

Analysis of Quality Control and Product Failure Risks in Garment Manufacturing Using Statistical Quality Control (SQC) and Failure Mode and Effect Analysis (FMEA) Case Study: CV Muharram Garment Indonesia

Aulia Az-Zahra.¹, Dutho Suh Utomo², Ridzky Zul Asdi³

^{1,2,3}Program Studi Teknik Industri, Universitas Mulawarman, Jalan Sambaliung No. 9 Kampus Gunung Kelua, Samarinda

e-mail: ¹auliazzharaa@gmail.com, ²dutho@ft.unmul.ac.id, ³asdiridzky@ft.unmul.ac.id

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Abstract

Quality control is essential for maintaining product conformity with company standards and reducing defects during the production process. At CV Muharram Garment Indonesia, several defects are still found in the production of screen-printed T-shirts, including faded prints, misaligned prints, and incorrect colors. This study aims to analyze the quality control condition, identify failure risks, and formulate improvement recommendations for the screen-printing process. The methods used were Statistical Quality Control (SQC), Failure Mode and Effects Analysis (FMEA), and 5W+1H. SQC was applied using check sheets, histograms, p-charts, and cause-and-effect diagrams to analyze defect patterns and process variation. FMEA was subsequently used to prioritize potential failure risks based on Severity, Occurrence, and Detection ratings provided by the owner of CV Muharram Garment Indonesia through an FMEA questionnaire. Data collected from January to December 2025 showed a total production of 1,380 pieces with 107 defect records, consisting of 43 faded-print defects, 36 misaligned-print defects, and 28 incorrect-color defects. The p-chart indicated out-of-control points for faded prints in August 2025 and misaligned prints in November 2025. The initial FMEA assessment resulted in three risks with the highest RPN values: uneven squeegee pressure with an RPN of 240, operator inaccuracy in ink mixing with an RPN of 200, and screen displacement combined with insufficiently secured table clamps with an RPN of 160. Improvement recommendations were formulated using 5W+1H, including standardization of squeegee use, inspection of screen positioning and table clamps, and standardization of ink mixing procedures. These recommendations have not yet been implemented and evaluated; therefore, their effectiveness in reducing defects cannot yet be concluded.

Keywords: 5W+1H, Failure Mode and Effect Analysis, Quality Control, Statistical Quality Control

1. INTRODUCTION

The garment industry is a business sector that produces various clothing products to meet consumer needs. This industry involves a value-adding process in which raw materials are transformed into finished products with higher utility (Herlina, dkk., 2021). Competition within the garment industry requires companies not only to fulfill production demand but also to ensure the quality of the products produced. Products that fail to meet established quality standards may reduce customer satisfaction, increase rework costs, generate raw material waste, and decrease overall company productivity (Amdani and Trisnawati, 2021).

CV Muharram Garment Indonesia is a garment company that produces various types of clothing, one of which is screen-printed T-shirts. The production process of screen-printed T-shirts consists of material preparation and inspection, fabric cutting, sewing, screen preparation, screen printing, drying or finishing, quality inspection, and packaging. Based on observations of the production process, several defects were identified, including faded prints, misaligned prints, and incorrect colors. These defects may affect the appearance of the products and cause them to fail to meet the quality standards established by the company (Suryanto, 2023).

Quality control is necessary to identify the number, types, and causes of product defects occurring during the production process. One method that can be applied is Statistical Quality Control (SQC). The SQC method can assist companies in improving operational efficiency (Nugroho dkk. 2023), it can be used to identify defect data through check sheets, examine the distribution of

defects using histograms, evaluate process stability through p-charts, and identify the root causes of defects using cause-and-effect diagrams.

Quality control analysis alone is insufficient to determine which defect causes require immediate corrective action. Therefore, this study employs FMEA method to assess the risk level associated with each cause of defect and to establish risk priorities for subsequent improvement actions (Teja, et al., 2022). Risk priorities are determined based on the Risk Priority Number (RPN), which is calculated by multiplying the Severity, Occurrence, and Detection scores. Subsequently, improvement recommendations are developed using the 5W+1H approach to ensure that the proposed actions are more focused and can be implemented by the company.

Previous studies have applied SQC to identify quality control conditions and FMEA to determine risk priorities. However, the relationship among these methods needs to be clearly established so that each method contributes to the subsequent analytical stage. The research gap addressed in this study lies in integrating statistical quality control results with failure risk analysis, in which process conditions identified through SQC are combined with potential causes identified through the cause-and-effect diagram and risk prioritization through FMEA as the basis for formulating improvement recommendations.

Therefore, this study does not merely identify the types of defects occurring in the production process but also establishes a sequence linking process variation, potential causes, risk levels, and improvement actions within an integrated analysis.

This study aims to analyze the quality control of printed T-shirt products, determine the priority of failure risks in the production process, and propose improvement recommendations for CV Muharram Garment Indonesia.

2. RESEARCH METHOD

Statistical Quality Control (SQC)

The SQC method was used to analyze the statistical quality control conditions of printed T-shirt products (Hamdani dan Fariza, 2019). The tools used included check sheets, histograms, p-charts, and cause-and-effect diagrams (Puspitasari et al., 2022). The use of these tools aimed to identify the root causes of quality problems so that corrective actions could be implemented to improve both process and product quality (Royidi, 2021).

1. Check Sheet

A check sheet was used to record the production quantity and the number of defective products based on the types of defects occurring in each production period.

2. Histogram

A histogram was used to illustrate the number of defective products by defect type, thereby identifying the most dominant type of defect.

3. P-chart

A P-chart was used because the research data consisted of attribute data, in which products were classified as either defective or non-defective. The p-chart was used to determine whether the proportion of defective products remained within the statistical control limits.

a. Calculating the Proportion of Defects

$$\bar{p} = \frac{np}{n} \quad (1)$$

where: np = number of defective items in the subgroup
 n = number of items inspected in the subgroup

b. Average Proportion of Defective Products

$$CL = \bar{p} = \frac{\sum np}{\sum n} \quad (2)$$

where: $\sum np$ = total number of defective products
 $\sum n$ = total number of items inspected

c. Upper Control Limit (UCL) and Lower Control Limit (LCL)

$$UCL = \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad (3)$$

$$LCL = \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \quad (4)$$

where: $\bar{p}$ = average proportion of defective products
n = number of products produced

4. Fishbone Diagram

Fishbone diagram was used to identify potential causes of faded prints, misaligned prints, and incorrect colors. The potential causes were identified based on production-process observations, interviews with the company, and an analysis of the production conditions. The identified potential causes were subsequently used as the basis for identifying failure risks in the FMEA.

Failure Mode and Effect Analysis (FMEA)

FMEA was used to identify potential failures in the production process and determine improvement priorities. The assessment was conducted based on three parameters: Severity (S), Occurrence (O), and Detection (D). The Risk Priority Number (RPN) was used to prioritize each potential failure, thereby identifying failures that require immediate attention and corrective action before improvement recommendations are proposed (Dahlia and Profita, 2024). The RPN value can be calculated using the following equation.

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

where: S = severity
 O = occurrence
 D = detection

The S, O, and D ratings in this study were provided by one assessor, namely the owner of CV Muharram Garment Indonesia. The owner was selected as the assessor because of their direct knowledge and experience regarding the production process, operational conditions, and quality problems associated with screen-printed T-shirts.

The assessment was conducted using an FMEA questionnaire based on the Severity, Occurrence, and Detection scales used in this study. The scales were presented in the FMEA assessment table and served as the reference for the owner when assigning ratings. The completed FMEA questionnaire was also included in the research appendix.

Therefore, the S-O-D ratings represent the expert judgment of the company owner, rather than the average ratings of multiple assessors or a consensus among several assessors.

The Occurrence rating represented the owner's assessment of the likelihood of a failure cause occurring, whereas the Detection rating represented the effectiveness of the existing controls in detecting the failure. A lower Detection score indicates better detection capability, while a higher score indicates lower detection capability.

The evaluation criteria for each parameter *severity (S)*, *kejadian occurrence (O)*, and *detection (D)* are described as follows (Arifianto and Briliana, 2021).

Table 1. Severity scale

Effect	Criteria	Rating
No Effect	No effect on the product; the failure has no impact.	1
Very Minor	Minor effect; the failure is noticed only by certain customers.	2
Minor	Minor effect; the failure can be perceived by certain customers.	3
Very Low	Slight effect; the failure is perceived by most customers.	4
Low	The product's primary function remains operational, but its performance is slightly reduced.	5
Moderate	The primary function remains operational, but additional functions do not operate, resulting in customer dissatisfaction.	6
High	The failure has a major impact on the product, resulting in customer dissatisfaction.	7
Very High	The product is unable to function but remains safe; customers are highly dissatisfied.	8

Table 1. Severity scale

Effect	Criteria	Rating
Hazardous with Warning	The failure affects safety or violates regulations, but a warning is provided.	9
Hazardous without Warning	The failure is hazardous or violates regulations without warning.	10

Table 2. Occurrence scale

Effect	Criteria	Frekuensi	Rating
Very Low	Failure is almost impossible to occur.	<1 than 1.500.000	1
Low	Failure occurs rarely.	1 in 150.000 – 1 in 15.000	2-3
Moderate	Failure occurs occasionally.	1 in 2.000 – 1 in 80	4-6
High	Failure occurs repeatedly.	1 in 20 – 1 in 8	7-8
Very High	Failure is almost certain to occur.	1 in 3 - > 1 in 2	9-10

Table 3. Detection scale

Effect	Criteria	Rating
Almost Certain	Design controls are almost certain to detect the cause of failure	1
Very High	There is a very high likelihood that the cause of failure will be detected	2
High	Controls have a high capability to detect potential failures	3
Moderately High	The likelihood of detection is moderately high, but not always reliable	4
Moderate	Controls have a moderate chance of detecting the failure	5
Low	The likelihood of detection is low	6
Very Low	There is a very low likelihood that the failure can be detected	7
Remote	The probability of detection is very remote	8
Almost Impossible	Controls are almost unable to detect the failure	9
No Detection	No controls are capable of detecting the failure	10

According to Sahira, et al (2025), the classification of risk categories based on the SOD scores indicates the risk levels evaluated using the Risk Priority Number (RPN) scale of 1–10, as presented in the following table.

Table 4. Skala RPN

Risk Level	RPN Score Range	Description
Very Low	$X < 50$	Risk is acceptable
Low	$50 \leq X < 100$	Requires routine monitoring
Moderate	$100 \leq X < 150$	Requires periodic action
High	$150 \leq X < 250$	Requires immediate mitigation action
Very High	$X \geq 250$	Must be addressed as soon as possible

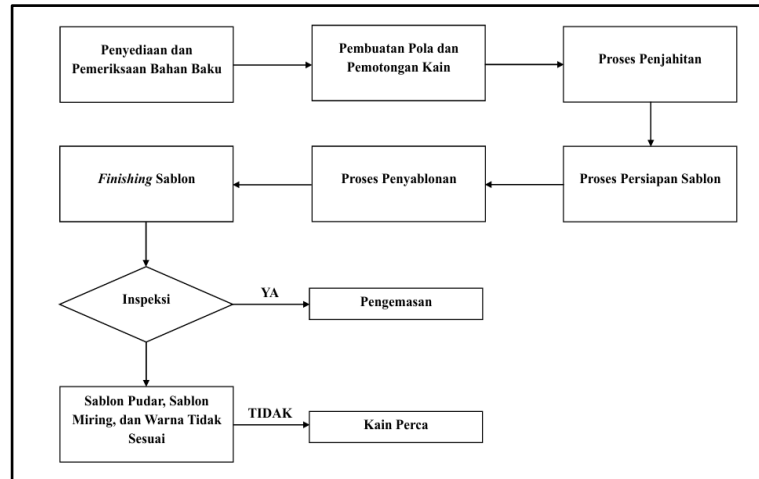
5W + 1H

Improvement recommendations were developed based on the three risks with the highest RPN values. The 5W+1H approach was used to describe what needs to be improved (*what*), the reason for the improvement (*why*), the location of implementation (*where*), the implementation time (*when*), the responsible party (*who*), and the implementation method (*how*).

3. RESULTS AND DISCUSSION

3.1 Overview of the Printed T-Shirt Production Proces

The printed T-shirt production process begins with the preparation and inspection of raw materials. This is followed by pattern making and fabric cutting, sewing, screen-printing preparation, and screen printing using a squeegee. The printed products then undergo a drying or finishing process. Subsequently, the products proceed to the quality control stage to ensure that no defects are present. Products that meet the established standards are then packaged before distribution. Three major defect types were identified in the process: faded prints, misaligned prints, and incorrect colors.



Picture 1. Flowchart of the printed t-shirt production process

3.2 Statistical Quality Control (SQC) Analysis

3.2.1 Check sheet and Histogram

Production data from January to December 2025 showed a total production volume of 1,380 pieces and 107 defect records, consisting of 43 faded-print defects, 36 misaligned-print defects, and 28 incorrect-color defects.

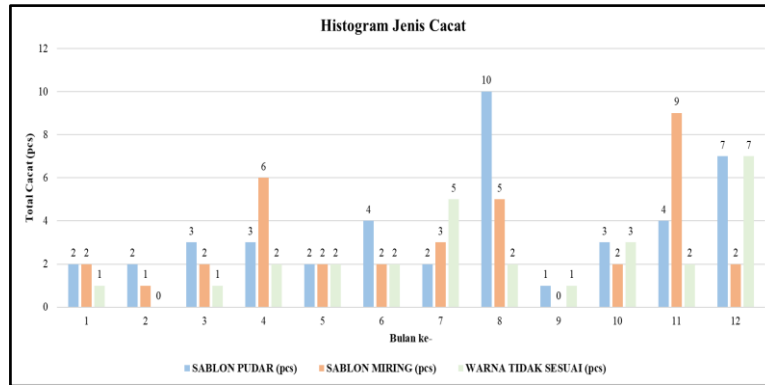
The term “107 defect records” is used rather than “107 defective products” to clarify that the figure represents the total recorded defect occurrences across the three defect categories. This distinction is important because the recorded defects may not necessarily represent 107 unique defective units if more than one defect can occur on the same product.

Table 5. Check sheet

Month	Production Quantity (pcs)	Defect Types (pcs)			Total Defects (pcs)
		Faded Print	Misaligned Print	Inappropriate Color	
Januari 2025	95	2	2	1	5
Februari 2025	90	2	1	0	3
Maret 2025	100	3	2	1	6
April 2025	105	3	6	2	11
Mei 2025	110	2	2	2	6
Juni 2025	115	4	2	2	8
Juli 2025	120	2	3	5	10
Agustus 2025	125	10	5	2	17
September 2025	110	1	0	1	2
Oktober 2025	115	3	2	3	8
November 2025	125	4	9	2	15
Desember 2025	170	7	2	7	16
Total	1380	43	36	28	107

Based on the data, faded prints had the highest frequency, with 43 defect records, followed by misaligned prints with 36 records and incorrect colors with 28 records.

The histogram shows the number of defective products based on the types of defects occurring during the screen-printed T-shirt production process. Among all defect types, faded printing defects had the highest frequency compared to the other defects.



Picture 2. Histogram

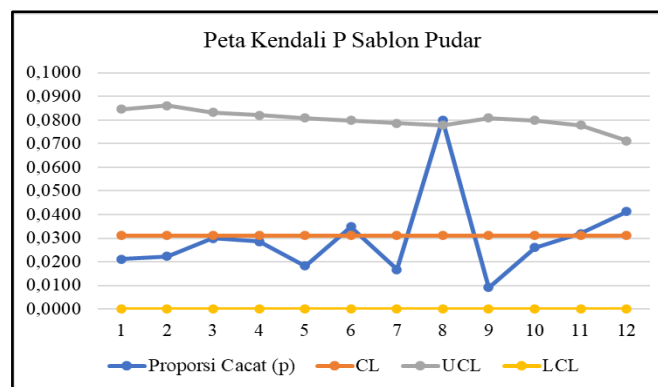
These results indicate that faded prints were the most frequently recorded defect during the observation period. However, defect frequency was not used as the sole basis for determining improvement priorities because risk priority was also assessed based on Severity, Occurrence, and Detection through FMEA.

3.2.2 P-Chart Analysis

The p-control chart was used to determine whether the screen-printed T-shirt production process was under statistical control. The analysis was conducted for each type of defect during the period from January to December 2025 using data obtained through Equations (2.1) to (2.4).

1. P- Chart of Faded Printing

The p-chart analysis indicated that the faded-print process was not in a state of complete statistical control. The average proportion of faded-print defects across the observation period was 0.0312. In August 2025, 10 defect records were identified out of 125 production units, yielding a defect proportion of 0.0800 that exceeded the calculated Upper Control Limit (UCL) of approximately 0.0778. This out-of-control point confirms the presence of special-cause variation during that specific period. However, while the p-chart detects statistical deviations from the expected process variability, it does not directly establish specific causal relationships. Consequently, the potential causes of this variation were further investigated using a cause-and-effect (fishbone) diagram and prioritized through Failure Mode and Effects Analysis (FMEA).

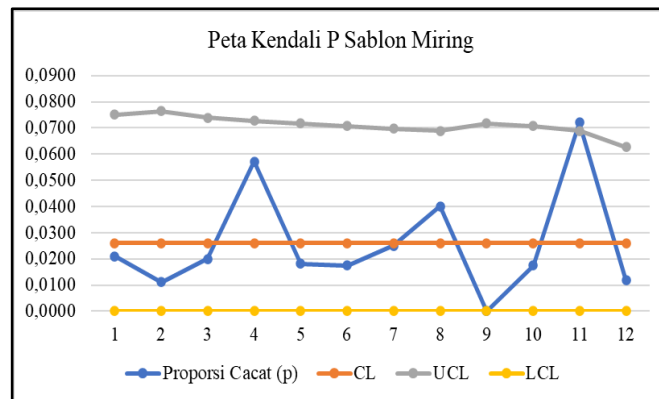


Picture 3. P- chart of faded printing

2. P- Chart of Misaligned Printing

The p-control chart analysis for misaligned-print defects similarly revealed a state of statistical instability. In November 2025, 9 defect records were identified out of 125 production units, yielding a defect proportion of 0.0720 that exceeded the calculated Upper Control Limit (UCL) of 0.0689. This out-of-control point confirms the presence of special-cause variation during that month, highlighting an urgent need for targeted investigation and corrective action regarding screen positioning and printing-table stability. However, because a p-chart detects statistical signals without proving direct causality, this study does not definitively claim screen displacement or unsecured table clamps as the confirmed root causes. Rather, these factors were

identified as potential contributing causes requiring further evaluation through cause-and-effect mapping and FMEA risk prioritization.



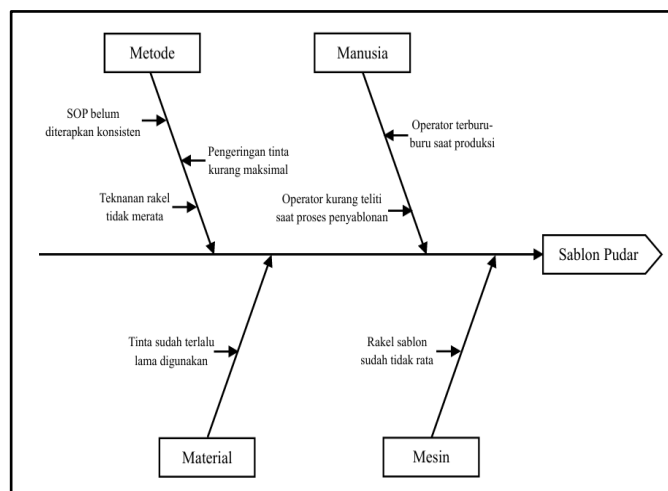
Picture 4. P- chart of misaligned printing

3. P- Chart cacat of Incorrect Color Printing

The p-control chart analysis for color-mismatch defects showed that all monthly observations remained strictly within the calculated control limits, indicating that the variation for this defect category remained under statistical control throughout the observation period. Nevertheless, because color mismatch accounted for a total of 28 recorded defect occurrences and continued to impact overall product conformity, it was retained for subsequent evaluation. Identifying the root causes and risk levels associated with these defects through fishbone analysis and FMEA remains essential for comprehensive quality improvement.

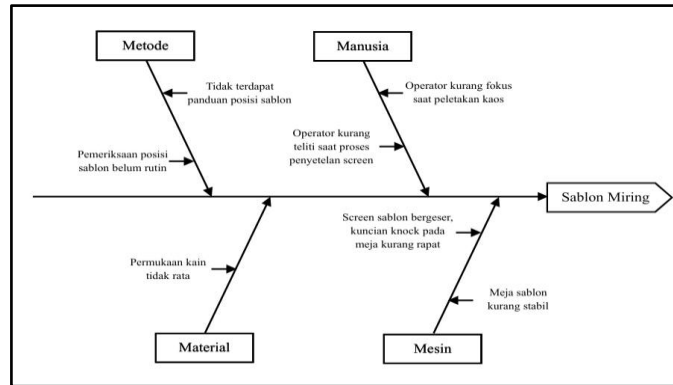
3.2.3 Analysis Fishbone Diagram

The cause-and-effect diagram was used to identify potential causes rather than statistically prove causal relationships. The causes were identified based on production-process observations and interviews with the company. The identified causes were then grouped according to factors such as man, method, material, machine, and measurement..



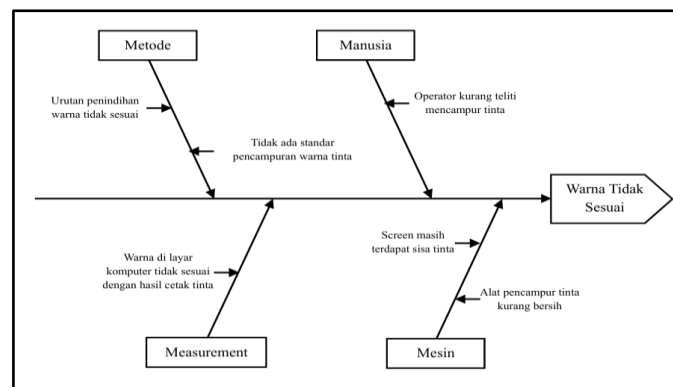
Picture 5. Fishbone of faded printing

The potential causes included inconsistent squeegee pressure, inconsistent application of work standards, ink conditions, and the condition of the squeegee and supporting equipment. One potential cause that received a high priority in the FMEA assessment was uneven squeegee pressure.



Picture 6. Fishbone of misaligned printing

The potential causes included screen displacement, insufficiently secured table clamps, operator inaccuracy during screen setup, and the absence of a screen-positioning guide. One of the potential causes with a high priority was screen displacement combined with insufficiently secured table clamps.



Picture 7. Fishbone of incorrect color printing defects

The potential causes included operator inaccuracy when mixing ink, an inappropriate color-overprinting sequence, the absence of standardized color-mixing procedures, residual ink on the screen, and the condition of the mixing equipment. The potential cause receiving a high priority was operator inaccuracy in mixing ink.

3.3 Risk Analysis Using Failure Mode and Effects Analysis (FMEA)

FMEA was conducted to determine the priority of risks associated with the potential causes identified through the cause-and-effect diagram. In contrast to the previous version of the manuscript, this section explicitly states that all S-O-D ratings were provided by the owner of CV Muharram Garment Indonesia. This clarification addresses the reviewer's concern regarding the identity and basis of the assessor. The ratings were assigned using an FMEA questionnaire based on the predetermined assessment scales. The owner assessed 20 potential causes.

Table 6. Penentuan prioritas risiko

Failure Mode	Code	Effect of Failure	S	O	D	RPN	Risk Level
Faded printing	R1	Uneven squeegee pressure	8	6	5	240	High
	R2	Inadequate ink drying	7	5	4	140	Medium
	R3	Inconsistent implementation of SOPs	6	4	4	96	Low
	R4	Operator rushing during production	6	4	3	72	Low

Table 6. Penentuan prioritas risiko

<i>Failure Mode</i>	<i>Code</i>	<i>Effect of Failure</i>	<i>S</i>	<i>O</i>	<i>D</i>	<i>RPN</i>	<i>Risk Level</i>
Faded printing	R5	Lack of operator attentiveness during the printing process	7	4	4	112	Medium
	R6	Uneven or worn squeegee	5	3	3	45	Very Low
Misaligned printing	R7	Ink used beyond its optimal shelf life	5	4	4	80	Low
	R8	Screen displacement and loose knock locks on the printing table	8	5	4	160	High
	R9	Unstable printing table	5	3	3	45	Very Low
	R10	Operator inaccuracy during screen setup	7	5	4	140	Medium
	R11	Operator lack of focus during T-shirt placement	6	5	3	90	Low
	R12	Absence of printing position guidelines	6	4	5	120	Medium
	R13	Irregular inspection of printing position	5	4	4	80	Low
	R14	Uneven fabric surface	5	3	2	30	Very Low
Color mismatch	R15	Operator inaccuracy in ink mixing	8	5	5	200	High
	R16	Improper color layering sequence	7	4	4	112	Medium
	R17	Absence of ink color mixing standards	6	5	4	120	Medium
	R18	Residual ink remaining on the screen	6	4	4	96	Low
	R19	Insufficiently cleaned ink mixing tools	5	4	3	60	Low
	R20	Color differences between the computer screen and printed ink output	5	3	4	60	Low

Based on the Severity scale used in the study, a score of 8 corresponds to a condition in which the product cannot perform its intended function but remains safe. Therefore, the use of Severity = 8 for several visually related printing defects needs to be reconfirmed with the company owner using the established Severity criteria. The rating should not be changed arbitrarily by the researcher, because the original rating was obtained directly from the company owner through the FMEA questionnaire. If the owner confirms that Severity = 8 is appropriate, the value can be retained and supported by an explicit justification in the manuscript. If the owner revises the rating, the affected RPN values and risk rankings must be recalculated.

Based on Table 6, the highest risk was associated with faded printing defects caused by uneven squeegee pressure, with an RPN value of 240. This indicates that inconsistent squeegee pressure can significantly affect printing quality, resulting in less vivid colors and faded designs.

The second highest risk was color mismatch defects, with an RPN value of 200. The main cause was operator inaccuracy during ink mixing. Minor errors in color composition can produce colors that differ from the original design and may only become apparent after the printing process is completed.

The third highest risk was misaligned printing defects, with an RPN value of 160. This risk was caused by screen displacement and loose knock locks on the printing table. These conditions can shift the design position, resulting in misaligned printing outcomes.

Table 7. Risiko prioritas

<i>Failure Mode</i>	<i>Code</i>	<i>Effect of Failure</i>	<i>RPN</i>	<i>Risk Level</i>
Faded printing	R1	Uneven squeegee pressure	240	Hard
Misaligned printing	R8	Screen displacement and loose knock locks on the printing table	160	Hard
Color mismatch	R15	Operator inaccuracy in ink mixing	200	Hard

Uneven squeegee pressure had the highest initial RPN of 240. This potential cause is associated with unclear or uneven screen-printing results and may reduce the visual quality of the printed product. Based on the identified risk conditions, uneven squeegee pressure may result in an uneven distribution of ink on the T-shirt surface.

Operator inaccuracy when mixing ink had an initial RPN of 200. This potential cause may result in printed colors that do not conform to the specified design. Inaccurate ink mixing may create differences between the intended design color and the final printed color.

Screen displacement and insufficiently secured table clamps had an initial RPN of 160. This condition may cause the printed design to become misaligned or asymmetrical on the T-shirt surface.

These findings indicate that the defect with the highest frequency is not necessarily the only defect requiring priority attention. SQC provides information regarding defect frequency and process stability, whereas FMEA provides information regarding the risk level of potential failure causes based on Severity, Occurrence, and Detection. Therefore, SQC and FMEA serve complementary functions in this study.

3.4 Proposed Improvements Using the 5W + 1H Method

Improvement recommendations were developed based on the three defect causes with the highest RPN values identified through FMEA. The proposed improvements focus on enhancing work standards, improving equipment inspection procedures, and increasing operator accuracy. These actions are expected to reduce the occurrence of defects and improve the overall quality of the screen-printing production process.

The first improvement recommendation is the development of a squeegee usage standard. This standard is needed to provide operators with guidelines regarding pressure, angle, and squeegee handling during the printing process. The implementation of this standard is expected to reduce faded printing defects caused by uneven pressure.

Table 8. Improvement Recommendations for Faded Printing Defects

Faded Printing Defect	
Uneven squeegee pressure	
What	Develop a standard for squeegee usage during the printing process
Why	To reduce faded printing results and maintain consistent ink thickness on the T-shirt surface
When	Before production begins and during the printing process
Where	Printing area in the production department
Who	Printing operators and production supervisors
How	Establish work instructions for proper squeegee handling techniques, conduct regular inspections of squeegee pressure during production, and replace uneven or worn squeegees

The second improvement recommendation is routine inspection of the screen position and printing table locks. Inspections should be conducted before production begins and whenever there is a change in orders. This action aims to prevent screen displacement that may cause misaligned printing defects.

Table 9. Improvement Recommendations for Misaligned Printing Defects

Misaligned Printing Defect	
Screen displacement and loose knock locks on the printing table	
What	Ensure that the screen position and printing table locks remain stable before production
Why	To maintain proper design alignment and reduce misaligned printing defects on the product
When	Before the printing process begins and during design changes
Where	Printing table area in the production department
Who	Printing operators
How	Inspect the screen position before printing, tighten the knock locks on the printing table, and routinely check the condition of the printing table to ensure screen stability during operation

The third improvement recommendation is the development of an ink color mixing standard. The company should provide guidelines for color composition, conduct sample testing before production, maintain the cleanliness of mixing tools, and ensure that screens are free from residual ink from previous processes. These recommendations are expected to reduce color mismatch defects.

Table 10. Improvement Recommendations for Color Mismatch Defects

Color Mismatch Defect Operator inaccuracy in ink mixing	
What	Develop an ink color mixing standard for the production process
Why	To ensure that the printed color matches the specified design and reduce color mismatch defects in the product
When	Before the printing process begins
Where	Ink mixing area in the production department
Who	Ink mixing operators and production supervisors
How	Develop color composition guidelines, conduct color sample inspections before production begins, and provide guidance to operators to improve accuracy during the ink mixing process

4. CONCLUSION DAN RECOMMENDATIONS

4.1 CONCLUSION

Based on the results, a total of 1,380 screen-printed T-shirts were produced from January to December 2025, with 107 recorded defect occurrences consisting of 43 faded-print defects, 36 misaligned-print defects, and 28 incorrect-color defects. Faded prints represented the most frequently recorded defect during the observation period.

The p-chart analysis identified special-cause variation in faded prints in August 2025 and misaligned prints in November 2025. In August 2025, the faded-print proportion was 0.0800, exceeding the UCL of approximately 0.0778. In November 2025, the misaligned-print proportion was 0.0720, exceeding the UCL of 0.0689. Meanwhile, all observations for incorrect-color defects remained within the established control limits.

Based on the initial FMEA assessment provided by the owner of CV Muharram Garment Indonesia, the risks with the highest RPN values were uneven squeegee pressure with an RPN of 240, operator inaccuracy when mixing ink with an RPN of 200, and screen displacement combined with insufficiently secured table clamps with an RPN of 160. These risks were therefore identified as the initial improvement priorities.

The improvement recommendations developed using 5W+1H include establishing standards for squeegee use, inspecting screen positioning and table clamps, and establishing standardized ink color-mixing procedures. These recommendations are proposed corrective actions and have not yet been implemented; therefore, their effectiveness in reducing defects cannot yet be determined.

4.2 RECOMMENDATIONS

Future research may implement the proposed improvement actions and compare defect data before and after implementation to evaluate the effectiveness of the corrective actions. Future studies may also extend the observation period and collect additional process data during periods in which the process is statistically out of control to enable a more comprehensive investigation of special-cause variation. In addition, future research may apply other quality improvement approaches, such as Six Sigma, to provide a more comprehensive analysis of quality improvement.

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