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Quality Control Analysis Using Lean Six Sigma and Kaizen (Case Study at Hilton Konveksi)

Dwi Ayu Indah Lestari[1)]
wiayulstr@gmail.com

Rediawan Miharja[2)]
rediawan.miharja@fe.unsika.ac.id

[1)2)]Universitas Singaperbangsa Karawang

ABSTRAK

The garment manufacturing industry in Indonesia faces ongoing challenges in maintaining consistent product quality, as seen at Hilton Konveksi, where defect rates often exceed the acceptable 1% tolerance limit. This study aims to identify the root causes of product defects in the production of work trousers and propose structured improvements to enhance quality control. Using the Lean Six Sigma methodology integrated with the DMAIC (Define, Measure, Analyze, Improve, Control) framework and supported by the Kaizen philosophy, the research provides a systematic and data-driven approach to process optimization. Data were collected through observation, interviews, check sheets, and company documentation. The results show that the average defect rate reached 5.1%, with slanted stitching being the most frequent issue, accounting for 36% of total defects. Root cause analysis using the 5M (Man, Machine, Method, Material, Environment) framework revealed multiple contributing factors, including operator fatigue, lack of SOPs, and inadequate equipment maintenance. Kaizen-based improvement recommendations were implemented, focusing on preventive actions and employee involvement. The calculated sigma level of 3.61 indicates moderate process capability. Overall, the study demonstrates that the integration of Lean Six Sigma and Kaizen can effectively reduce defects, improve product quality, and enhance operational efficiency in garment manufacturing.

Kata kunci: Quality Control, Lean Six Sigma, Kaizen, Garment

INTRODUCTION

The development of Indonesia's textile and apparel industry has faced significant challenges in recent years. According to data from the Central Statistics Agency, this sector experienced a decline in growth from 7.08% in 2019 to 5.97% in 2023. This decrease is influenced by various factors, both from the demand and supply sides. From the demand side, factors such as uncompetitive prices, intensifying global competition, and changing fashion trends are the primary causes (Pusat Strategi Kebijakan Pengawasan, 2024). Meanwhile, on the supply side, suboptimal technology adoption rates and dependence on imported raw materials have contributed to the decline in the performance of Indonesia's textile and apparel industry. Given the high level of competition in this industry, product quality is a crucial factor in determining the success of a garment manufacturing business, with good product quality creating consumer satisfaction with the product (Rahmola et al., 2022).

One sector in the textile and apparel industry that plays a significant role is the garment manufacturing business. Garment manufacturing is a business that produces clothing in large quantities based on consumer demand, using standard sizes to meet the needs of the community that requires them (Rahmanda et al., 2023). Owners of garment manufacturing businesses require structured planning and management to ensure the sustainability and competitiveness of their businesses. This management encompasses production planning, production processes, and quality control of the products produced (Rahayu et al., 2022). These aspects are part of operational management, which plays a role in optimizing resources to achieve operational efficiency and effectiveness. In operations management, there are ten strategic decisions aimed at helping organizations improve operational efficiency and effectiveness. One of these decisions is quality management, which focuses on controlling and improving product quality to meet consumer standards and expectations (Damayanti et al., 2022).

Quality management is a strategic approach aimed at ensuring that both goods and services meet predetermined standards. In practice, it encompasses quality control, which involves a series of processes designed to guarantee that the final product conforms to specified requirements. Quality control includes various aspects such as the selection of raw materials, the production process, and final product inspection before delivery to customers. Failure to maintain product quality may result in a decline in consumer trust (Alista et al., 2024).

Several garment manufacturing businesses have implemented quality control measures; however, many still face significant challenges in maintaining consistent product quality. Common issues include limited technical knowledge, a shortage of skilled labor, and suboptimal use of tools and technology, leading to increased defective products, delays in delivery, and rising production costs. At Hilton Konveksi, the quality control process for trousers remains suboptimal, as indicated by the high percentage of defective products exceeding the acceptable tolerance limit of 1%. Frequent defects include uneven or misaligned stitching, torn fabric, and damaged pockets. These issues not only compromise product quality but also lead to increased production costs due to the need for repairs or remakes. Additionally, extended production time results in higher workloads for production staff and reduced operational efficiency, causing delays in product distribution. If these problems are not promptly addressed, Hilton Konveksi risks losing customer trust and experiencing a decline in competitiveness within the garment industry.

Table 1. Check Sheet Production Hilton Konveksi October 2024 - March 2025

No	Month	Total Production (Unit)	Types of Defect			Total Defect (Unit)	Defect Rate (%)
			Slanted Stitching	Torn Bag	Torn Fabric		
1.	Okt	4.000	72	59	62	193	4,8
2.	Nov	4.000	68	49	53	170	4,3
3.	Des	4.000	64	61	58	183	4,6
4.	Jan	4.000	82	51	77	210	5,3
5.	Feb	4.000	70	73	100	243	6,1

6.	Mar	4.000	89	69	73	231	5,8
Total		24.000	445	362	423	1.230	5,1

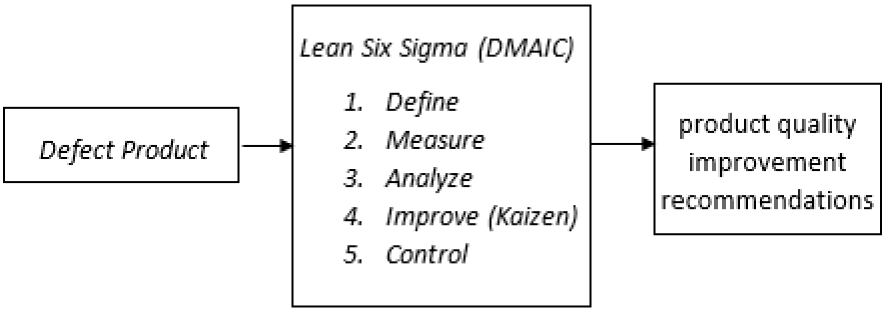
Source: Data Processed, 2025

An effective approach to minimizing defects in the production process involves implementing quality control through the integration of Lean Six Sigma with the Define, Measure, Analyze, Improve, Control (DMAIC) framework and the Kaizen philosophy. Lean Management and Six Sigma are complementary methodologies that enable organizations to achieve operational excellence by enhancing efficiency and reducing waste. The application of Lean Six Sigma has been proven to effectively address productivity issues and eliminate production waste in real time, thereby directly enhancing customer satisfaction. This approach allows companies to systematically identify root causes of defects, implement continuous improvements, and optimize production processes for greater effectiveness and efficiency (Adeodu et al., 2021). Among the Lean tools, Kaizen stands out as a statistically significant method for reducing or even eliminating waste, emphasizing gradual, continuous improvement through collaborative efforts involving all members of the organization (Jugulum & Samuel, 2008; Leksic et al., 2020).

Previous studies have also implemented quality improvement initiatives by integrating multiple methods. For example, quality control using the Six Sigma and Kaizen methodologies was applied to identify product defects, determine their root causes, and propose improvement actions to enhance the quality of sweet bread at UD CJ Bakery (Hairiyah et al., 2020). The studies Kusnandar about quality improvement in sugar production using Lean Six Sigma indicating the root cause of defect and the recommendation improvement can increase sigma level (Kusnandar & Nugroho, 2023). Another study employed Six Sigma and Kaizen to improve productivity within a company setting (Kurniawan & Wahyuni, 2023).

Conceptual Framework

Figure 1. Lean Six Sigma Framework



Source: Data Processed, 2025

The diagram represents the conceptual framework of this study, illustrating the systematic approach used to address product defects through the Lean Six Sigma methodology, specifically the DMAIC (Define, Measure, Analyze, Improve, Control) framework. The process begins with the identification of defective products as the primary problem input. These defects are then subjected to structured analysis using the five phases of DMAIC. In the Define stage, the nature and scope of the quality issues are clarified. The Measure phase involves collecting relevant data to quantify the problem. Subsequently, the Analyze phase focuses on identifying the root causes of defects through rigorous data analysis. In the Improve stage, which integrates the Kaizen philosophy, continuous improvement efforts are undertaken to develop and implement effective solutions. Kaizen emphasizes small, incremental changes that collectively enhance the production process. Finally, the Control phase ensures that the improvements are sustained over time through monitoring and standardization. The output of this entire process is a set of well-informed product quality improvement recommendations. This framework highlights a data-driven, iterative strategy for enhancing product quality and operational performance by reducing variation and waste within the production system (Helmold, 2020).

METODE

This study employs a quantitative research approach using the Lean Six Sigma methodology integrated with the DMAIC (Define, Measure, Analyze, Improve, Control) framework and the Kaizen philosophy as the primary method for quality improvement. The approach is designed to systematically identify, analyze, and reduce product defects within the production process. Through data collection and statistical analysis, the research aims to uncover the root causes of quality issues, implement continuous improvement strategies, and establish control mechanisms to sustain the improvements. This methodological integration enables the study to provide evidence-based recommendations for enhancing product quality and operational efficiency in a structured and measurable manner.

Sample

The sample in this study consists of production data and personnel involved in the manufacturing process of work trousers at Hilton Konveksi. This includes operators, quality control staff, and director who are directly engaged in or responsible for the production output. The sampling technique used is purposive sampling, targeting individuals and data sources that are most relevant to identifying and analyzing product defects. The selected sample ensures that the data collected accurately reflects the quality issues encountered in the production line, thus supporting effective problem diagnosis and improvement recommendations.

Data Collection

Data for this research were collected through a combination of primary and secondary sources. Primary data were obtained through direct observation of the production process, interviews with production and quality control staff, and the use of check sheets to record the types and frequency of product defects. Secondary data were sourced from company documents such as production reports, defect logs, and standard operating procedures. This comprehensive data collection approach ensures the accuracy and validity of the information required for analysis using the DMAIC methodology.

Data Analysis Technique

The data analysis technique employed in this study follows the Lean Six Sigma DMAIC framework. In the Measure and Analyze stages, tools such as Pareto Charts and Fishbone Diagrams (Ishikawa) are used to identify the most frequent defects and their root causes. Statistical analysis is applied to quantify defect rates and evaluate process capability. In the Improve phase, Kaizen is utilized to propose continuous improvements, while the Control phase ensures sustainability through standardization and monitoring. This structured analysis allows for data-driven decisions that enhance product quality and process efficiency.

Operational Variable

The operational variables in this research use management quality variables, with sub-variables including product defect rate, type of defect, root cause of defect, and improvement action.

RESULTS

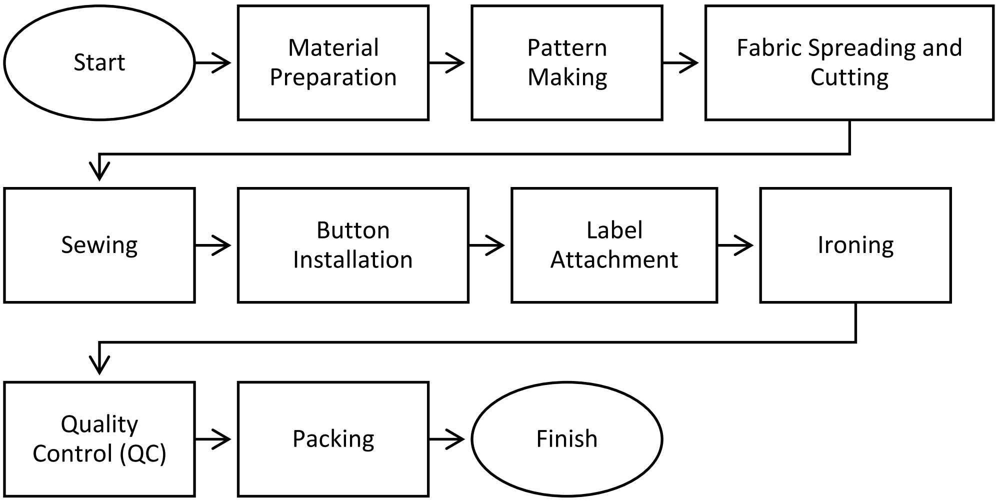
Phase 1: Define

In define phase, data is collected first, then the problems affecting Hilton Konveksi's production process and customer satisfaction are identified in detail. This phase defines the production process flow, types of waste, and types of defect that occur during the production process.

a. Define Production Process

The production process of work trousers at PT Hilton Konveksi consists of a series of sequential stages designed to ensure product quality and operational efficiency. Each stage plays a crucial role in transforming raw materials into finished goods, with specific activities and quality control measures integrated throughout the workflow to minimize defects and meet customer expectations.

Figure 2. Production Process Flowchart



Source: Data Processed, 2025

The production process starts with material preparation, which involves selecting and readying fabrics and other materials like threads, buttons, and labels to make sure they meet quality standards and reduce the chance of defects later. Next, patterns are made based on the design and size requirements; these patterns act as guides for cutting the fabric and are important for the garment's fit and shape. After that, the fabric is spread in layers and cut carefully according to the patterns to ensure consistency and avoid problems such as uneven cuts or stretched fabric, which can affect the final quality.

The sewing stage follows, where the cut pieces are stitched together to form the trousers. Good sewing quality is crucial for both durability and appearance, and any issues like uneven stitching or thread tension are checked closely. Buttons are then attached precisely to make sure they are both functional and evenly placed, as mistakes here can cause customer dissatisfaction. Labels with brand, size, and care details are added next, which are important for product identification and meeting retail rules; wrong labeling can lead to complaints or issues with regulations. The trousers are then ironed to remove wrinkles and give a neat, finished look while also helping spot minor defects like sewing mistakes or fabric damage. After ironing, quality control staff thoroughly inspect each garment to find any defects such as poor stitching, missing buttons, or incorrect labels; defective items are either fixed or rejected. Finally, the trousers that pass inspection are carefully folded, packed, and labeled to protect them during shipping and maintain a good brand image when delivered to customers.

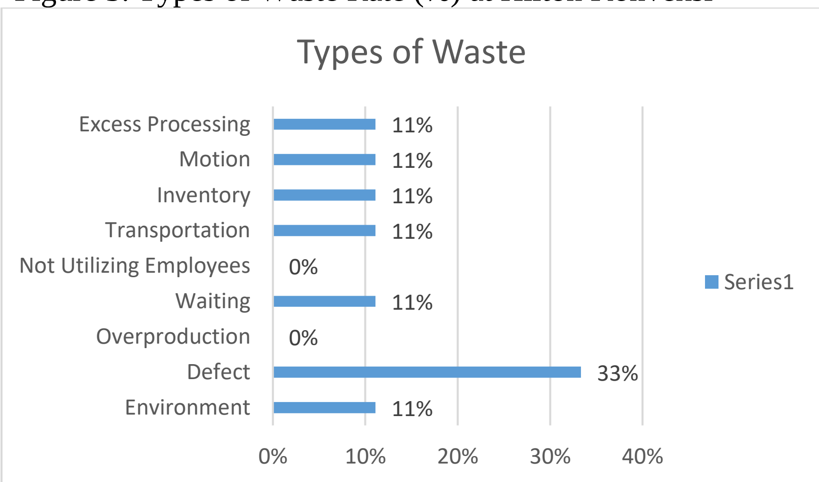
b. Define Types of Waste

Table 2. Define Types of Waste at Hilton Konveksi

Types of waste	Findings
Environment	Work environment factors do not fully support productivity. Although lighting is considered adequate by all parties, the hot and uncontrolled temperature of the production room is a real problem in the field, especially for sewing operators. This can affect focus, stamina, and work speed.
Defect	Product defects are a significant problem. Handling is still reactive (rework), and there is no preventive mechanism or systematic improvement of the root causes.
Overproduction	Overproduction does not explicitly occur in this garment manufacturing company. All three respondents stated that production is based on client orders. This indicates that the make-to-order production system is functioning effectively. However, the absence of a formal raw material stock control system or forecasting system still has the potential to indirectly cause overproduction if there are planning errors, especially if there are sudden changes in orders from clients.
Waiting	Waiting time is a real waste felt by all lines. The causes are interdepartmental coordination and material delays, which impact production delays.
Not Utilizing Employees	The company does not yet have an effective employee empowerment and aspiration system. The innovation potential from the lower levels has not been optimally utilized.
Transportation	There is no efficient production transportation system. All goods and materials are moved manually. This situation can lead to waste of labor and time and may pose ergonomic risks and slow down production flow.
Inventories	Despite order-based production, inventory and material management remain disorganized, particularly during raw material receipt. The potential for stockpiling and efficiency loss persists.
Motion	Motion waste still occurs, especially at the operator level. Many physical activities could be minimized through ergonomic tool arrangement.
Excess Processing	Excess processing arises due to high defect rates. This indicates that defects directly impact time and labor waste.

Source: Data Processed, 2025

Figure 3. Types of Waste Rate (%) at Hilton Konveksi



Source: Data Processed, 2025

c. Define Types of Defect

Table 3. Define Types of Defect in Production Process

No.	Month	Total Production (Unit)	Types of Defect			Total Defect (Unit)	Defect Rate (%)
			Slanted Stitching	Torn Bag	Torn Fabric		
1.	Oct	4.000	72	59	62	193	4,8
2.	Nov	4.000	68	49	53	170	4,3
3.	Des	4.000	64	61	58	183	4,6
4.	Jan	4.000	82	51	77	210	5,3
5.	Feb	4.000	70	73	100	243	6,1
6.	Mar	4.000	89	69	73	231	5,8
Total		24.000	445	362	423	1.230	5,1

Source: Data Processed, 2025

Phase 2: Measure

In this phase, calculate the CL (Center Line), UCL (Upper Control Limit), and LCL (Lower Control Limit), create a p-chart, calculate the DPMO (defects per million opportunities), sigma level, and calculate process capability.

a. Determine the proportion

$$Proportion\ (p) = \frac{defect\ per\ month}{total\ production\ per\ month}$$

$$Proportion\ (p) = \frac{193}{4000}$$

$$Proportion\ (p) = 0{,}04825$$

b. Determine the CL (Center Line)

$$CL = \frac{Total\ defect}{total\ production}$$

$$CL = \frac{1.230}{24.000}$$

$$CL = 0{,}5125$$

c. Determine the UCL (Upper Control Limit)

$$UCL = CL + 3\sqrt{\frac{CL(1-CL)}{total\ production}}$$

$$UCL = 0{,}05125 + 3\sqrt{\frac{0{,}05125(1-0{,}05125)}{24.000}}$$

$$UCL = 0{,}06171$$

d. Determine the LCL (Lower Control Limit)

$$LCL = CL - 3\sqrt{\frac{CL(1-CL)}{total\ production}}$$

$$LCL = 0{,}05125 - 3\sqrt{\frac{0{,}05125(1-0{,}05125)}{24.000}}$$

$$LCL = 0{,}04079$$

Table 4. Control Chart Process Production

No.	Total Defect (unit)	Total Production	Proportion *Defect (p)*	CL	UCL	LCL
1.	193	4.000	0,04825	0,05125	0,06171	0,04079
2.	170	4.000	0,04250	0,05125	0,06171	0,04079
3.	183	4.000	0,04575	0,05125	0,06171	0,04079
4.	210	4.000	0,05250	0,05125	0,06171	0,04079
5.	243	4.000	0,06075	0,05125	0,06171	0,04079
6.	231	4.000	0,05775	0,05125	0,06171	0,04079
TOTAL	1.230	24.000				

Source: Data Processed, 2025

e. Determine the DPU (Defect Per Unit

$$DPU = \frac{Total\ Defect\ per\ Month}{Total\ Production\ per\ Month}$$

$$DPU = \frac{193}{4.000}$$

$$DPU = 0{,}0483$$

f. Determine the DPO

$$DPO = \frac{Total\ Defect\ per\ Month}{(Total\ Production\ per\ Month\ x\ CTQ)}$$

$$DPO = \frac{193}{(4.000\ x\ 3)}$$

$$DPO = 0{,}01608$$

g. Determine DPMO

$$DPMO = DPO\ x\ 1.000.000$$

$$DPMO = 0{,}01608\ x\ 1.000.000$$

$$DPMO = 16.083$$

h. Sigma Level

After getting DPMO, then calculate the sigma level of Hilton Konveksi at this time. The sigma level is obtained by converting the value in DPMO into the relationship table between sigma and DPMO values. It is known that the average value of DPMO is 17,083 and converted to the company's sigma level of 3.61.

Table 5. Result of DPU, DPO, DPMO, and Sigma Level

No	Month	Total Production (Unit)	Total Defect	DPU	CTQ	%Yield	DPO	DPMO	Sigma Level
1.	Oct	4.000	193	0,0483	3	0,9518	0,01608	16.083	3,67
2.	Nov	4.000	170	0,0425	3	0,9575	0,01417	14.167	3,68
3.	Des	4.000	183	0,0458	3	0,9543	0,01525	15.250	3,50
4.	Jan	4.000	210	0,0525	3	0,9475	0,01750	17.500	3,60
5.	Feb	4.000	243	0,0608	3	0,9393	0,02025	20.250	3,54
6.	Mar	4.000	231	0,0578	3	0,9423	0,02888	19.250	3,56
Total		24.000	1.230						
Average				0,051		0,95	0,03	17.083	3,61

Source: Data Processed, 2025

i. Process Capabilities

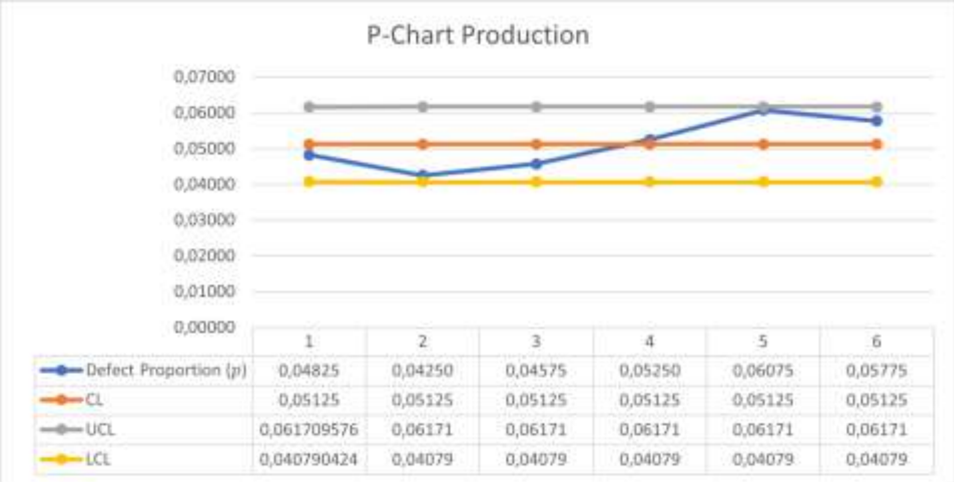
$$CP = \frac{Level\ Sigma}{3}$$

$$CP = \frac{3,61}{3}$$

Phase 3: Analyze

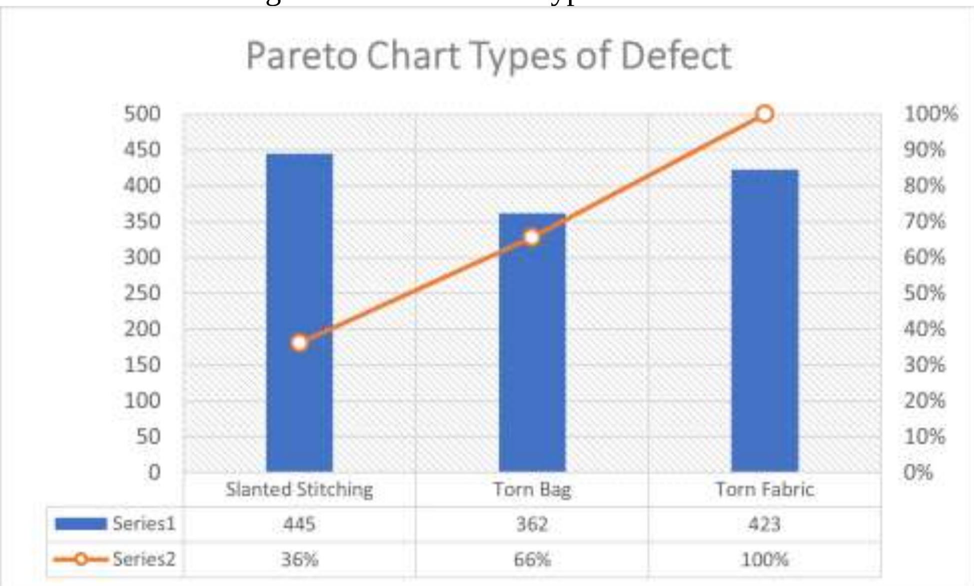
The analyze phase is the third step in the six sigma method used for quality improvement. At this stage, several situations are carried out, namely determining stability and ability to handle, and identifying the source and root of the problem.

Figure 4. P-Chart Production Process



Source: Data Processed, 2025

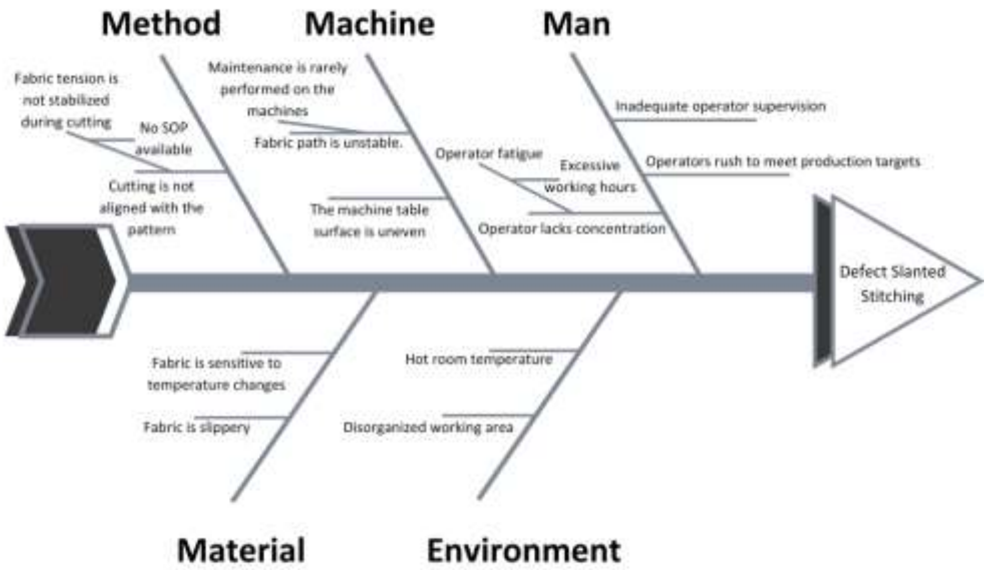
Figure 5. Pareto Chart Types of Defect



Source: Data Processed, 2025

Based on the Pareto diagram above, it can be seen that the dominant type of defect in Hilton Konveksi is the defect in the slanted stitching, which is 36%, therefore this type of defect is the main thing in doing quality control. The next step is to create a fishbone diagram that serves to find out information from the factors of a problem or defect that has been made the main thing, which is something from the results of brainstorming from parties involved in the pants production process.

Figure 6. Fishbone Diagram Defect Slanted Stitching



Source: Data Processed, 2025

Based on the Pareto diagram above, the root of the problem occurs in the 5Ms (Man, Machine, Method, Material, and Environment).

Phase 4: Improve

In Improve phase using the Kaizen approach for the defect Slanted Stitching, based on the 5M (Man, Material, Method, Machine, Environment). The Kaizen method emphasizes continuous, small, and incremental improvements involving everyone from workers to management.

Figure 7. Improvement Recomendation using Kaizen Approach

Factor	Problem Identified	Kaizen Recommendation	Target	Frequency	Involved Personnel
Man	Operators experience fatigue, lack focus, and rush work	Introduce daily stretching, shift rotation, and morning briefing to set realistic goals	Reduce fatigue-related errors	Daily	Line operators, supervisors
Material	Fabric is slippery and sensitive to temperature	Use anti-slip pads and store fabric in a temperature-controlled room	Minimize material handling defects	Continuous	Warehouse staff, cutting team
Method	No SOP, inconsistent cutting process	Create visual SOPs and involve operators in standard creation workshops	Standardize work processes	Monthly review	QC team, production operators
Machine	Unstable fabric path, uneven table, poor maintenance	Establish a “clean, inspect, lubricate, tighten” (CILT) routine by operators	Reduce machine-related defects	Daily check, weekly maintenance	Operators, maintenance team

Source: Data Processed, 2025

DISCUSSION

Based on the results of the analysis conducted with the Lean Six Sigma DMAIC and Kaizen approach, it is known that the work pants production process at Hilton Konveksi still faces various problems that have an impact on the high level of product defects. In measure phase, the average defect rate found during the period October 2024 to March 2025 reached 5.1%, which significantly exceeded the maximum tolerance threshold of 1%. The most dominant type of defect was slanted stitching, which accounted for 36% of the total defects, making it a top priority in quality control.

In analyze phase, the results of root cause identification through Pareto and Fishbone diagrams showed that the main causes came from five categories in the 5M framework, namely Man, Machine, Method, Material, and Environment. From the Man aspect, it was found that operators often experience fatigue, lack of focus, and work under time pressure, thus contributing to sewing errors. From the Machine aspect, the lack of machine maintenance and the unstable condition of the work equipment led to technical glitches during the production process. In terms of Method, the irregularity of work procedures and the absence of visual SOPs led to inconsistencies in the cutting and sewing process. In addition, in terms of Material, the type of fabric used tends to be slippery and temperature sensitive, requiring special handling. Meanwhile, in the Environment*aspect, the hot and less ergonomic working environment conditions affected the productivity and accuracy of the operators' work.

In the Improve phase, a Kaizen approach was implemented, which emphasized continuous and participatory improvement. Some of the corrective actions implemented included the development of visual SOPs, work rotation, pre-work stretching exercises, procurement of anti-skid mats, and implementation of machine maintenance routines using the CILT method (clean, inspect, lubricate, tighten). These improvement strategies aim to reduce errors stemming from human and technical factors, as well as create more conducive working conditions and uniform process standards. Furthermore, based on the results of the calculation of process capability, an average sigma level value of 3.61 was obtained, which indicates that the production process is still in the medium category and not yet fully stable.

This indicates that there is still room for improvement in order to achieve a higher level of process capability and approach the ideal manufacturing industry standards. With the implementation of preventive and systematic corrective actions, as well as strengthening at the Control phase through regular monitoring and process standardization, Hilton Konveksi is expected to significantly reduce defect rates, improve operational efficiency, and strengthen the company's competitiveness in the competitive convection industry.

CONCLUSION

This study concludes that the application of Lean Six Sigma integrated with the DMAIC framework and Kaizen philosophy significantly contributes to identifying, analyzing, and reducing defects in the production process at Hilton Konveksi. The analysis revealed that the average defect rate reached 5.1%, exceeding the acceptable tolerance limit of 1%, with slanted stitching identified as the most dominant defect type. Root cause analysis through the 5M approach (Man, Machine, Method, Material, and Environment) showed that both human factors and technical inefficiencies played a critical role in defect occurrences.

The implementation of continuous improvement strategies based on the Kaizen method—such as standard operating procedures, machine maintenance routines, and ergonomic improvements—has the potential to reduce defect rates and improve overall production quality. Furthermore, the sigma level analysis showed a performance level of 3.61, indicating moderate process capability that still requires further optimization. Therefore, sustainable quality improvements can be achieved by institutionalizing preventive measures, fostering employee involvement, and ensuring consistent monitoring and control. These efforts are essential to enhance operational efficiency, product quality, and customer satisfaction in a highly competitive garment manufacturing industry.

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