The Indonesia Journal of Computer Science
www.ijcs.net
Volume 13, Issue 5, October 2024
https://doi.org/10.33022/ijcs.v13i5.4412

Welding Quality Control Using Seven Tools Method

Mohammad Hamzah[1], Dwi Sukma Donoriyanto[2*], Rizqi Novita Sari[3]
dwisukama.ti@upnjatim.id
Universitas Pembangunan Nasional "Veteran" Jawa Timur

Article Information

Received : 27 Sep 2024
Revised : 13 Oct 2024
Accepted : 29 Oct 2024

Keywords

Welding, Quality Control, Seven tools

Abstract

PT. XYZ is the largest shipyard company in Indonesia. In the ship production process, PT. XYZ Indonesia strives to provide the best for consumers, especially in terms of the quality of making the KCR-301 ship, where during the welding process there are still several defects such as Incomplete Penetration, Incomplete Fusion, Slag Inclusion and Porosity. The purpose of this study was to determine the percentage of the most dominant defects in welding and provide recommendations for improving the quality of welding on the KCR-301 ship using the seven tools method. Based on the results of the study, it was found that the most dominant defect in welding quality was Incomplete Penetration of 800 mm (2.93%), then followed by Incomplete Fusion defects of 630 mm (2.31%), Slag Inclusion defects of 595 mm (2.18%), and Porosity defects of 460 mm or (1.69%). The proposed improvements to the most dominant ones with the proposed recommendations for improvement are to emphasize to the welder to be required to better understand the procedures and SOPs that will be used to weld properly.

A. Introduction

The quality of a product can determine the sustainability of a company [1]. The main variable consumers consider when choosing a product, aside from the price, is the quality of the product [2], [3]. A quality product can be produced from a process that is also of high quality [4], [5], [6].

PT. XYZ is the largest shipyard company in Indonesia. In the ship production process, PT. XYZ Indonesia strives to provide the best for consumers, especially in terms of the quality of making the KCR-301 ship, where during the welding process several welding defects were still found, namely Incomplete Penetration (IP), Incomplete Fusion (IF), Slag Inclusion (SI), and Porosity (POR). From the observed welding, it was known that there were several defects in the KCR-301 ship with a total of 9.3% of defects.

From the problems above, this study aims to determine the most dominant percentage of defects and the factors causing defects and to provide suggestions for improving welding quality. In this research, the Seven Tools method is used. Seven Tools is a collection of tools that can be used for the purpose of analyzing data through mapping, compiling data, making diagrams, to tracing things that might happen and can clarify a phenomenon that is happening in a company [7], [8], [9], [10].

The Seven Tools are easy to understand and implement, even for non-experts. Unlike more complex quality control methods. The tools can be used across various industries and for a wide range of quality problems [11]. They are flexible and not tied to any particular product type or process [12]. The tools are based on quantitative data, allowing objective decision-making. Tools like histograms and control charts make it easier to analyze trends and variability in product quality [13], [14]. These tools can often be implemented quickly, providing immediate insight into quality problems [15]. The Seven Quality Tools are effective for organizations looking for a simple, affordable, and reliable method to improve product quality [16]. Therefore, in accordance with the problems above, the researcher applies the Seven Tools method to find out the causes of product defects to provide suggestions for improving welding quality control at PT. XYZ.

B. Research Method

The method used in this research is the Seven Tools method. The Seven Tools method is a method that has been widely used to control the quality of a product. The stages of the Seven Tools method includes:

1. Data collection of product defects Types of welding defects. There are several types of welding defects at the location where the observation was conducted. The types of defects that occurred were also found in previous research on welding defects [17], [18], [19].
   a. Slag Inclusion (SI)
   b. Incomplete Penetration (IP)
   c. Incomplete Fusion (IF)
   d. Porosity (POR)
2. Data processing using the Seven Tools (Check sheet, Histogram, Pareto, Scatter, Flow Diagram, Control Chart, Cause and Effect Diagram) [20], [21], [22].

3. Next, an analysis and discussion are conducted, and a conclusion is drawn.

C. Result and Discussion

The data that has been collected is the basis for making Current Stream Mapping. Identification is carried out by mapping the goods delivery process through Value Stream Mapping. The mapping contains information on the process flow, category and time for each group of activities, namely value added, non-value added, and neccessary non-value added, the number of activities in each activity group, the total time for each activity group, and the total time for all activities mapped as follows.

The data used in this study is the data during the production process, namely the KCR 301 ship with a total welding of 27270 mm and welding data with 4 types of defects, namely Incomplete Penetration (IP), Incomplete Fusion (IF), Slag Inclusion (SI), and Porosity (POR), then processed using the Seven tools method:

1. *Check Sheet*

Check Sheet or the inspection sheet is a tool used to record the results of data collection and present data in a communicative form so that it can be converted into information.

Table 1. Check Sheet

No	Item	Types of Defects			
		Slag Inclusion	*Porosity*	*Incomplete Penetration*	*Incomplete Fusion*
1	*Fore Bullbouse Bow (FBB)*	LXXV	LX	CX	LXXXV
2	*House Pipe*	CLXXX	CXXX	CCXXV	CLXX
3	*Stern Tube*	CLX	CXX	CCX	CLXXV
4	*Me Seat*	CLXXX	CL	CCLV	CC

2. Stratification

Stratification is a stage for grouping data into groups that have the same characteristics [23]. According to the data collected, the criteria are set for defects in the welding of the KCR 301 ship.

Table 2. Stratification

No	Item	Type of Defects				Disabled (mm)
		Slag Inclusion	*Porosity*	*Incomplete Penetration*	*Incomplete Fusion*	
1	*Fore Bullbouse Bow (FBB)*	75	60	110	85	330
2	*House Pipe*	180	130	225	170	705
3	*Stern Tube*	160	120	210	175	665
4	*Me Seat*	180	150	255	200	785
$\sum$		595	460	800	630	2485

https://doi.org/10.33022/ijcs.v13i5.4412

3. Histogram

A histogram is a bar chart that depicts a number of data grouped into classes at certain intervals.

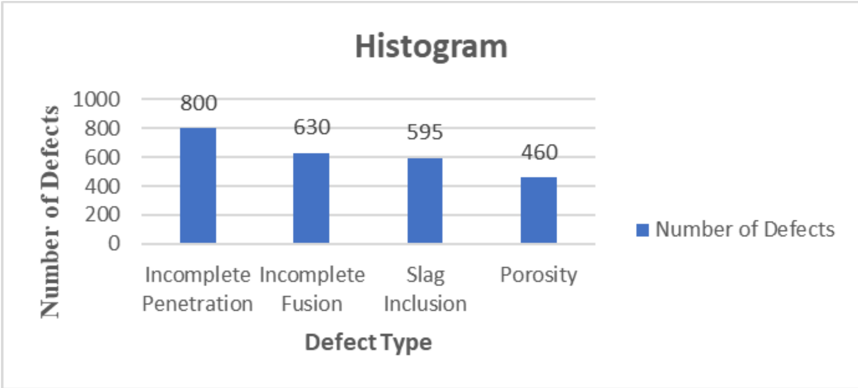

Figure 1. Histogram

Based on Figure 1, it can be seen that the sequence of intervals of each type of defect that occurs most often includes Incomplete Penetration (IP) defects of 740 mm, Incomplete Fusion (IF) defects of 600 mm, Slag Inclusion (SI) defects of 555 mm, and Porosity (POR) defects of 460 mm.

4. Pareto Chart

A Pareto chart is a bar graph that is often used as an interpretation tool to rank each type of defect from largest to smallest [24].

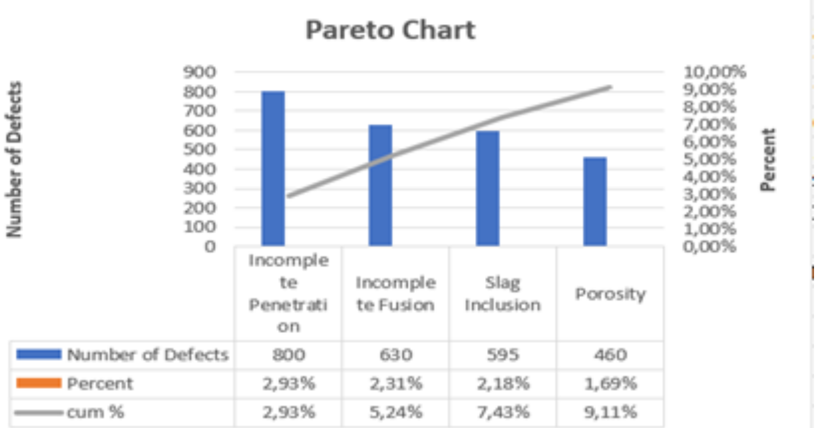

Figure 2. Pareto

Based on Figure 2, it can be seen that the most dominant type of defect seen from the cumulative percentage is Incomplete Penetration (IP) with a percentage of (2.9%), followed by Incomplete Fusion (IF) with a percentage of (2.31%), then Slag Inclusion (SI) with a percentage of (2.18%), and Porosity (POR) with a percentage of (1.69%).

5. *Scatter Diagram*

Scatter Diagramused to show the relationship or correlation between two measurements of the defect-causing factors related to a characteristic [25].

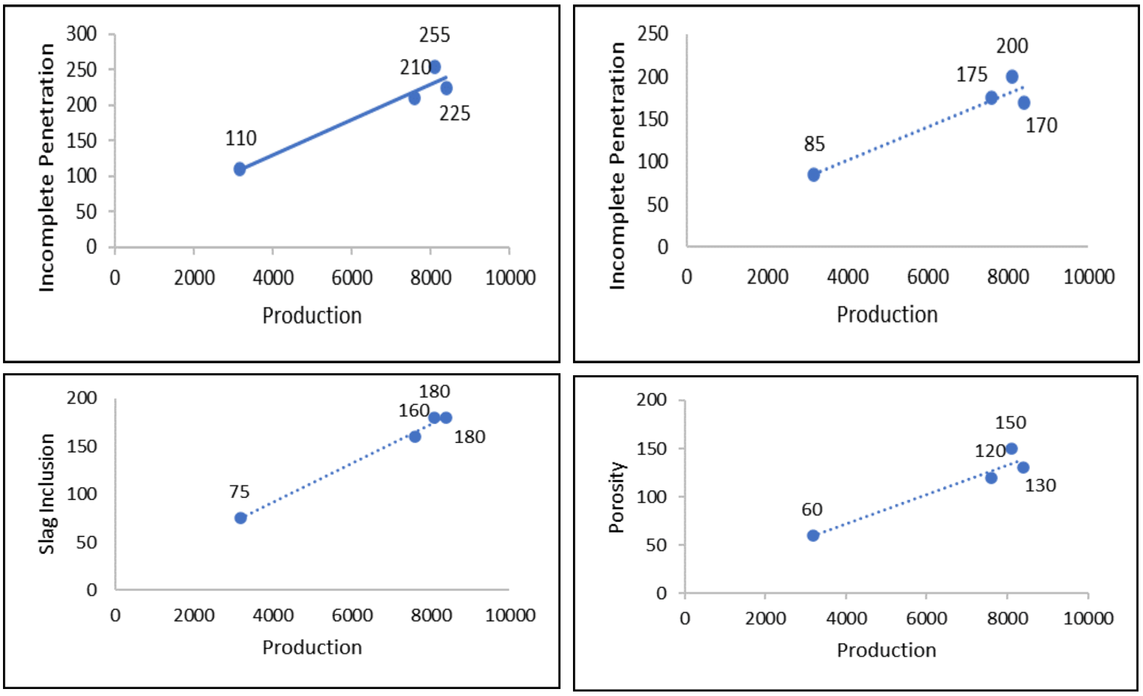

Figure 3. Scatter Diagram

Based on Figure 3, the four types of defects show that there is a positive relationship (positive correlation) where an increase in variable X is followed by an increase in variable Y, meaning that when there is an increase in welding, there is also an increase in the number of defects and vice versa.

6. Control chart

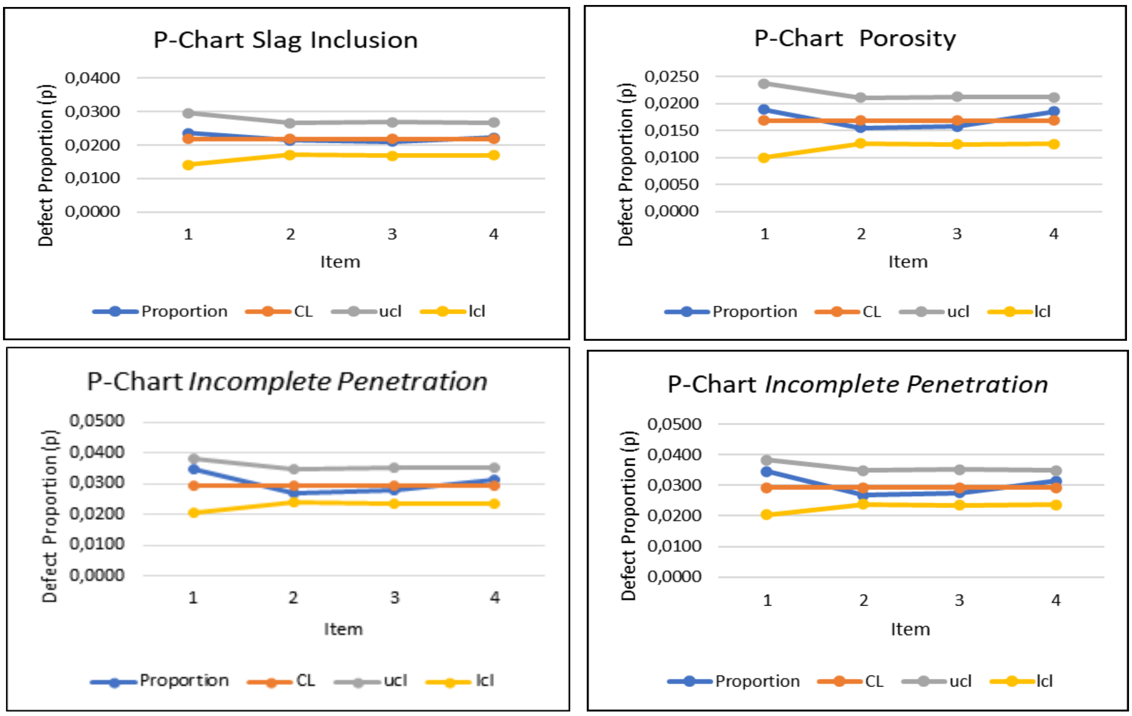

Figure 4. Control Chart

Based on Figure 4. The p attribute control chart shows that the four types of defects that occurred were still within control limits (none were out of control).

7. Fishbone

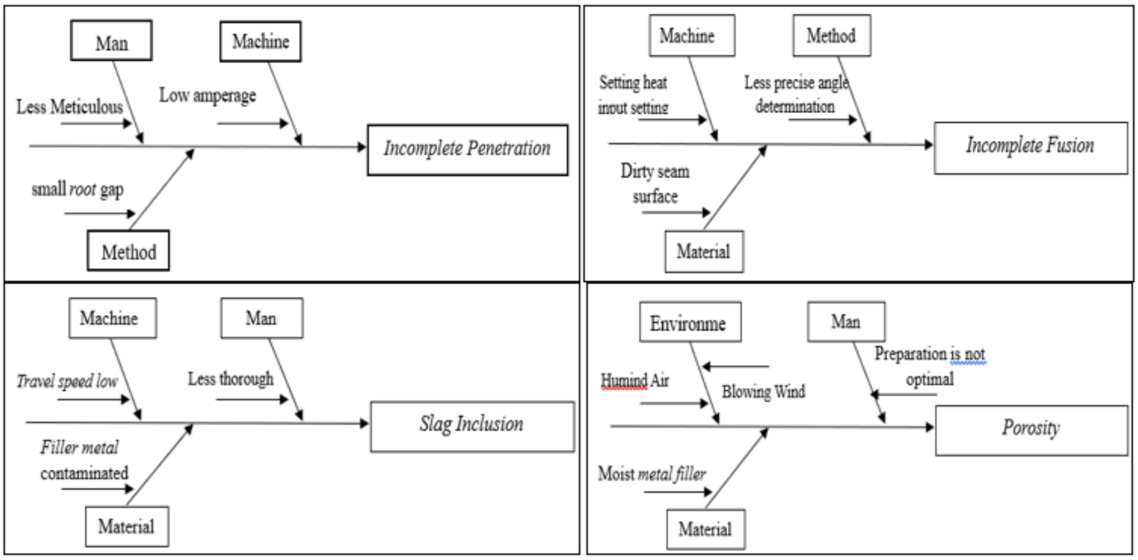

Figure 5. Fishbone

Based on Figure 5, the causes of defects in each factor can be identified. For Incomplete Penetration (IP) defects, the cause of the problem is reviewed from the machine, human, and work method. For Incomplete Fusion (IF) defects, the cause of the problem is reviewed from the material, machine, and work method. For Slag Inclusion (SI) defects, the cause of the problem is reviewed from the human, machine, and material. For Porosity (POR) defects, the cause of the problem is reviewed from the material, human, and environment.

D. Conclusion

The conclusion that can be drawn based on this study is that the most dominant defect in welding quality is Incomplete Penetration (IP) of 800 mm or (2.93%), followed by Incomplete Fusion (IF) of 630 mm or (2.31%), Slag Inclusion (SI) of 595 mm or (2.18%), and Porosity (POR) of 460 mm or (1.69%). The Incomplete Penetration (IP) defect factor with the determination of the root gap is too small or too narrow.

E. References

[1] J. R. Hanaysha, M. E. Al-Shaikh, S. Joghee, and H. M. Alzoubi, “Impact of innovation capabilities on business sustainability in small and medium enterprises,” *FIIB Business Review*, vol. 11, no. 1, pp. 67–78, 2022.

[2] D. H. F. Fauzi and H. Ali, “Determination of purchase and repurchase decisions: Product quality and price analysis (Case study on Samsung smartphone consumers in the city of Jakarta),” *Dinasti International Journal of Digital Business Management*, vol. 2, no. 5, pp. 794–810, 2021.

[3] M. H. Al Togar and Y. R. Al Hakim, “The Effect of Price Perception, Product Diversity, Service Quality and Store Image on Purchase Intention in Bread

Products," *Journal of Marketing and Business Research (MARK)*, vol. 2, no. 1, pp. 35–46, 2022.

[4] J. Yang, S. Li, Z. Wang, H. Dong, J. Wang, and S. Tang, "Using deep learning to detect defects in manufacturing: a comprehensive survey and current challenges," *Materials*, vol. 13, no. 24, p. 5755, 2020.

[5] Y. Lu, X. Xu, and L. Wang, "Smart manufacturing process and system automation–a critical review of the standards and envisioned scenarios," *J Manuf Syst*, vol. 56, pp. 312–325, 2020.

[6] S. T. Foster and J. W. Gardner, *Managing quality: Integrating the supply chain*. John Wiley & Sons, 2022.

[7] Z. N. Halizah and A. D. Sumarna, "The Quality Control Using Seven Tools Method For Defect Product On Scanner Production," *Jurnal Akunida*, vol. 9, no. 1, pp. 25–36, 2023.

[8] S. Mizuno, *Management for quality improvement: the 7 new QC tools*. Productivity press, 2020.

[9] N. R. Tague, *The quality toolbox*. Quality Press, 2023.

[10] A. Wiranto, "POTENTIAL ANALYSIS OF INDUSTRIAL WASTE USING SEVEN BASIC QUALITY TOOL PARETO DIAGRAM," *International Journal of Economy, Education and Entrepreneurship (IJE3)*, vol. 3, no. 3, pp. 907–920, 2023.

[11] Y. D. Nurcahyanie and T. Koesdijati, "Disabled analysis of ceramic products on the glass process using the seven tools method (case study: PT. NJMX surabaya," *Tibuana*, vol. 3, no. 01, pp. 53–60, 2020.

[12] O. McDermott, J. Antony, and M. Sony, "THE USE AND APPLICATION OF ISHIKAWA'S SEVEN BASIC TOOLS IN EUROPEAN ORGANISATIONS.," *International Journal for Quality Research*, vol. 16, no. 4, 2022.

[13] S. Fatimah and H. C. Wahyuni, "Product Quality Control Using the Six Sigma method and Seven Tools in the PDL Shoe Industry," *Tibuana*, vol. 6, no. 1, pp. 12–22, 2023.

[14] R. W. Damayanti, A. R. Wijaya, and B. Hartono, "Seven Management and Planning Tools in Megaproject Management: A Literature Review," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2019, p. 012014.

[15] Y. Erdhianto, "Quality Control Analysis to reduce the number of defects in the packaging of PG Kremboong Sugar Products using seven tools method," *Tibuana*, vol. 4, no. 01, pp. 28–35, 2021.

[16] A. Burhanudin and A. S. Cahyana, "Reducing Production Defects in Indonesian Furniture Using Seven Tools and 5W+ 1H," *Indonesian Journal of Innovation Studies*, vol. 25, no. 4, pp. 10–21070, 2024.

[17] J. J. Perdomo and L. A. Ganhao, "Failures Related to Welding," in *Analysis and Prevention of Component and Equipment Failures*, ASM International, 2021, pp. 266–306.

[18] J. Zhang *et al.*, "A Water Environment-Based Simulated Method for Ultrasonic Testing of Slag Inclusion Weld Defects Based on Improved VMD," *Sensors*, vol. 24, no. 13, p. 4199, 2024.

[19] R. Rochmoeljati, I. Nugraha, and N. A. C. Mulia, "Welding quality control using statistical Quality Control (SQC) methods and Failure Mode Effect

Analysis (FMEA) at PT. XYZ," *Nusantara Science and Technology Proceedings*, pp. 39–45, 2022.

[20] R. P. Wardhani, E. Gustianta, T. Mesin, F. Teknik, and U. Tridharma, "Seven Tools As the Problem Solving Ways T0 Improve Quality Control," *MECHA Jurnal Teknik Mesin*, vol. 3, no. 2, pp. 10–15, 2021.

[21] R. Ginting and A. F. Malik, "Crude Palm Oil Product Quality Control Using Seven Tools (case study: XYZ Company)," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2020, p. 012046.

[22] F. N. Khasanah and D. A. Kurniawati, "Quality Control System Analysis of Crank Shaft Products using Seven Tools Method at PT ABC," in *Proceedings of the National Conference on Electrical Engineering, Informatics, Industrial Technology, and Creative Media*, 2023, pp. 624–632.

[23] J. Antony, O. McDermott, and M. Sony, "Revisiting Ishikawa's original seven basic tools of quality control: a global study and some new insights," *IEEE Trans Eng Manag*, vol. 70, no. 11, pp. 4005–4020, 2021.

[24] B. C. Gupta, *Statistical Quality Control: Using MINITAB, R, JMP and Python*. John Wiley & Sons, 2021.

[25] A. R. R. Dana and D. S. Donoriyanto, "Safety Belt Product Quality Analysis to Analyze The Number of Defects Using The Seven Tools Method at PT. XYZ," *The Indonesian Journal of Computer Science*, vol. 13, no. 1, 2024.