZ shows significant results. Based on the comparison data of six months before and after the implementation of corrective actions, which include the creation of the QC checklist, the establishment of the color mixing SOP, and operator training, there was a 22.6% reduction in the average color mismatch defects. This reduction reflects a real improvement in process control and enhanced output quality.

Specifically, in January, the number of color mismatch defects decreased from 261 cases to 200, which represents a 23.37% reduction. This positive trend continued consistently in the following months, with the highest reduction recorded in March at 24.00%, indicating that the quality control system and operator training were beginning to have a significant impact on production outcomes. Although there were slight fluctuations from month to month, the overall data demonstrated a stable downward trend, with every month showing a decrease of over 17%.

These results reinforce the assumption that the primary cause of defects, which was previously the incorrect color mixing due to uncalibrated measuring instruments and insufficient operator competence, has been effectively minimized through a systematic, data-driven approach. Furthermore, the establishment of SOPs and the implementation of a QC checklist played a crucial role in ensuring process uniformity and accurate execution on the shop floor. This, in turn, allowed for better control over potential deviations.

With a reduction in the defect rate of off-color products by over a fifth of the previous total, the company has demonstrated a clear commitment to continuous improvement in quality management. However, to ensure the sustainability of these results, regular monitoring, internal audits, and periodic evaluations of SOP implementation and operator training must continue to be carried out. If this positive trend persists, PT XYZ will not only reduce production costs due to rejects but also strengthen its reputation for consistency in quality within both the domestic and international textile markets.

4) ACT

Based on the evaluation results of the effectiveness of corrective actions, PT XYZ has established strategic standardization steps to maintain and further improve the quality of the dyeing process. One of the main actions is the establishment of a new Standard Operating Procedure (SOP) specifically governing the color mixing process and the calibration of measuring instruments, in response to findings that color discrepancies were primarily caused by inconsistencies in dye measurements and inaccuracies in the measuring instruments. This SOP will serve as a mandatory reference in the production process to ensure uniformity and accuracy throughout the entire dyeing line.

Next, the company conducts monthly audits to ensure compliance with the established SOPs. This audit serves not only as an internal control tool but also as a preventive measure to detect potential deviations early that could lead to recurring defects. Additionally, PT XYZ has taken a more progressive step by adopting color mixing automation technology. This technology is designed to eliminate variations caused by human intervention, as well as enhance the precision and efficiency of the dyeing process.

The entire sequence of actions has been designed and implemented using the PDCA (Plan-Do-Check-Act) principles. In the Plan phase, the company identified the root causes through the 5 Why analysis and fishbone diagram. The Do phase was realized by implementing the SOPs, conducting operator training, and developing the QC checklist. In the Check phase, the evaluation of non-conforming color defects data revealed a 22.6% reduction. Meanwhile, the Act phase was executed through standardization, regular audits, and the integration of automation technology as part of continuous improvement.

With the achievement of a reduction in non-conforming color defects, the company is now in a better position to meet the quality standards expected by its customers. The application of a data-driven approach, documented processes, and commitment to continuous improvement strengthens PT XYZ's competitiveness in the textile industry, which demands high consistency and precision in production outcomes.

DISCUSSION

The findings of this study indicate that the integrated application of the Fishbone diagram, 5 Why analysis, and the PDCA (Plan-Do-Check-Act) cycle significantly improved the quality control system in the dyeing process at PT XYZ by effectively identifying the root causes of the most frequent defect: color mismatch. This defect accounted for more than 50% of all non-conforming fabric cases recorded in 2024, marking it as a persistent and systemic issue rather than an incidental occurrence. The 22.6% reduction in defect rates following the implementation of corrective actions clearly demonstrates the effectiveness of a structured and data-driven approach. These results directly address the primary objective of the study, which was to evaluate whether an integrated quality improvement strategy could minimize production errors and enhance process reliability. The findings also emphasize that quality improvement does not always require substantial technological investment. Significant impact can also result from procedural refinement and human resource development, especially in processes requiring high accuracy such as dye mixing.

A deeper causal analysis through the Fishbone diagram categorized the sources of the color mismatch defect into four domains: people, materials, machines, and methods. Among these, human and methodological factors were found to be the primary contributors. Specifically, the lack of operator training and the absence of a Standard Operating Procedure (SOP) for the calibration of measuring instruments led to inaccurate dye formulation. These findings were reinforced through 5 Why analysis, which traced the root cause back to the absence of a documented calibration procedure. This often-overlooked but critical factor highlights the systemic nature of the issue. When compared to previous studies, the results are largely consistent with the findings of Prasetyo and Handayani (2018), who demonstrated that the combination of Fishbone and 5 Why techniques was effective in identifying root causes of quality problems in food manufacturing. Similarly, Siregar et al. (2020) identified calibration issues as a common source of color defects in textile production. However, the current study extends previous work by embedding these root cause tools within the PDCA cycle. This allowed not only for effective diagnosis but also for sustained corrective action and measurable improvement. In contrast, Nuraini and Wahyudi (2021) applied the PDCA cycle in a garment production setting but failed to achieve significant defect reduction due to inadequate problem identification. Therefore, the main contribution of the present study lies in the comprehensive integration of diagnosis and intervention strategies within a continuous improvement framework. Furthermore, this study supports Yun's (2020) observation that technological solutions often fail when not accompanied by organizational reform. The balanced emphasis on both human systems and planned automation sets this study apart from those focusing exclusively on either aspect.

The practical and theoretical implications of this study are substantial. From a practical perspective, the successful implementation of the combined Fishbone–5 Why–PDCA approach provides a replicable quality improvement model for textile manufacturers facing similar defects. The method enabled the company to shift from reactive to preventive quality management. Quantitative tools such as the Pareto chart were instrumental in identifying and prioritizing issues with the most significant impact on quality, which helped allocate resources efficiently. From a theoretical standpoint, the findings reinforce the importance of systemic thinking in quality management. This is consistent with the Kaizen philosophy introduced by Imai (1986), which suggests that continuous improvement requires structured methodologies supported by a commitment to measurable and standardized work systems. Moreover, the company's initiative to adopt automated dye mixing technology demonstrates foresight in merging human-centered interventions with long-term technological solutions. This confirms that digital transformation must be built on a strong procedural foundation to produce sustainable improvements in quality and consistency.

Despite its contributions, the study is not without limitations. First, it focused exclusively on one production process and one defect type, which may limit the generalizability of the findings to other areas of textile production. Second, the evaluation period following the intervention lasted only six months. This relatively short timeframe may not be sufficient to assess the long-term sustainability of the improvements. Third, the study did not control for all external variables, such as fluctuations in raw materials, changes in personnel, or environmental conditions, which could have influenced the outcomes. Future research should adopt a longitudinal design and include a wider range of production settings and defect types to provide a more comprehensive understanding of the impact of integrated quality improvement tools. Additionally, developing a key performance indicator (KPI) framework aligned with PDCA would help organizations systematically monitor and sustain improvements over time. By expanding the study scope and refining its methodology, future research can offer more generalizable insights and further advance best practices in industrial quality management.

CONCLUSION

This study aims to analyze the dominant causes of color defects in the dyeing process at PT XYZ and evaluate the effectiveness of the corrective actions taken. Based on the Pareto analysis, color defects were found to be the most dominant type of defect, accounting for more than 50% of the total defects. Through the Fishbone approach and 5 Why analysis, it was discovered that the root causes stem from human and method factors, particularly the inaccuracy of dye mixing due to infrequent calibration of measuring instruments and the absence of standard operating procedures (SOP) governing this process. The implementation of improvements through the PDCA method proved effective, as evidenced by a 22.6% reduction in defect rates over a six-month period.

This study has limitations in terms of its scope, as it focuses solely on one type of defect, namely color inconsistency, without examining the systemic impact of other defects that might interact within the production process. Additionally, the evaluation period only spans six months after the implementation of improvements, so the long-term effectiveness of the actions taken cannot yet be confirmed. The data used is also quantitative and does not include direct measurement of the operators' or management's perceptions regarding the changes implemented.

Further research is recommended to expand the scope of analysis to include other types of defects in order to gain a comprehensive understanding of the interconnections between quality variables within the dyeing process. It is also advised that the company conducts continuous quality audits and periodically evaluates the effectiveness of the Standard Operating Procedures (SOPs). The implementation of automation technology in color mixing should be expedited to enhance process consistency and minimize dependence on human factors. Future studies could also explore approaches such as Six Sigma or Total Quality Management (TQM) for more holistic quality improvement.

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