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Analysis of Defective Jeans Products at RWC Shop Using a U-Control Chart and FMEA

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Abstract: *RWC Shop is a small and medium-sized enterprise producing jeans in Pekalongan Regency that continues to encounter product defects that are not detected during the early stages of production. Although the defect rate is relatively low, undetected defects can affect product quality, production efficiency, and business sustainability. This study addresses the limited application of integrated quality control using a u-control chart and Failure Mode and Effects Analysis to identify process control conditions and priority causes of defects. The study aims to evaluate defective product control and determine priority improvement actions. Production and defect data from November 2024 to November 2025 were analyzed using a u-control chart, while interview and assessment data were analyzed using a fishbone diagram and Failure Mode and Effects Analysis. The results show that defect proportions remained within the established control limits. Three major defects were identified: striped products, damaged zippers, and holes. The highest Risk Priority Number was 48, associated with low-quality materials and sewing operator negligence. Recommended improvements include raw-material inspection, supplier evaluation, improved work scheduling, additional workforce, and standardized operating procedures. The novelty lies in integrating statistical process control with systematic failure-risk prioritization for quality improvement in a small-scale jeans manufacturing enterprise.*

Keywords: product defects, FMEA, jeans, quality, control chart

INTRODUCTION

The textile industry is an important manufacturing sector that contributes to regional economic activity and employment. In Central Java, the textile sector has a substantial industrial presence, with 414 textile industries recorded by the Central Statistics Agency in 2024 (Badan Pusat Statistik, 2024). However, the number of textile industries declined during the 2019–2021 period, indicating increasingly competitive conditions within the industry. Such competition requires manufacturers, including small and medium-sized enterprises (SMEs), to maintain consistent product quality while improving production efficiency. Product quality is an important determinant of competitiveness because it enables products to meet customer expectations and supports customer satisfaction and trust (Juwito & Al-Faritsy, 2022; Suseno & Kalid, 2022). In manufacturing, quality is not only associated with the characteristics of the final product but is also determined by the consistency of the production process and its ability to meet established quality standards (Kusuma & Muttaqin, 2021; Pratiwi & Sugiyarti, 2022). Consequently, maintaining product quality requires systematic control throughout the production process rather than relying solely on inspection of finished products.

Production failures are among the factors that can compromise product quality and generate economic consequences for manufacturing businesses. Defective products that do not meet predetermined quality standards may increase production costs, reduce output, and create customer complaints and returns (Terang et al., 2023). Moreover, discrepancies between the quality of raw materials and the resulting production output may generate losses in terms of product quality, production quantity, and operating costs (Azura et al., 2024). Previous studies have demonstrated that quality-control practices can reduce defective products and improve production performance (Elvina & Dwicahyani, 2022; Faiz et al., 2022). However, quality control should not only determine whether a production process is statistically stable but should also identify the underlying causes of defects and establish priorities for corrective action. This distinction is particularly important for SMEs, which generally operate with more limited resources and may have less comprehensive quality-control systems (Husein & Rochmoeljati, 2021).

This issue is evident at RWC Shop, an SME engaged in jeans manufacturing in Pekalongan Regency. The production process has experienced several types of defects, including striped products, damaged zippers, and holes, some of which are not detected during the early stages of production. In 2024, approximately 0.29% of the products were identified as defective after failing to be detected during the initial production stages. Although this proportion is relatively small, defects can have operational and economic implications because they may require rework, increase production costs, reduce effective output, and affect customer confidence. Defective products may also reduce company profitability and influence product selling prices (Novianti & Sedyati, 2024), while production failures can prevent the company from achieving predetermined production targets and fulfilling customer demand (Wardana & Widiasih, 2023). Therefore, a quality-control approach that can distinguish between the statistical condition of the production process and the specific causes requiring corrective action is relevant to the operational conditions of RWC Shop.

A *u-control chart* provides an appropriate statistical approach for monitoring attribute data in which the number of defects is evaluated relative to the production unit. The method enables manufacturers to determine whether variations in defect rates remain within established control limits or indicate an unstable production process (Aziz et al., 2023; Sutarmin, 2025). Nevertheless, identifying that a process is statistically within control limits does not necessarily mean that all defects are acceptable from an operational perspective. A process may remain statistically controlled while still producing defects that require corrective action. For this reason, statistical process monitoring needs to be complemented by a method capable of identifying the sources and priorities of potential failures. *Failure Mode and Effects Analysis* is a systematic approach that identifies potential failure modes, evaluates their severity, occurrence, and detectability, and establishes priorities for corrective action (Sutiono et al., 2023). The combination of these approaches allows the analysis to move from determining whether the defect process is statistically controlled to determining which causes should receive priority for improvement**.**

The *state of the art* indicates that previous research has employed various quality-control approaches, including *Statistical Quality Control*, *Six Sigma*, and *Failure Mode and Effects Analysis*, to identify and reduce defective products (Faiz et al., 2022; Syaputra & Al-

Faritsy, 2024). However, the application of a *u-control chart* and *Failure Mode and Effects Analysis* as an integrated approach to jeans manufacturing in an SME remains limited in the studies considered in this research. Existing approaches tend to emphasize either statistical monitoring of production quality or identification of failure causes, whereas the present study connects the two analytical stages. The *u-control chart* is used to establish the statistical condition of the defect-production process, while *Failure Mode and Effects Analysis* is subsequently used to identify the causes of failure and determine improvement priorities. Furthermore, no previous study identified in the present literature review has specifically examined the quality-control conditions of RWC Shop. This constitutes the research gap addressed by the study, particularly in providing an integrated quality-control framework that is applicable to the operational constraints of an SME jeans manufacturer.

Accordingly, this study aims to evaluate the control condition of defective jeans products at RWC Shop using a *u-control chart* and to identify the priority causes of product defects using *Failure Mode and Effects Analysis*. The study specifically addresses two questions: (1) whether the proportion of defective jeans products at RWC Shop remains within the established statistical control limits, and (2) which failure factors represent the highest priorities for quality improvement and what corrective actions can be recommended? The uniqueness of this study lies in integrating statistical process control with systematic failure-risk prioritization within a specific SME jeans manufacturing context. This integration is expected to provide not only evidence regarding the stability of the production process but also practical improvement priorities that can be implemented to reduce defects and strengthen quality-control practices at RWC Shop.

METHODS

This study was conducted at RWC Shop, an SME engaged in jeans manufacturing and located in Rowocacing Village, Kedungwuni District, Pekalongan Regency, Central Java, Indonesia. The research object was the quality of jeans products, particularly the occurrence of defective products during the production process. The research was conducted for more than six months, from August 2025 to February 2026, beginning with the issuance of the research permit. The research procedure consisted of problem identification, literature and field studies, data collection, data processing and analysis, formulation of improvement recommendations, and drawing conclusions. The overall research procedure is presented in Figure 1.

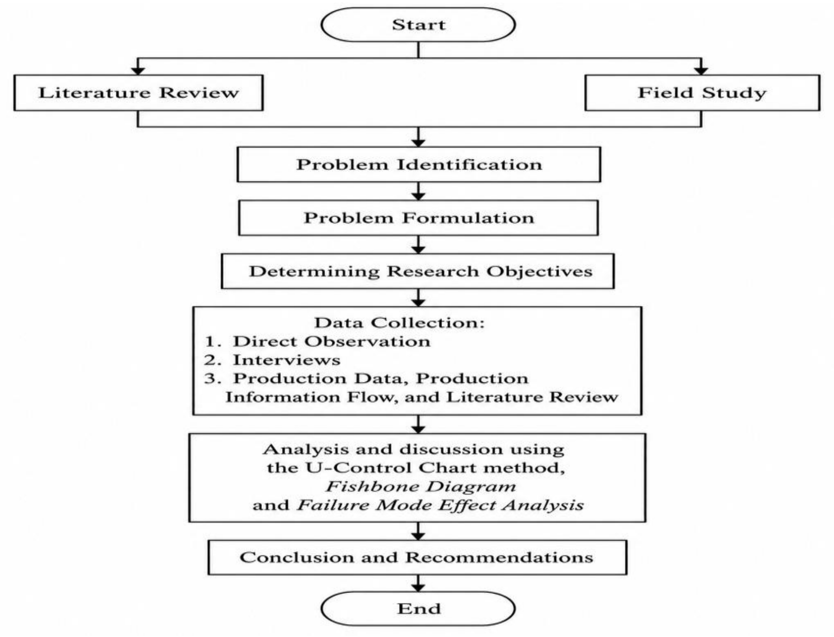


Figure 1. Research Flowchart

Data collection involved both primary and secondary data. Primary data were obtained through direct observation, interviews, surveys, and production records relevant to the research context (Sulung & Muspawi, 2024). Interviews were conducted with the owner of RWC Shop to obtain information regarding production activities, production output, and defective products. In addition, questionnaires were administered to four respondents consisting of the owner, two finishing workers, and one production worker. The respondents were selected based on their direct involvement and knowledge of the jeans production process. Secondary data were obtained from relevant literature concerning quality control, u-control charts, fishbone diagrams, and Failure Mode and Effects Analysis (FMEA). Secondary data were used to strengthen the theoretical and methodological basis of the analysis (Hafizah et al., 2025).

The analysis was conducted in three complementary stages. The first stage involved analyzing production and defect data using a u-control chart. A control chart is used to determine whether a production process remains statistically controlled or exhibits variations beyond the established control limits (Sulistiyo & Vitasari, 2023). The u-control chart was selected because the study focused on attribute data in the form of the number of defects per unit of production. The analysis involved calculating the Center Line (CL), Upper Control Limit (UCL), and Lower Control Limit (LCL) and plotting the results on a u-control chart. The calculation was performed using the following equations:

$$U\ Line\ (U) = \frac{\sum Ci}{\sum Ni} \tag{1}$$

$$Upper\ Control\ Limit\ (UCL) = \bar{u} + 3\sqrt{\frac{\bar{u}}{n_i}} \tag{2}$$

$$Center\ Line\ (CL) = U \tag{3}$$

$$Lower\ Control\ Limit\ (LCL) = \bar{u} - 3\sqrt{\frac{\bar{u}}{n_i}} \tag{4}$$

Note:

U = Average Number of Defects per Unit

ΣCi = Total Number of Defects Found in the Inspected Sample

ΣNi = Total Number of Samples Inspected

n = Number of Samples per Unit Inspected

The second stage involved identifying the potential causes of defective products using a fishbone diagram. The fishbone diagram was used to systematically examine the cause-and-effect relationships associated with the identified defects (Aristriyana & Ahmad Fauzi, 2023). The potential causes were categorized into four major factors: man, referring to workers; method, referring to production procedures; machine, referring to equipment used in production; and material, referring to the quality and condition of raw materials. The analysis was based on field observations, interviews, and information obtained from the respondents.

The third stage involved applying Failure Mode and Effects Analysis (FMEA) to identify and prioritize the failure modes requiring corrective action. FMEA provides a systematic approach for identifying potential failure modes, evaluating their effects and causes, and determining priorities for improvement (Pangestuti et al., 2022). The assessment used three

criteria: Severity (S), Occurrence (O), and Detection (D). Each criterion was assessed on a scale of 1–5 based on the established evaluation criteria, as presented in Tables 1–3.
The Risk Priority Number (RPN) was calculated by multiplying the three assessment scores:

$$RPN = S \times O \times D \quad (5)$$

where RPN represents the Risk Priority Number, S represents Severity, O represents Occurrence, and D represents Detection. A higher RPN indicates a greater priority for corrective action. The RPN scores were obtained from the questionnaire and interviews with the selected respondents. The failure modes with the highest RPN values were subsequently evaluated to formulate improvement recommendations appropriate to the operational conditions of RWC Shop.

The proposed corrective actions were developed by considering the relationship between the identified failure causes, their risk priorities, and the actual production conditions observed at RWC Shop. This analytical sequence allowed the study to combine statistical process control through the u-control chart with causal analysis through the fishbone diagram and risk prioritization through FMEA. The combination was intended to provide a more comprehensive basis for identifying defective-product problems and determining feasible quality-improvement actions for the SME.

RESULTS AND DISCUSSION

The results and discussion section presents the findings obtained after the data collection process was completed. Data were collected through direct interviews with the owner of RWC Shop, resulting in production data and defective-product data for the period from November 2024 to November 2025. The production output and types of defects identified during the observation period are presented in Table 1.

Table 1. Production Output and Types of Defects

No.	Month	Production Output (pcs)	Streaked	Damaged Zipper	Holes	Total Defects
1	Nov-24	2,156	0	6	3	9
2	Dec-24	1,528	3	2	0	5
3	Jan-25	1,735	3	4	2	9
4	Feb-25	1,539	2	1	0	3
5	Mar-25	2,317	0	5	0	5
6	Apr-25	1,285	4	1	0	5
7	May-25	2,822	2	0	2	4
8	Jun-25	1,320	0	3	0	3
9	Jul-25	1,036	4	2	0	6
10	Aug-25	1,616	0	3	0	3
11	Sep-25	2,735	5	1	0	6
12	Oct-25	1,234	3	0	0	3
13	Nov-25	1,312	1	4	2	7
Total		22,635	27	32	9	68

Source: RWC Shop

As shown in Table 1, RWC Shop produced a total of 22,635 pairs of jeans during the November 2024–November 2025 observation period. A total of 68 defective products were identified, corresponding to an overall defect rate of approximately 0.30%. Damaged zippers constituted the most frequently identified defect, with 32 cases, followed by streaked products with 27 cases and holes with 9 cases. Although the overall defect rate was relatively low, the occurrence of defects remains operationally relevant because defective products may require rework, replacement, or additional inspection, thereby increasing production costs and potentially affecting delivery and customer satisfaction.

The occurrence of defects despite the relatively low overall defect rate indicates that quality control remains necessary in the production process. Product defects can originate from various factors, including human resources, raw materials, production methods, and equipment. Therefore, quality control should not be limited to calculating the percentage of defective products but should also identify the causes of defects so that appropriate preventive actions can be implemented. This is consistent with (Faiz et al., 2022), who demonstrated that Statistical Process Control can be used to monitor product quality and identify quality problems in the production process. Similarly, (Aziz et al., 2023) showed that the application of Seven Tools can assist small and medium-sized businesses in identifying and controlling defective products. Thus, even when the defect rate is relatively small, systematic quality control is still important to maintain production consistency.

The data presented in Table 2 were subsequently used as the input for the u-control chart and Failure Mode and Effects Analysis (FMEA). The u-control chart was applied to determine whether the observed defect rate remained statistically within the established control limits. As an illustration, the control-limit calculations for November 2024 were performed as follows:

$$U\ Line\ (U) = \frac{\Sigma Ci}{\Sigma Ni} = \frac{2}{2156} = 0{,}00093 \tag{6}$$

$$Upper\ Control\ Limit\ (UCL) = U + 3\sqrt{\frac{U}{n}} = 0{,}00093 + 3\sqrt{\frac{0{,}00093}{2156}} = 0{,}0029 \tag{7}$$

$$Center\ Line\ (CL) = U = 0{,}00093 \tag{8}$$

$$Batas\ kendali\ bawah = U - 3\sqrt{\frac{U}{n}} = 0{,}00093 - 3\sqrt{\frac{0{,}00093}{2156}} = -0{,}001 \tag{9}$$

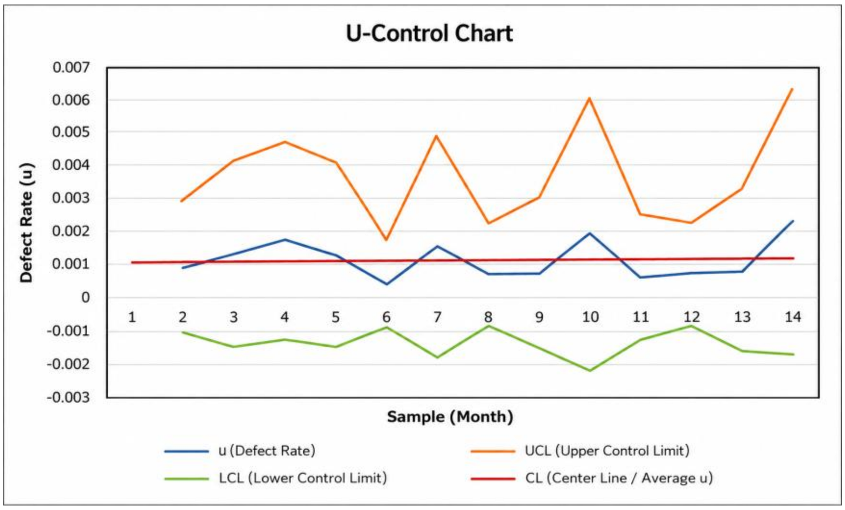
Table 2. Data Processing Using the u-Control Chart

No.	Month	Production Output	Streaked	Damaged Zipper	Holes	Total Defects	u	UCL	LCL
1	Nov-24	2,156	0	6	3	9	0.000928	0.002896	-0.001040
2	Dec-24	1,528	3	2	0	5	0.001309	0.004086	-0.001468
3	Jan-25	1,735	3	4	2	9	0.001729	0.004724	-0.001266
4	Feb-25	1,539	2	1	0	3	0.001300	0.004056	-0.001457
5	Mar-25	2,317	0	5	0	5	0.000432	0.001726	-0.000863
6	Apr-25	1,285	4	1	0	5	0.001556	0.004858	-0.001745
7	May-25	2,822	2	0	2	4	0.000709	0.002212	-0.000795
8	Jun-25	1,320	0	3	0	3	0.000758	0.003030	-0.001515
9	Jul-25	1,036	4	2	0	6	0.001931	0.006026	-0.002165
10	Aug-	1,616	0	3	0	3	0.00061	0.00247	-

	25						9	5	0.001238
11	Sep-25	2,735	5	1	0	6	0.000731	0.002283	-0.000820
12	Oct-25	1,234	3	0	0	3	0.000810	0.003242	-0.001621
13	Nov-25	1,312	1	4	2	7	0.002287	0.006247	-0.001674
Total		22,635	27	32	9	68	0.015097		
Average		1,741.154					0.001060		

Source: Processed research data

The study used 13 monthly observations to evaluate the production process using the u-control chart. As presented in Table 2, the highest observed u value was 0.002287, the lowest LCL was −0.002165, and the highest UCL was 0.006247. These values were subsequently plotted to visualize the variation in the defective-product proportion over the observation period.



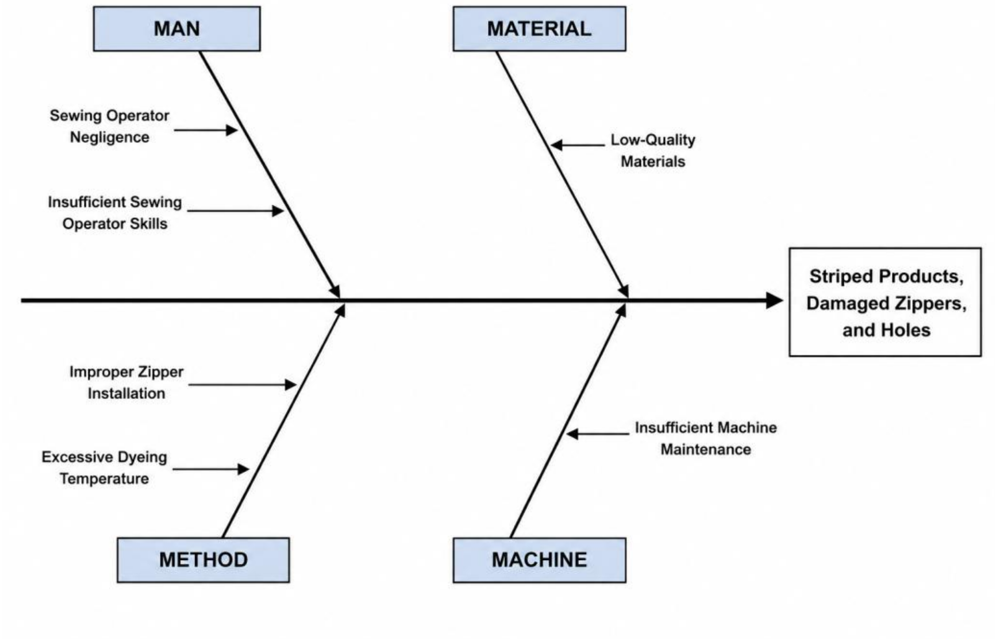
Source: Processed research data

Figure 2. u-Control Chart

Figure 2 shows that all observed defect proportions remained within the established upper and lower control limits. Thus, the production process can be considered statistically controlled with respect to the observed defect rate. However, being statistically controlled does not necessarily mean that the process is operating at an optimal quality level. The presence of recurring defects indicates that preventive improvements are still required to reduce the occurrence of defective products and improve process capability.

The finding that all observations remain within the control limits indicates that the variation in the defect rate during the observation period did not demonstrate an out-of-control condition. This finding is consistent with the purpose of Statistical Process Control, which is to monitor process variation and distinguish normal variation from variation requiring managerial intervention. (Sulistiyo & Vitasari, 2023) demonstrated the usefulness of control charts in evaluating production-process conditions, while (Faiz et al., 2022) found that Statistical Process Control can support the identification and monitoring of product-quality problems. Therefore, the result of the u-control chart suggests that RWC Shop's defect occurrence was relatively stable, although the existence of recurring defects means that continuous quality improvement remains necessary.

The three major types of defects identified through interviews were streaked products, damaged zippers, and holes. These defects indicate that the problem is not limited to a single production stage but may result from interactions among human factors, materials, methods, and machinery. Therefore, a fishbone diagram was used to identify the potential cause-and-effect relationships underlying the observed defects. The analysis classified potential causes into four categories: man, material, method, and machine, as presented in Figure 3.



Source: Processed research data

Figure 3. Fishbone Diagram

The fishbone analysis provides a basis for moving beyond statistical identification of defect occurrence toward identification of the operational causes that require intervention. The identified causes were subsequently evaluated using FMEA to determine which failure modes should receive priority based on their potential severity, frequency of occurrence, and difficulty of detection.

The identification of causes from the four categories demonstrates that product defects are multidimensional and cannot be attributed solely to the final production stage. (Aristriyana & Ahmad Fauzi, 2023) used a fishbone diagram and FMEA to identify the causes of product defects and demonstrated that quality problems can be traced to several interacting production factors. Similarly, (Azura et al., 2024) integrated quality-improvement methods to identify sources of defective products and determine appropriate improvement priorities. The present finding therefore reinforces the importance of examining defects from the perspectives of human resources, materials, methods, and machinery before determining corrective actions.

The FMEA assessment was performed by assigning scores for Severity (S), Occurrence (O), and Detection (D) to each identified failure cause. The scores were obtained from four respondents at RWC Shop using the 1–5 rating scale described in Tables 1–3. The results of the severity, occurrence, and detection assessments are presented in Tables 3, 4, and 5, respectively.

Table 3. Severity Assessment Results

Failure Cause	R1	R2	R3	R4	Total	Mean	S
Insufficient sewing skills	5	4	3	4	16	4.00	4
Sewing operator negligence	4	4	4	4	16	4.00	4
Low-quality materials	3	4	4	4	15	3.75	4
Improper zipper installation	2	4	5	5	16	4.00	4
Excessive dyeing temperature	4	4	4	5	17	4.25	5

Inadequate machine maintenance	5	4	5	4	18	4.50	5

Source: Processed research data

Table 4. Occurrence Assessment Results

Failure Cause	R1	R2	R3	R4	Total	Mean	O
Insufficient sewing skills	4	1	2	1	8	2.00	2
Sewing operator negligence	3	2	2	2	9	2.25	3
Low-quality materials	4	2	2	2	10	2.50	3
Improper zipper installation	4	2	3	1	10	2.50	3
Excessive dyeing temperature	4	1	3	1	9	2.25	3
Inadequate machine maintenance	2	1	2	2	7	1.75	2

Source: Processed research data

Table 5. Detection Assessment Results

Failure Cause	R1	R2	R3	R4	Total	Mean	D
Insufficient sewing skills	1	4	2	2	9	2.25	3
Sewing operator negligence	3	4	3	3	13	3.25	4
Low-quality materials	4	4	3	2	13	3.25	4
Improper zipper installation	2	4	2	2	10	2.50	3
Excessive dyeing temperature	2	4	3	3	12	3.00	3
Inadequate machine maintenance	3	4	2	3	12	3.00	3

Source: Processed research data

The Severity, Occurrence, and Detection scores were subsequently used to calculate the Risk Priority Number (RPN). Because the assessment criteria use discrete values from 1 to 5, the final scores were rounded to the nearest applicable integer to maintain consistency with the established FMEA scale. The resulting RPN values are presented in Table 6.

Table 6. FMEA Results

Category	Failure Mode	Failure Effect	S	Failure Cause	O	Existing Control	D	RPN
Man	Insufficient sewing skills	Product does not meet specifications	4	Insufficient training	2	Sewing operator training	3	24
Man	Sewing operator negligence	Lack of operator focus	4	Insufficient rest and excessive workload	3	Outsourcing	4	48
Material	Low-quality materials	Material damage	4	Limited availability of quality materials	3	Material inspection	4	48
Method	Improper zipper installation	Zipper does not function properly	4	Insufficient sewing skills	3	Inspection during zipper installation	3	36
Method	Excessive dyeing temperature	Material structure is damaged	5	Improper dye processing	3	Appropriate dyeing process	3	45
Machine	Inadequate machine maintenance	Machine breakdown	5	Insufficient maintenance	2	Routine machine maintenance scheduling	3	30

Source: Processed research data

The RPN results in Table 6 indicate that the highest RPN value was 48, identified for two failure causes: sewing operator negligence and low-quality materials. Although the u-control chart demonstrated that the overall defect process remained statistically controlled, the FMEA analysis revealed specific operational risks that require improvement. This finding demonstrates the complementary role of the two analytical methods: the u-control chart evaluates the stability of the defect process at the aggregate level, whereas FMEA identifies the specific failure modes that should receive corrective-action priority.

The complementary findings obtained from the u-control chart and FMEA are important because statistical control does not automatically indicate that all potential failure causes have been adequately controlled. (Husein & Rochmoeljati, 2021) combined Statistical Quality

Control and FMEA to identify defective-product causes and determine improvement priorities. Likewise, (Elvina & Dwicahyani, 2022) demonstrated that the integration of Lean Six Sigma and FMEA can support systematic efforts to reduce product defects. Therefore, the results of this study suggest that the u-control chart and FMEA should be interpreted together: the former provides information regarding process stability, while the latter provides information regarding risk priorities.

The first priority, low-quality materials, indicates that material-related problems may originate before the production process begins. Materials received from suppliers may not fully comply with the required specifications, making certain defects inherent to the input material and difficult to eliminate solely through changes in worker procedures. Previous research has also indicated that inadequate raw-material quality can increase the potential for defective products (Oktafiani & Qurochman, 2025). Consequently, incoming-material inspection and sample testing before mass production are important preventive measures.
This finding is also supported by (Pratiwi & Sugiyarti, 2022), who examined the influence of raw-material quality and production processes on product quality and highlighted the importance of controlling material quality as part of the production system. In addition, (Azura et al., 2024) demonstrated that quality analysis can be used to identify factors contributing to defective products and formulate improvement strategies. Thus, the RPN value of 48 for low-quality materials indicates that quality control at RWC Shop should begin before materials enter the main production process. Supplier evaluation, incoming-material inspection, and sample testing can reduce the probability of defective materials being processed into finished products.

The second priority, sewing operator negligence, indicates that human factors remain an important source of production risk. The RPN value of 48 results from the combination of relatively high severity, occurrence, and difficulty of detection. Operator fatigue, excessive workload, insufficient rest, or inconsistent adherence to production procedures may increase the probability of errors. Worker evaluation and continuous monitoring are therefore necessary to maintain production consistency (Oktafiani & Qurochman, 2025). In the context of RWC Shop, this finding suggests that quality improvement should not focus exclusively on final-product inspection but should also address workload management, worker competence, and standardized production procedures.

The importance of human factors in product quality is also supported by (Aristriyana & Ahmad Fauzi, 2023), who identified operator-related factors as one of the potential sources of product defects through fishbone and FMEA analysis. In addition, (Sutiono et al., 2023) demonstrated that FMEA can be used to identify production risks associated with operational factors and determine appropriate corrective actions. These findings strengthen the interpretation that sewing operator negligence at RWC Shop should be addressed through preventive interventions, including periodic training, supervision, workload management, and standardised work procedures rather than relying only on inspection after production.

Based on the FMEA results, corrective actions were formulated by considering the operational conditions and resource constraints of RWC Shop. The proposed improvements are presented in Table 7.

Table 7. Recommended Corrective Actions

No.	Failure Cause/Effect	Recommended Improvement
1	Insufficient sewing training	Provide periodic sewing training based on established operating standards.
2	Insufficient rest and excessive workload	Increase the number of workers where necessary and provide adequate rest periods.
3	Limited availability of quality materials	Conduct raw-material sample testing before mass production and establish cooperation with reliable suppliers.
4	Inadequate sewing skills	Provide guidance and practical training on correct sewing techniques.
5	Improper dye processing	Monitor the product-dyeing process to ensure that the results comply with established specifications.

6	Insufficient machine maintenance	Increase the frequency of preventive maintenance and replace machine components showing reduced performance.

Source: Processed research data

The corrective actions presented in Table 7 demonstrate that quality improvement at RWC Shop should be implemented through a combination of preventive and corrective measures. Human-resource interventions should focus on improving sewing skills, regulating workloads, and establishing standardized operating procedures. Material-related interventions should emphasize supplier evaluation and incoming-material inspection before production. Meanwhile, dyeing processes conducted by third parties should remain subject to monitoring and clearly defined quality specifications to ensure consistency. Regular machine maintenance is also necessary to reduce equipment-related failures and maintain production continuity.

The proposed actions are consistent with previous studies emphasizing the importance of preventive quality control. (Kusuma & Muttaqin, 2021) highlighted the role of quality control and risk management in maintaining product quality, while (Wardana & Widiasih, 2023) demonstrated the application of DMAIC and FMEA to identify and control quality problems in manufacturing processes. Furthermore, (Suseno & Kalid, 2022) showed that FMEA can be used to determine priority corrective actions based on the risks associated with identified failure causes. Therefore, the corrective actions proposed for RWC Shop are not only directed at reducing existing defects but also at preventing the recurrence of similar problems.

Overall, the findings indicate that a low aggregate defect rate does not necessarily imply that no quality improvement is required. The u-control chart confirmed that the observed defect proportions remained within statistical control limits, while FMEA identified low-quality materials and sewing operator negligence as the two highest-priority failure causes, each with an RPN of 48. This combination of process-control analysis and risk-prioritization analysis constitutes the main novelty of this study, particularly in the context of an SME jeans manufacturer. Rather than evaluating defect frequency alone, the study integrates the u-control chart, fishbone analysis, and FMEA to connect statistical process stability with the underlying operational causes of defects and to establish actionable improvement priorities. This integrated approach provides RWC Shop with a more targeted quality-control framework that can be adapted to its limited-resource production environment.

The overall finding is in line with previous studies demonstrating that quality improvement is more effective when statistical monitoring is combined with systematic identification and prioritisation of defect causes. (Juwito & Al-Faritsy, 2022) showed that Six Sigma can support defect reduction, while (Syaputra & Al-Faritsy, 2024) demonstrated the application of Six Sigma in controlling product quality in garment production. Similarly, (Elvina & Dwicahyani, 2022) and (Wardana & Widiasih, 2023) emphasised the value of combining improvement frameworks with FMEA to identify priority risks. Accordingly, the contribution of the present study lies in applying the u-control chart, fishbone analysis, and FMEA sequentially so that the analysis moves from monitoring defect stability, identifying potential causes, to prioritising corrective actions. This provides a practical quality-control framework for RWC Shop and other small-scale garment manufacturers facing similar resource limitations.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The quality control analysis at RWC Shop indicates that the production process remained statistically controlled based on the u-control chart, although defective products were still identified and may affect production efficiency and product quality. The integration of the u-control chart, fishbone diagram, and FMEA provides a systematic approach to identifying and prioritizing quality problems in small-scale garment production. FMEA identified low-quality materials and sewing operator negligence as the two highest-priority failure factors, each with an RPN of 48. The findings indicate that quality improvement should focus on preventive control of raw materials, improvement of workforce management, and standardization of production procedures. These findings contribute to industrial engineering practice by demonstrating an integrated quality-control approach that can support SMEs in identifying process risks and establishing feasible improvement priorities within resource-constrained production environments.

Limitations

This study has several limitations. First, the analysis was conducted only at RWC Shop and covered a one-year observation period; therefore, the findings cannot be generalized directly to other garment SMEs or industrial sectors with different production characteristics. Second, the FMEA assessment involved only four respondents, which may limit the representativeness of the Severity, Occurrence, and Detection ratings. Third, the analysis focused on three identified types of product defects and four main causal factors, while other operational, environmental, or supplier-related factors may also contribute to product quality. In addition, the study did not evaluate the effectiveness of the proposed corrective actions through post-implementation monitoring. Therefore, the findings should be interpreted within the operational context and observation period of RWC Shop.

Recommendations

Future research should involve a larger number of SMEs or production units and extend the observation period to improve the generalizability of the findings. Further studies should also evaluate the implementation and effectiveness of the recommended corrective actions through longitudinal monitoring of defect rates and RPN values. Additional quality-management approaches, such as Six Sigma, Statistical Process Control, Failure Mode and Effects Analysis with fuzzy logic, or other risk-based methods, may be integrated with the u-control chart to provide a more comprehensive assessment of production quality. Future research may also incorporate supplier performance, worker workload, machine conditions, production environment, and production costs to develop a broader quality-improvement framework for garment SMEs.

Author Contribution

All authors contributed substantially to the development and completion of this study. Their contributions included research conceptualization, formulation of the research methodology, literature review, data collection, data analysis, interpretation of findings, preparation and revision of the manuscript, and final review and approval of the manuscript for publication. All authors have read and approved the final version of the manuscript.

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