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QUALITY CONTROL OF T – BOLT CLAMP PRODUCTS USING THE SEVEN TOOLS METHOD: A CASE STUDY OF PT XYZ

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Abstrak — *This research aims to identify and anticipate the dominant types of defects, so that the root causes can be analyzed and corrective actions can be proposed based on statistical quality control. The production of T-bolt clamps at PT XYZ in 2025 revealed significant fluctuations in product quality, with an average defect rate of 2.54% from a total of 360,706 units manufactured. The peak defect rate occurred in July, reaching 4.8%, indicating systemic issues in the manufacturing process. This study aims to identify the dominant defect types, analyze their root causes, and propose corrective actions based on statistical quality control.The Seven Tools of Quality—Check Sheet, Pareto Chart, Fishbone Diagram, Histogram, Control Chart, Scatter Diagram, and Stratification—were applied to systematically evaluate production data. Results show that Dimensional Deformation was the most critical defect, accounting for 43.25% of total defects. The Fishbone Diagram revealed contributing factors across human, machine, material, method, measurement, and environmental categories. Histogram and Control Chart analyses indicated that the process was generally stable, though several periods exhibited special cause variation. The Scatter Diagram demonstrated a positive correlation (r =0.68) between workplace temperature and defect occurrence, while Stratification confirmed that Machine B produced significantly more defects than Machine A (p<0.05).In conclusion, dimensional defects are primarily influenced by environmental conditions and machine performance. Recommended improvements include workplace temperature control, regular machine calibration, operator training, and continuous monitoring through statistical process control. These measures are expected to reduce defect rates below 3% and enhance long-term production stability.*

Keywords: *Seven Tools of Quality, T-bolt clamp,Dimensional Deformation,Statistical Process Control*

1. INTRODUCTION

Amidst the high productivity demands at PT XYZ, product quality stability is a major challenge that must be managed with discipline. As a crucial component in high-pressure piping and connection systems, T-bolt clamps demand uncompromising precision standards. Even the slightest failure in the material or dimensions of these clamps can have a direct impact on operational safety and overall system efficiency. Therefore, consistency of produc tion results is a key benchmark for the company in maintaining credibility and minimizing costs due to failed products (rejects). Throughout 2025, PT XYZ's produc tion line processed a fairly dynamic production volume, with a monthly average of around 30,000 units. However, fluctu

ations in this production volume have a quite visible impact on the defect rate in the field. Cumulative annual data shows that of the total 360,706 units produced, 9,240 units were identified as having production defects. Although the average was at 2.54%, there was a worrying upward trend from June to August, with the defect rate reaching 4.8% in July.

Bulan	Total Produksi (Unit)	Jumlah Cacat (Unit)	Tingkat Cacat (%)
Januari	28.417	341	1,2%
Februari	29.863	448	1,5%
Maret	30.154	633	2,1%
April	29.328	821	2,8%
Mei	31.572	1.01	3,2%
Juni	30.645	1.379	4,5%
Juli	31.891	1.531	4,8%
Agustus	30.436	1.065	3,5%
September	29.119	728	2,5%
Oktober	30.762	554	1,8%
November	28.935	405	1,4%
Desember	29.584	325	1,1%
Total	**360.706**	**9.24**	**2,54% (Rata-rata)**

Table 1 Recapitulation of Production and Defects of T-bolt Clamps at PT XYZ in 2025

The high number of defects in the middle of the year was an important signal for management to make improvements. This condition reflects a bottleneck in the work flow that requires a more detailed root cause mapping. To that end, this report will explore every stage of the production process, from material usage to the technical aspects of the machine, to understand why these produc tion variations tend to lower quality stan dards. The use of integrated quality analysis tools is a strategic step we have taken. We utilize a structured data collection mecha nism to observe the pattern of defect occur rences over time, while dissecting the main causal factors through cause-and-effect diagrams. The primary focus of this evalu ation is to identify weak points that trigger failures, so that improvements can be made more precisely. It is hoped that through sharp identification and planned mitigation measu res, PT XYZ can stabilize production quality and ensure that each T-bolt clamp unit produced always meets the specified specifications, while simulta neously redu cing the number of defective products back to a safer and more efficient level.

2. METHODOLOGY

This research was conducted on the T-bolt clamp component production line at PT XYZ. Data collection spanned one full year, from January 1, 2025, to December 31, 2025, with the goal of obtaining a comprehensive and accurate operational picture of the company's annual quality performance. The research focused on T-bolt clamp products produced throughout the period, with a primary emphasis on the identification, classification, and in-depth analysis of the factors causing defects that occurred during the manufac turing process. To quantitatively evaluate and improve production quality, this study emplo yed the Seven Tools method. This method serves as a systematic and structured analy tical instrument for mapping process deviations through the use of Check Sheets, Pareto Charts, Fishbone Diagrams, Histo grams, Control Charts, Scatter Diagrams, and Stratification. This method was selected based on its proven effectiveness in transfor ming complex raw data into logical and actionable information to support strategic decision-making and problem-solving on the production floor.

2.1. Data collection technique

The data collection techniques, in this study utilized three systematic approaches:

- ***Observation Method.*** *Data collection through observational methods was carried out by directly and carefully observing the entire workflow on the production line. Researchers monitored how each manufacturing stage was carried out to understand the actual operational conditions in the field. This approach was crucial for identifying potential technical obstacles, machine operation, and operational behaviors that directly impact the consistent quality of T-bolt clamps produced by PT XYZ.*
- ***Interview Method****. Interviews were conducted in a structured, in depth question and answer session with parties directly involved in the production process, such as line operators, machine technicians, and Quality Control depart ment staff. This process aimed to gather*

factual information regarding technical obstacles in the field and to gain a practical perspective on the variables that often trigger production defects that are not captured by the formal reporting system.

- *Data Collection (Documentation), Data collection was conducted by integrating two main categories of information sources:*
  - *Primary Data, namely data obtained directly in the field through in-depth observation and interviews with key informants within PT XYZ.*
  - *Secondary Data, namely historical company data, including daily Quality Control reports and monthly produc tion records.*

***2.2. using recapitulation data**. This data contains a summary of total daily production output and the number of product units classified as defective throughout 2025. This then serves as the primary quantitative database for proces sing using the Seven Tools method. By integrating these three data collection techniques, this study aims to accurately map production failure patterns. The results of this data analysis will then serve as the basis for formulating mitigation measures and recommen dations for fundamental process improve ments to ensure stable production quality in the future. When defective products are returned to a safer and more efficient level.*

3. RESEARCH RESULTS AND DISCUSSION

The initial step in controlling the quality of T-bolt clamp components at PT XYZ is to collect structured data using a Check Sheet. This instrument is designed to ensure that every product unit declared as reject during the period of January to December 2025 is recorded with high accuracy based on the type of defect found. The use of this check sheet becomes a quantitative foundation in the research, because it allows the identi fication of product failure patterns that have been sporadic into systematically classified information. During the observation period, a total of 9,240 defective product units were found out of 360,706 total production units. Through the check sheet, the data is categorized into four main types of defects to facilitate mapping of problems on the production floor, as presented in the follo wing table:

No	Jenis Cacat	Definisi Operasional	Frekuensi (Jan-Des 2025)	Persentase
1	Deformasi Dimensi	Ketidaksesuaian ukuran *diameter* atau *gap* pada *T-bolt* yang menyebabkan klem tidak mampu mengunci dengan sempurna.	3.996	43,25%
2	Cacat *Finishing / Coating*	Permukaan logam yang terkelupas, berkarat, atau proses pelapisan yang tidak merata (*uneven coating*).	2.68	29,00%
3	Kegagalan Las (*Welding Fault*)	Sambungan pada baut atau *strap* yang retak atau tidak menyatu dengan kuat akibat panas las yang tidak stabil.	1.663	18,00%
4	Ketidakpresisian *Thread*	Ulir baut (*bolt thread*) yang tidak presisi atau rusak, menyulitkan pemasangan mur (*nut*).	901	9,75%
Total			**9.24**	**100%**

Table 2 Check Sheet for Types of T-Bolt Clamp Product Defects (2025)

The data summarized in the check sheet provides an initial overview of the production line performance. The high frequency of Dimensional Deformation reaching 43.25% indicates a systemic issue in the forming machine parameters or the material varia bles used. Meanwhile, Finishing Defects contributing 29% indicate the need for evaluation of the production environment or metal surface treatment process. Collecting data through this check sheet is not just a matter of recording numbers, but a crucial process to separate "real problems" from "minor disturbances". With well-documented data in the check sheet, PT XYZ manage ment can see the failure trend on a monthly basis, which helps in determining when and where quality interventions should be carried out. The table above serves as valid empirical evidence to move on to the next stage of analysis, namely prioritizing impro vements through a Pareto Chart to address the quality challenges faced by the company. Using the following Pareto diagram illustrates the distribution of defect types that occurred during the period January to December 2025 in the T-bolt component production process.

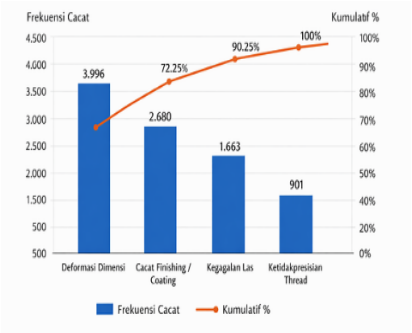


Table 3 Pareto Diagram of Production Defects (Jan-Dec 2025)

The main objective of this analysis is to identify the most dominant types of defects so that they can be the focus of quality improvement. From the data collection results, there are four main defect categories: Dimensional Deformation, Finishing/Coating Defects, Weld Failures, and Thread Imprecision. The graph shows that the first two categories account for more than 70% of the total defects, indicating priority areas for corrective action and process improvement. In an effort to improve the quality of T-bolt component production, an in-depth analysis was conducted on the most dominant type of defect, namely Dimensional Deformation. To systematically understand the root cause, a Fishbone Diagram (Cause-Effect Diagram) was used as a visual aid. This can be seen in Figure 1 as follows:



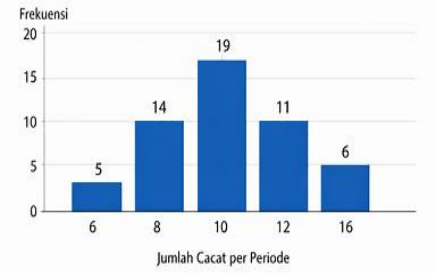
Figure 1 Fishbone Diagram of Dimensional Deformation

A fishbone diagram helps to describe the various factors that contribute to deformation by grouping the causes into six main categories: Man, Machine, Material, Method, Measurement, and Environment. Through this approach, the production team can trace the relationship between human factors, equipment, materials, work methods, measu rement systems, and environmental condi tions to the emergence of dimensional defects. This analysis forms the basis for more targeted improvement steps, such as improving operator training, regular machine calibration, and reviewing work procedures to ensure proper dimensions. Using a histo gram, the distribution of the number of Dimensional Deformation defects per produc tion period can be shown. Data were taken from 25 observation periods with an average total of defects $\bar{x}$=6.4 units per period. To assess the shape of the distribution, the data was grouped into class intervals (0–2, 3–5, 6–8, 9–11, and 12+). The frequency of each class was calculated using the basic formula:

$$fi = \frac{ni}{N} x\ 100\%$$

where
n = is the number of defects in class i
N = total observations.

By entering the data, the calculation results show that class 6–8 defects have the highest frequency (15 times), indicating that most processes are around the average. The distribution curve approaches a normal shape, indicating natural variation in the production process.



Gambar 2 Distribusi Cacat Deformasi Dimensi

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

With a standard deviation of s=2.3, the defect distribution indicates that 95% of the data falls within ±2s of the mean, so the process can be categorized as statistically stable. However, several periods with defects exceeding 10 units require review as they fall outside the general pattern. Further

analysis can focus on machine and work method factors to reduce extreme variations. Control charts are used to monitor the stability of the production process based on the number of defects per period. The process mean is calculated as:

$$CL=\bar{x}=6,4$$

Meanwhile, the upper and lower control limits are determined by the formula:

$$UCL=\bar{x}+3s=6,4+3(1,6)=11,2$$

$$LCL=\bar{x}-3s=6,4-3(1,6)=1,6$$

From the graph, it can be seen that most of the points are between UCL and LCL, indica ting that the defect variation is still within the statistical control limits.

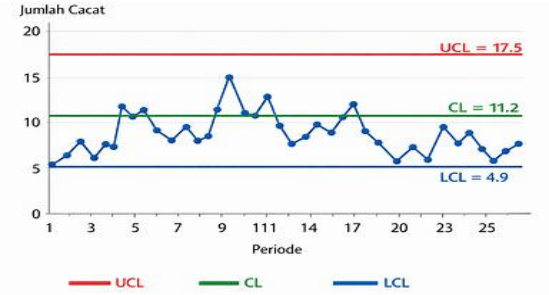


Figure 3 Control Chart of Dimensional Deformation Defects

There are three data points that exceed the upper limit (UCL = 11.2), indicating the presence of special cause variation that needs to be investigated. Possible causes are inconsistent machine calibration or changes in material quality. Overall, the T-bolt production process can be categorized as statistically controlled, but still requires regular monitoring to maintain product quality and reduce defects below the control limit. Stratification is carried out to separate defect data based on production machines (Machine A and Machine B). Of the total 25 periods, Machine A produces an average of $\bar{x}$ *A = 5.8 defects per period, while Machine*

B produces an average of $\bar{x}$ *B = 7.1. This difference is tested using a simple t-test:*
By entering data from both machines, the test results show a t-value of 2.15 with p<0.05, so the difference in defects between Machine A and Machine B is statistically significant. Stratification is carried out to separate defect data based on production

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} - 2r\left(\frac{s_1}{\sqrt{n_1}}\right)\left(\frac{s_2}{\sqrt{n_2}}\right)}}$$

machines.

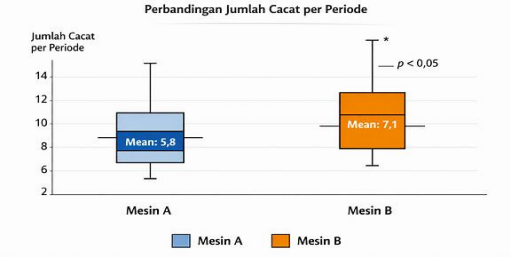


Figure 4. Stratification of Production Defects

The stratification diagram shows that Machine B produces deformation defects more frequently than Machine A. This indicates the need for recalibration of Machine B or evaluation of operator work procedures.

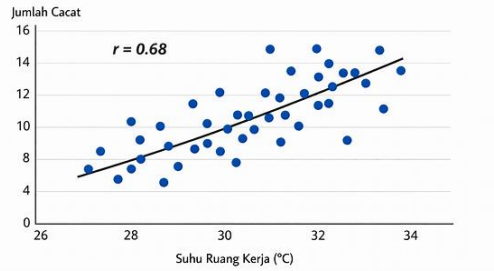


Figure 5 Correlation of Production Defects vs. Work Room Temperature

Data stratification shows that Machine B produces deformation defects more frequently than Machine A. This indicates the need for corrective action, such as recalibration of Machine B or review of the work procedures of the operators working on that machine. Using the combination of the Scatter Diagram and Stratification, we can conclude that the environment (temperature) and production machine are the dominant factors influencing dimensional deformation defects. Correlation of Defects vs. Work room Temperature: This scatter diagram shows the relationship between the number of Dimensional Deformation defects and the workroom temperature. Across 25 observa tion periods, the average defect rate was:

By entering the data and calculating with the correlation formula, the value of r = 0.68 is obtained, indicating a moderate strong positive correlation: the higher the tempe rature, the more defects appear. Interpre tation of the scatter diagram shows that environmental factors (temperature) play a significant role in product quality. This supports the need to control the temperature of the work space so that dimensional deformation can be suppressed. Correlation and stratification analysis show that the temperature of the work space and the performance of the production machine are the dominant factors that influence dimen sional deformation defects.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusions

The author provides several conclusions based on the results of the research conducted as follows:

- *The results of this study can be concluded that the analysis of the data produced can be used as a basis for further consideration and as a bench mark for companies in formulating mitigation steps and recommendations for fundamental process improvements, in order to ensure that the stability of production quality is maintained in the future.*

- *The research results can be used to quantitatively evaluate and improve production quality levels. This study applied the Seven Tools method.*

- *This method can be used as a syste matic and structured analysis instru ment for mapping process deviations through the use of check sheets, Pareto charts, fishbone dia grams, histograms, control charts, scatter diagrams, and stratification.*

4.2. Recommendations

The author provides several recom menda tions based on the research results as follows:

- *The results of the production quality analysis using a combination of statis tical tools, such as the Pareto Diagram, Fishbone Diagram, Histogram, Control Chart, Scatter Diagram, and Stratifica tion, indicate that Dimensional Deforma tion defects are the most significant primary problem. The Pareto analysis indicates that this defect accounts for more than 40% of the total defects, while the Fishbone analysis identifies root causes stemming from human, machine, material, method, measurement, and environmental factors.*

- *The Histogram and Control Chart show that the process is generally stable, but there are several periods with defects above the control limits (UCL), indicating special cause variation. The Scatter Diagram shows a positive correlation (r = 0.68) between workspace temperature and the number of defects, while the Stratification analysis demonstrates that Machine B produces more defects than Machine A, with a significant difference (p < 0.05).*

- *Based on these calculations, the recom mended improvement measures are not merely descriptive but based on robust statistical data. The primary focus is on controlling the work environment, calibra ting machines, improving operator competency, and implementing a conti nuous statistical monitoring system.*

5. REFERENCES

[1] American Society for Quality (ASQ)., Seven Basic Quality Tools. Milwaukee: ASQ.

[2] Atmaja, D. A. S. P., Purbawati, P., & Yusup, M. (2023). Penerapan Metode Seven Tools Dalam Pengendalian Kualitas Produk. Jurnal Ilmiah Sistem Informasi Dan Ilmu Komputer, 3(3), 238–246

[3] Damayanti,V.N.(2022). Analisis Pengen dalian Kualitas Produk Dengan Menggu nakan Metode Statistical Process Control (Spc) Dan New Seven Tools Di Pt Hari Mukti Teknik.

[4] Crosby, P. B., Quality is Free. New York: McGraw-Hill.

[5] Deming, W. E., Out of the Crisis. Cam bridge: MIT Press.

[6] Dale, B. G., van der Wiele, T., & Van Iwa Arden, J., Managing Quality. 6th Edition. Chichester: Wiley.

[7] Evans, J. R., & Lindsay, W. M., Mana ging for Quality and Performance Exce llence.10th Edition. Boston: Cengage Learning.

[8] Feigenbaum, A. V., Total Quality Control. 3rd Edition. New York: McGraw-Hill.

[9] Gasperz, V., Total Quality Management. Jakarta: Gramedia Pustaka Utama.

[10] Gilang Kistianto, D., & Prakoso, I. (2023). Analisis Kualitas Produk Joran Pancing Dengan Menggunakan Metode New Seven Tools (Studi Kasus: Pt.X). Jurnal Ilmiah Teknik Dan Manajemen Industri, 3(1), 68–79.

[11] Gitlow, H. S., Oppenheim, A. J., Oppen heim, R., & Levine, D. M., Quality Management. 3rd Edition. New York: McGraw-Hill.

[12] Hoerl, R. W., & Snee, R. D., Statistical Thinking: Improving Business Perfor mance. 2nd Edition. New Jersey: Wiley.

[13] Ishikawa, K., Guide to Quality Control. Tokyo: Asian Productivity Orga nization.

[14] ISO9001., Quality Management Sys tems Requirements. Geneva: Interna tional Organization for Standardization.

[15] Juran, J. M., Juran's Quality Hand book. 5th Edition. New York: McGraw-Hill.

[16] Juwito, A., & Al-Faritsyi, A. Z. (2022). Analisis Pengendalian Kualitas untuk Mengurangi Cacat Produk dengan Metode Six Sigma di UMKM Makmur Santosa. Jurnal Cakrawala Ilmiah, 1(12), 3295–3315. http://bajangjournal.com/index.php/JCI

[17] Montgomery, D. C., Introduction to Statistical Quality Control. 7th Edition. New York: John Wiley & Sons.

[18] Mitra, A., Fundamentals of Quality Control and Improvement. 4th Edition. New Jersey: Wiley.

[19] Oakland, J. S., *Total Quality Manage ment and Operational Excellence.* 4th Edition. London: Routledge.

[20] PT XYZ. (2025). Laporan Produksi dan Quality Control T-bolt Clamp Tahun 2025. Dokumen internal perusahaan.

[21] Pengendalian, A., Dengan, K., Stati stical, M., Control, P., Solar, P., & Heater, W. (2022). Jki 1.2.2022. 1(2), 191– 201.

[22] Syarifah Nazia, Safrizal, & Muhammad Fuad. (2023). Peranan Statistical Quality Control (Sqc) Dalam Pengendalian Kualitas: Studi Literatur. Jurnal Mahasiswa Akuntansi Samudra, 4(3), 125–138. https://doi.org/10.33059/jmas.v4i3.8079