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Quality Control and Efficiency of Pants Production Process Using Six Sigma DMAIC and Triz at PT Magnum Attack Indonesia

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ABSTRACT

Manufacturing competition in the apparel industry necessitates continuous improvement in product quality and operational efficiency to minimize defects and maintain competitive advantage. This study aims to optimize the pants production process at PT Magnum Attack Indonesia through the integration of Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) and TRIZ (Teoriya Resheniya Izobretatelskikh Zadach) methodologies. A descriptive quantitative approach was employed, utilizing secondary data from July to December 2024. The research methodology involved CTQ (Critical to Quality) mapping, calculation of DPMO (Defects Per Million Opportunities) and sigma levels, root cause identification using Pareto and fishbone diagrams, and formulation of improvement recommendations through the TRIZ contradiction matrix and inventive principles. Secondary data for July–December 2024 were analyzed to map CTQ, calculate DPMO and sigma levels, and identify root causes using Pareto and fishbone diagrams. Improvement recommendations were formulated through the TRIZ contradiction matrix and inventive principles. The results showed a total production of 6,951 units with 430 defects (DPU 0.06186; Final Yield 93.82%; total DPMO 127,024; average sigma 4.45). The dominant defects were suture (43.95%) and precision (31.86%), which accounted for 75.81% of the total defects. Key solutions include layout/ergonomics and visual aids (principle 17), enforcement of inspection SOPs (principle 10), local quality control in critical embroidery areas (principle 3), and digitization of CAD-based tech packs (principle 28). This approach reduces defects without sacrificing productivity and provides a foundation for continuous improvement toward increased competitiveness. The practical implications include reduced rework costs, improved customer satisfaction, and sustainable quality enhancement mechanisms.

KEYWORDS *DMAIC, Defect Reduction, Quality Control, Six Sigma, TRIZ*

INTRODUCTION

Increasingly fierce competition in the manufacturing industry makes performance a major factor in determining the long-term sustainability of a company. Companies must strive to improve production efficiency and quality in order to maintain a competitive advantage. However, the main challenge in today's industry is maintaining quality standards while reducing production costs and reducing defect rates (Achouch et al., 2022; Anderson, 2020; Psarommatis, May, Dreyfus, & Kiritsis, 2020; Rüßmann et al., 2015; Tofail et al., 2018). One of the strategies commonly applied by companies in the manufacturing sector is continuous improvement (Apriani, dkk., 2024) (Wang, dkk., 2024). This strategy makes the company continue to make improvements in various lines, including production lines, to ensure that the production process runs effectively and efficiently (Arizona, 2024). A production can be said to be very good if the defect percentage of the product is 0.01%. (Irwanto, dkk., 2020)

PT Magnum Attack Indonesia is a company engaged in fashion and apparel. PT Magnum Attack Indonesia produces various types of apparel with various models, including shirts, t-shirts, polos, jerseys, pants, hats (Esho, 2015; Muhammad, 2022; Ratuannisa, Santosa, Kahdar, & Syarief, 2020). The company has set a maximum defect value of 1% per year, but the highest defect of 8% is still found in September 2024. Although PT Magnum Attack Indonesia has gained recognition for its quality, product diversity, and competitive prices, continuous improvement in quality and efficiency remains essential to maintain customer trust and expand market reach. (Sigh, dkk., 2024)

Currently, there is a gap between the company's existing quality control measures and the potential for optimization using more advanced methodologies. Although the company has used advanced technology and a skilled workforce, the existing quality control system has not fully addressed all potential sources of defects and inefficiencies in the production process. This can result in variations in product quality, increased production costs, and delays in meeting customer demands (Anderson, 2020; Bevilacqua, Ciarapica, & De Sanctis, 2017; Hartley, 2017; Ivanov & Rozhkov, 2020; Um, Lyons, Lam, Cheng, & Dominguez-Pery, 2017).

Based on historical data in the period August to October 2024, it was found that pants have the highest rate of defects as shown in Figure 1. Meanwhile, shirts, pants, polos, jerseys, and hats products have a lower number of defective products.

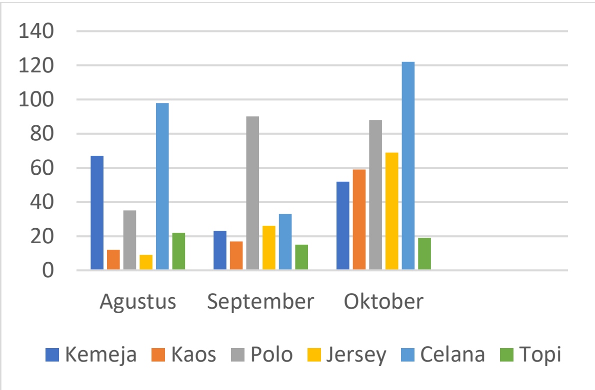

Figure 1. Comparison of Production Quantity and Defect

Source: Internal Company

Companies need to make repairs or even re-produce because there are defective products in the production process to meet production targets. This condition has a negative impact on the company, such as delivery delays and increased operational costs. Therefore, effective quality control is needed to maintain and improve product quality standards, so that the number of defects can be minimized and production efficiency can be maintained. Quality control aims to ensure that the products produced meet the standards that have been set as well as to improve and maintain the quality that has been complied with. (Irwanto, dkk., 2020)

Various methods can be used to carry out quality control, such as six sigma DMAIC is used to determine the level of capability of the production process, factors causing defects, and determine process improvement recommendations for PT Magnum Attack Indonesia. This approach can reduce defects, increase revenue, improve product quality, and increase customer satisfaction. The six sigma approach is also used in continual improvement and has become the basis for many manufacturing industries around the world as it has proven effective in delivering significant business improvements (Mittal, dkk., 2023) . There are five basic stages of six sigma, namely Definition, Measure, Analyze, Improve, and Control which are often implemented as a framework to solve problems in the process. In this method, one of the measurement indicators is used, namely Defects Per Million Opportunities (DPMO). DPMO is a statistical measure used in the six sigma method to calculate the number of product defects per one million opportunities (Sarah, dkk., 2021). This value helps companies to know how often the products produced are defective and how well the production process meets quality standards (Sheel, 2025).

In addition, the TRIZ method (Teoriya Resheniya Izobretatelskikh Zadach) which is an inventive problem-solving theory developed through an inductive approach. This method can be integrated into the improve section to overcome obstacles that arise by avoiding trade-offs that usually occur in system optimization and overcoming production process inefficiencies due to quality improvement (Alvarez, dkk., 2022). The TRIZ method supports creative thinking by utilizing 39 parameters and 40 patented innovation principles, which serve as a guide in formulating innovative solutions to complex and contradictory problems. Contradictory problems occur when there is a conflict or trade-off between two parameters in a system, where improvements in one aspect actually cause problems or worsen other aspects (Arizona, 2024).

This research aims to optimize the quality and efficiency of pants production at PT Magnum Attack Indonesia by integrating the six sigma DMAIC and TRIZ methods as a continuous improvement strategy to reduce defects, improve process capabilities, and overcome inefficiencies, so that the company is more competitive in the fashion industry. The formulation of the research problem includes the analysis of process capabilities based on sigma and DPMO values, identification of the dominant defect type, and the formulation of improvement recommendations with TRIZ. The benefits of the research include the application of theory to industrial practice for researchers, the development of cooperation and science for universities, and the reduction of defects, waste, and production costs for companies. The assumption of the research is that the company's internal conditions remain stable and each type of defect stands alone, with limitations on the use of defect data for the July-December 2024 period and the control phase is not implemented, so that the research output is in the form of quality improvement recommendations.

METHOD

This study employed a descriptive quantitative research design using secondary data obtained from PT Magnum Attack Indonesia, located in [specific location to be added]. The research methodology integrated Six Sigma DMAIC and TRIZ frameworks to identify and resolve product quality issues in the pants production process.

The research population consisted of all pants products manufactured between July and December 2024, totaling 6,951 units. A census sampling technique was applied, in which all defective products (430 units) identified during this period were analyzed to ensure comprehensive coverage of quality issues without sampling bias.

Data were collected through two primary techniques: (1) structured interviews with production supervisors and quality control personnel to obtain information on operational procedures and quality challenges, and (2) documentation review of production records and defect logs maintained by the company's quality assurance department. The data sources included internal documents such as production reports, defect tracking sheets, and quality control inspection records.

RESULTS AND DISCUSSION

Define Stage

SIPOC (*Supplier, Input, Process, Output, Customer*)

To understand the entire production process at PT Magnum Attack Indonesia systematically, the SIPOC (Supplier, Input, Process, Output, Customer) approach is used. This SIPOC diagram serves to map the process flow from the raw material supplier to the final product received by the customer. By compiling key elements such as suppliers, materials/information needed (inputs), the main steps of the production process (process), the results of the process (output), and the product recipient (customer), the company can identify the relationship between the components thoroughly and ensure that each stage runs according to the set quality standards.

In the garment industry, the existence of suppliers at PT Magnum Attack Indonesia plays a very important role because it is the main source in the provision of raw materials and design information that will be processed into the final product. The first type of supplier is a raw fabric supplier, which is a party that provides basic materials for the production of pants. The quality of the fabric received, both in terms of color, texture, fiber strength, and inter-batch consistency, greatly affects the quality of the final product. Therefore, the company selectively selectively selects fabric suppliers, both from local textile factories and from abroad, according to the quality standards set by the buyer. In addition to fabrics, there are also accessories suppliers that supply additional components such as buttons, zippers, brand labels, embroidery threads, and various other embellishments. The existence of these accessories is not only a complement to the function, but also provides aesthetic value and increases the marketability of the product. Therefore, the quality and timeliness of the delivery of accessories from suppliers greatly determine the smooth running of production.

In addition to physical materials, companies also rely on design providers or techpacks, which are technical documents that contain detailed specifications regarding patterns, sizes, types of materials, colors, and product completion methods. Techpack serves as the main guideline so that production results are in accordance with buyer demand. This document can be prepared by an internal design team in collaboration with buyers, or directly provided by buyers from both domestic and international markets. Thus, suppliers at PT Magnum Attack Indonesia not only play a role in providing materials such as fabrics and accessories, but also include parties who provide technical information in the form of product design.

CTQ Identification

In an effort to improve product quality and customer satisfaction, it is very important to identify the elements that have the most influence on product quality. These elements are known as Critical to Quality (CTQ), which are important characteristics that must be met in order for a product to be accepted by customers. This CTQ is obtained based on customer needs and expectations (Voice of Customer) which is then translated into measurable technical parameters.

After creating a CTQ tree, then determine the type of defect that occurred. In the production process of pants for the July-December 2024 period, there are three types of defects, namely seam, precision, and size. The percentages for each type of disability can be seen as shown in Table 1.

Table 1. Percentage of Type of Defect

No	Types of Defects	Frequency	Percentage
1	Stitches	189	43,95%
2	Accuracy	137	31,86%
3	Size	104	24,19%
Total		**430**	**100%**

The first type of defect found was damage to the seams with a percentage of 43.95%, which was characterized by untidy stitch results. This is an indication of visual and functional defects because it does not meet the company's quality standards, where the thread must not come loose, break, or form corrugated seams. Neat, strong, and consistent seams are essential for customers because they give a professional impression, increase product durability, and ensure comfort during use. Conversely, loose or wavy seams will lower customer confidence in the quality of the product and the brand.

Furthermore, defects related to accuracy with a percentage of 31.86%. Accuracy includes the accuracy of the position and type of logo, label, or tag, as well as the suitability of product colors and patterns. For customers, especially buyers or international brands, design accuracy is crucial to maintain brand identity and product consistency in the market. A mismatch on the label can lead to returns and complaints, while a difference in color or pattern can indicate a failure in the dyeing or washing process, which ultimately lowers the brand image and customer satisfaction.

In addition, 24.19% defects in size are also one of the problems. Products with non-standard sizes are at high risk of being returned by customers, which negatively impacts their satisfaction and loyalty levels. The right size greatly affects the comfort of use and the perception of quality, so mistakes in this aspect can make customers reluctant to make a repeat purchase. The overall high level of defects not only increases the cost burden of repairs and rework, but also reduces efficiency in the production process. Therefore, seams, precision, and size are Critical to Quality (CTQ) factors that must be controlled consistently to maintain product quality and customer trust.

Measure Stage

DPMO and Sigma Level

After identifying the characteristics included in the CTQ, the next step is to measure the level of capability of the production process by calculating the DPMO value and sigma level. This calculation aims to find out how often defects occur in the production process and the extent to which the process is able to produce products according to the set quality standards. Low DPMO values and high sigma levels indicate that the production process runs effectively with minimal defects.

a. DPMO calculation

Before measuring the level of capability of the production process, it is necessary to calculate the DPMO value to know how often defects occur in a million opportunities. This calculation is one of the important indicators in assessing the effectiveness and quality of the production process, as well as helping to determine the level of sigma achieved by the company. The calculation of the DPMO value is carried out using the formula as in equation 2.1.

$$DPMO = \frac{Total\ of\ damage}{Total\ of\ production\ x\ total\ of\ defect\ type} \times 1.000.000$$

Based on this formula, the DPMO value in the July-December 2024 period is obtained as shown in Table 2.

Table 2. DPMO calculation

Moon	Production Quantity	Number of Defects	DPMO
July	1000	80	26.667
August	886	98	36.870
September	950	33	11.579
October	1300	122	31.282
November	1840	78	14.130
December	975	19	6.496
Total	**6951**	**430**	**127.024**

Example calculation:

$$DPMO = \frac{80}{1000\ x\ 3} \times 1.000.000$$
$$DPMO = 0{,}02666 \times 1.000.000$$
$$DPMO = 26.667$$

After obtaining the DPMO value, then make a chart of the DPMO value. Figure 4.3 shows a graph of DPMO values.

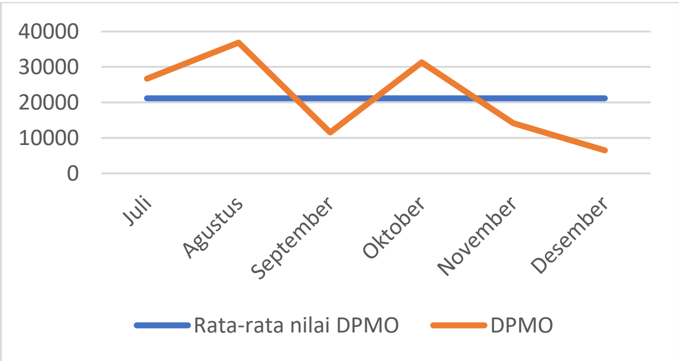

Figure 2. DPMO Value Chart

Based on the graph, it can be seen that the highest DPMO value was in August with a value of 36,870. Then, for the lowest DPMO value, it was in December with a value of 6,496. The average DPMO value in the July-December 2024 period is 21170.61.

b. Sigma Value Calculation

After obtaining the DPMO value, the value is then converted to a sigma value. The calculation of sigma values can be done with the formula in equation 4.2 with the help of *Ms. Excel* software.

$$\alpha = NORMSINV(\frac{1.000.000 \ - DPMO}{1.000.000}) \pm 1{,}5 \qquad \textbf{(2.1)}$$

Based on these equations, the results of the calculation of sigma values for the July-December 2024 period were obtained. The results of the calculation can be seen in Table 3.

Table 3. Sigma Value Calculation

Moon	DPMO	Sigma Value
July	26.667	4,2
August	36.870	4,0
September	11.579	4,7
October	31.282	4,1
November	14.130	4,6
December	6.496	5,0
Average	**127.024**	**4,45**

After the sigma value calculation is carried out, then make a graph of the sigma value. The graph can be seen in Figure 3.

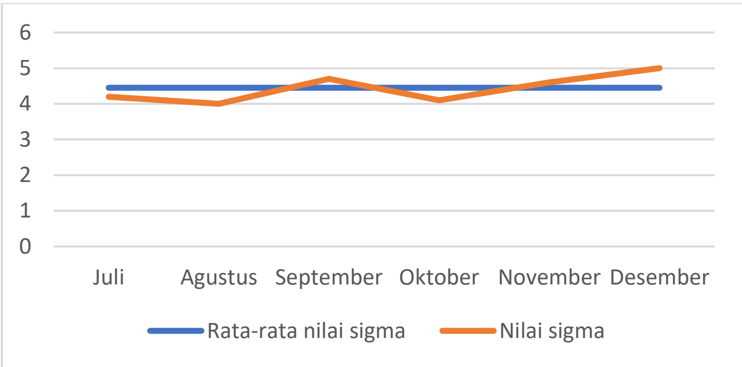

Figure 3. Sigma Value Graph

Based on Figure 3, it is known that the highest sigma value was in December at 5.0. As for the lowest sigma value, it was 4.0 in August. The average sigma value in the July-December 2024 period is 4.45.

Control Map Calculation

This study uses a P-chart type control map in analyzing the quality of the production process. This control map is used to monitor the proportion of defects in each production sample. This P-chart is calculated based on the value of the proportion of defects (dpp) in each period, as well as the average proportion of defects as a whole. Next, the upper control limit (UCL) and the lower control limit (LCL) are determined to evaluate whether the process is still in statistical control or irregularities have occurred. The results of the calculation of the control map for the July-December 2024 period can be seen in Table 4.

Table 4. Control Map P

Moon	Production Quantity	Number of Defects	Propose	CL	UCL	LCL
July	1000	80	0,08	0,062	0,071	0,053

August	886	98	0,11	0,062	0,071	0,053
September	950	33	0,03	0,062	0,071	0,053
October	1300	122	0,09	0,062	0,071	0,053
November	1840	78	0,04	0,062	0,071	0,053
December	975	19	0,02	0,062	0,071	0,053
Total	**6.951**	**430**				
Average	**1.159**	**71,7**				

After making the control map calculation, it then creates a control map graph. The graph can be seen in Figure 4.

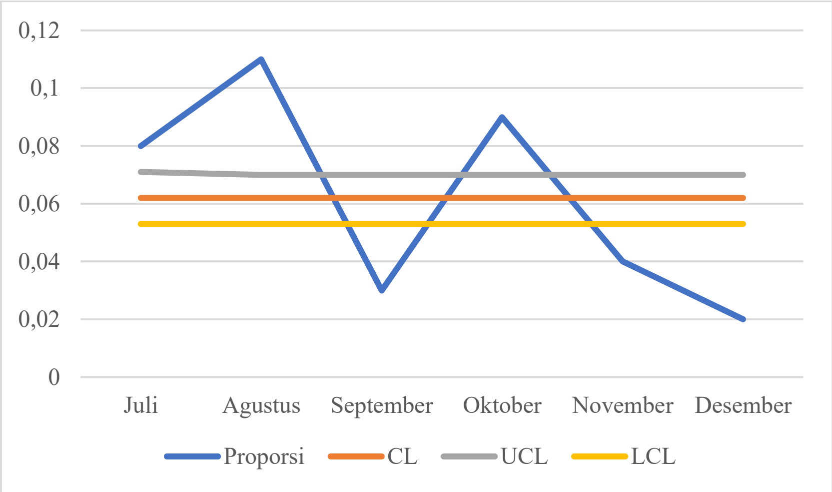

Figure 4. Control Map P

Based on Figure 4, it can be seen that the entire value of the defect proportion from July to December 2024 appears to be outside the upper control limit (UCL) and the lower control limit (LCL). This condition indicates that the production process is beyond statistical control, which indicates the existence of specific causes that affect the quality of the product in that period. Since no single defect proportion point is within the control limit, further evaluation of the factors that cause the process to get out of control is needed to restore stability and production quality.

Process Capability Calculation

The calculation of process capability is carried out by calculating DPU and Final *Yield Test*, with the following calculations.

DPU calculation:

$$DPU = \frac{Total\ of\ defect}{Total\ of\ production}$$

$$= \frac{430}{6951}$$

= 0,06186

Based on the results of DPU calculations, the average probability of defects per month is 6.18% in the production process of pants products.

$$Uji\ Final\ Yield = 100\% - \left(\frac{Total\ of\ defect}{Total\ of\ production} \times 100\%\right)$$

$$= 100\% - \left(\frac{430}{6951} \times 100\%\right)$$

$$= 100\% - 6{,}18\%$$

$$= 93{,}82\%$$

The calculation results showed a DPU value of 0.06186 or a possible defect of 6.18%, with a Final Yield of 93.82%. This value indicates that the production process is quite good because more than 90% of the products meet quality standards.

Analyze stage

In the *Analyze* stage, the main cause of defects in the production process is identified. This study uses two tools to identify the causes of defects, namely the Pareto diagram and the fishbone diagram. Meanwhile, the fishbone diagram helps to outline the root cause of the defect based on several main factors. This analysis is the basis for determining the focus of improvement at the next stage.

Diagram Pareto

Pareto diagrams are used to find out the most dominant types of defects in pants products. This diagram uses data on the type of defect in July–December 2024. The cumulative percentage of defect types can be seen in Table 5.

Table 4 Cumulative Percentage of Defect Types

No	Types of Defects	Frequency	Percentage	Cumulative Percentages
1	Stitches	189	43,95%	43,95%
2	Accuracy	137	31,86%	75,81%
3	Size	104	24,19%	100%
Total		**430**	**100%**	

Based on the table, it is then created a pareto chart chart. The pareto diagram can be seen in Figure 5.

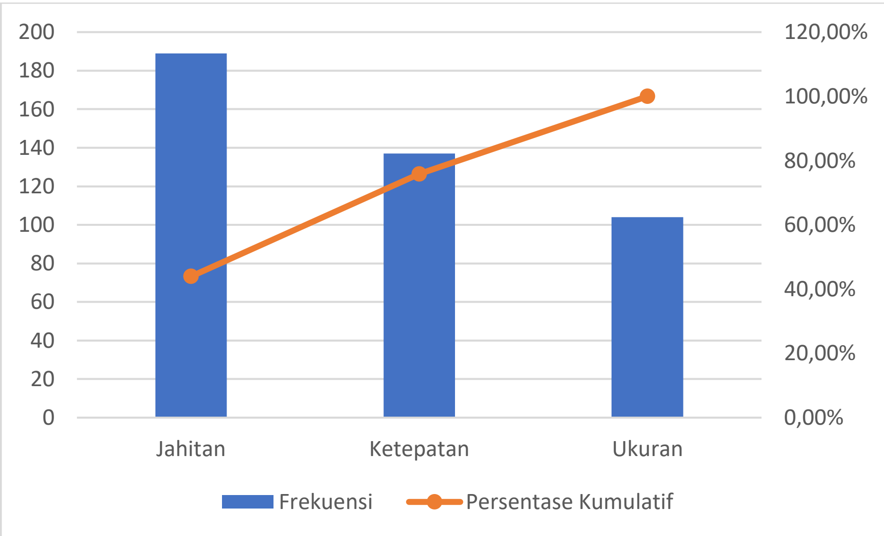

Figure 5. Diagram Pareto

Based on the figure, it can be seen that the most dominant type of defect is the seam with a percentage of 43.95%, followed by the precision defect of 31.86%. These two types of defects when combined have accounted for 75.81% of the total defects that occur, while size defects only contribute 24.19%. Referring to the pareto principle (80/20), the majority of problems come from a small number of causes, so repair efforts should be focused on seam defects and accuracy. By prioritizing improvements in these two categories, the potential for defect reduction can reach more than 75% of the total existing problems, which will ultimately significantly improve product quality.

Fishbone Diagram

The results of the analysis of the pareto chart show that suture and precision are the types of defects with the highest frequency compared to other types of defects. This is the basis for further analysis to find out the main cause of the defect. Therefore, *fishbone diagrams* are used as a tool to systematically identify the root cause of problems. The potential causes are then categorized into four main aspects, namely human, machine, method, and environmental factors, so that a more comprehensive picture can be obtained of the source of size defects in the production process.

Improve stage

At this stage, the first step is to find out the main causes of seam defects and precision defects, then determine repair solutions using the TRIZ method. The TRIZ analysis process through a contradiction matrix begins by identifying existing problems, namely by determining the system parameters to be improved as well as the parameters that are decreasing due to these changes (Nugraha & Haryono, 2022). After that, the problem is formulated in the form of a technical contradiction by referring to the 39 standard parameters listed in Table 2.2 in the TRIZ method. The next stage is to formulate a solution using the 40 inventive principles in TRIZ.

Based on the analysis of TRIZ at PT Magnum Attack Indonesia, the main causes of product defects come from inaccurate operators, undisciplined stitch checking procedures, inconsistent quality of ink or embroidery threads, and incorrect reading of the techpack. Contradictions arise between increased reliability and ease of operation, measurement accuracy and productivity, quantity of substance and productivity, and measurement accuracy and loss of time. The solutions chosen include rearranging the work layout to improve operator accuracy (principle 17), enforcement of SOPs for checking seams (principle 10), quality improvement only in critical embroidery areas (principle 3), and digitization of design instructions with CAD software to reduce misinterpretation (principle 28). This approach effectively reduces potential defects while maintaining productivity, consistency, and product quality in a sustainable manner.

Control stage

At the control stage, the improvement proposals that have been formulated at the improve stage such as rearranging the work layout to improve operator accuracy, implementing SOPs for checking stitch results, selecting materials with local quality in critical parts, and using digital media to read techpacks, needs to be monitored on an ongoing basis. Monitoring is carried out through observation of the production process, evaluation of the operator's work discipline, and periodic inspection of stitch results to ensure the effectiveness of the solution applied. If the improvement proves successful, the steps that have been implemented must be documented and made into new operational standards, so as to maintain consistent production quality and prevent the recurrence of the same problem in the future.

To ensure that the improvement solutions that have been determined at the improve stage can be implemented consistently, a controlling table is prepared as a guide for the company. Table 6 is a controlling table that contains the relationship between the causes of the problem, alternative solutions, and monitoring and evaluation plans that must be carried out. With this table, the control process will be more directed, easy to monitor, and can help maintain stable production quality.

Table 6. Controlling Table

No	*Before Controlling*	*Process Step*	*Control Item*	*Results*
1	Less conscientious operators	Rearrangement of the workbench layout, lighting settings, and use of visual aids (magnifying glass/mini camera)	Sewing operator and Layout work	Increased accuracy, reduced detail errors
2	Undisciplined procedure for checking suture results	Implementation and enforcement of SOPs for checking sewing results	Sewing operator & SOP inspection	More regular and consistent checks

Accuracy Defects

Yes	*Before Controlling*	*Process Step*	*Control Item*	*Results*
1	The quality of the ink or embroidery thread is not uniform	Inspection and selection of quality materials in critical embroidery areas (*local quality*)	Warehouse Parts & Embroidery Operators	The quality of the embroidery in the main area is more consistent
2	Mistake reading *techpack* or design specifications	Digitization of work instructions through *visual software*/templates	Sewing Operator & Design Team	Clearer design interpretation, reduced risk of misreading

Discussion

Pants Production Process Capabilities Based on Sigma and DPMO Values

Company standards must be reflected in the quality of production products to maintain the company's image and reputation. Data-based analysis efforts are needed to reduce the level of defects as well as assess the capabilities of the production process, one of which is through the application *of the six sigma* method by calculating sigma and DPMO values. Based on the results of the calculation of process capabilities, the total production of pants in the period from July to December 2024 was 6,951 units with a total of 430 defects. The DPU obtained was 0.06186 or showed the possibility of defects on average 6.18% of the total production. The *Final Yield calculation* resulted in a value of 93.82%, which means that more than 90% of pants products have met the company's quality standards. Furthermore, the calculated DPMO value reached a total of 127,024 with an average of 21,171 per month. The results of the DPMO conversion to sigma level showed that the production process was at an average level of 4.45 sigma. This value indicates that the production process of Levana pants has a fairly good capability, although there are still opportunities for improvement to reduce the defect level to approach a higher sigma level.

The Most Dominant Types of Defects in Pants Products

The first type of defect found in pants products is seam damage with a percentage of 43.95%. This defect is characterized by untidy stitches, loose or broken threads, and wavy stitch patterns. This condition is categorized as a visual as well as functional defect because it does not meet the company's quality standards, where the seams must be strong, flat, and consistent. Seams that do not meet standards have the potential to degrade the image of the product and trigger the return of goods by customers. On the other hand, precise stitching can increase the durability of the product, give a professional impression, and guarantee comfort when used. Therefore, in the context of CTQ, the seam is set to have a maximum tolerance limit of 2 mm deviating from the pattern, the distance between the seams is consistent 3–4 mm, and the thread must not be broken in a single seam line.

The second defect that often appears is inaccuracy with a percentage of 31.86%. These types of defects include errors in the positioning of logos, labels, or *tags*, as well as inconsistencies in the color and pattern of the product with design standards. For *international buyers* and brand owners, design accuracy is a crucial aspect in maintaining brand identity and product consistency in the market. Errors in the label can cause mismatch of information, while differences in color or fabric patterns indicate problems with the dyeing and washing process. This condition risks lowering customer confidence and the company's image in the global market. To prevent this, the CTQ specifications that must be met include the position of the label that is a maximum of 1–2 mm from the reference point, the color is in accordance with *the pantone standard* that has been determined, and the fabric pattern must not shift more than 3 mm from the design pattern.

In addition, size defects were also found with a percentage of 24.19% of the overall total. Products with sizes that do not meet the standard have a high risk of being returned by customers because they do not provide comfort in use. The right size is an important factor in maintaining customer satisfaction and loyalty, especially in fashion products that are directly related to body comfort. A missize not only lowers the perception of quality, but it can also reduce customer interest in making a repeat purchase. From the production side, the mismeasurement causes additional repair and rework costs that should be avoided. Therefore, the CTQ specification for pants size is set with a tolerance of ±0.5 cm from the standard length and waist circumference, and a maximum tolerance of ±0.3 cm in other parts according to the design specifications.

The high percentage of defects in sutures, accuracy, and size indicates that these three aspects are CTQ factors that must be strictly controlled. This control serves not only to ensure products comply with company standards, but also to increase customer satisfaction and trust. The application of clear technical specifications and tolerances helps operators and quality control departments to conduct more objective inspections. Thus, any deviations can be immediately detected and corrected before the product reaches the consumer. Consistency in CTQ control will greatly contribute to improving process capabilities as well as reducing the defect rate in pants production.

Based on the analysis of the pareto diagram, seam defects were recorded as the most dominant type of defect with a percentage of 43.95%. The next position was occupied by precision defects of 31.86%, while size defects only accounted for 24.19% of the total defects that occurred. When seam defects and precision are combined, they contribute to 75.81% of the overall quality problem. This indicates that most production problems are concentrated on two main aspects, namely the quality of the seams and the accuracy of the design and details of the product. Referring to the Pareto principle (80/20), the majority of problems can be suppressed by focusing on the dominant causes, namely seam defects and precision defects. Thus, the priority of repairs directed at seam defects and precision will have a significant impact in lowering the overall rate of product defects.

Quality Improvement Suggestions Using the TRIZ Method

Based on the results of the previous analysis, it is known that seam and precision defects are the most dominant types of defects and contribute the largest to the total quality problems. Therefore, improvements need to be focused on both aspects so that a significant reduction in the number of defects can be achieved. To formulate the right solution, the TRIZ method is used which is able to identify technical contradictions in the production process and provide alternative improvements based on inventive principles. This approach allows companies to find more systematic, innovative, and prevention-oriented solutions, so that product quality can be continuously improved.

Suggestions for repairing production defects at PT Magnum Attack Indonesia with the TRIZ method are focused on four main aspects: less thorough operators, undisciplined stitch checking procedures, inconsistent ink/embroidery thread quality, and incorrect reading of techpacks. For less conscientious operators, the solution chosen is principle 17 (another dimension) with rearrangement of work layout, visual media, and ergonomic improvements to increase accuracy without adding complicated procedures. In the matter of checking seams, principle 10 (preliminary action) is applied through the enforcement of SOPs as a standard that ensures consistency and discipline of operators. For accuracy defects due to non-uniform ink/thread, the solution chosen is principle 3 (local quality), namely improving quality in critical areas of the product so that consistency is maintained with cost efficiency and productivity remains stable. Meanwhile, the techpack reading error is overcome with principle 28 (mechanics substitution), which is the digitization of instructions using CAD software so that instructions are clearer, more accurate, and consistent, thereby reducing the risk of human error and supporting mass production. These four strategies are considered effective because they directly target the root of the problem, maintain productivity, reduce the defect rate, and improve product quality in a sustainable manner.

CONCLUSION

The analysis using Six Sigma DMAIC and TRIZ methods at PT Magnum Attack Indonesia showed that from 6,951 units produced, 430 defects were identified, resulting in a DPU of 0.06186 (6.18%), a Final Yield of 93.82%, a DPMO of 127,024, and an average sigma level of 4.45, indicating a fairly good process performance with potential for further improvement. The Pareto analysis revealed suture and precision defects as the most dominant, accounting for 75.81% of total issues, making them the primary targets for improvement. Recommended solutions included optimizing workstation layouts, enhancing lighting and visual aids, enforcing seam inspection SOPs, improving embroidery material quality, and digitizing design guides through CAD systems to reduce misinterpretation. The company is advised to maintain continuous quality control, evaluate improvements periodically, and reinforce defect prevention measures. Future research should expand the dataset and time frame, assess the control phase to validate improvement effectiveness, and integrate methods such as FMEA or Lean Manufacturing to further enhance production efficiency and quality performance.

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