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Implementation of Seven Tools in P4Head Defect Quality Control in the Automotive Component Industry

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ABSTRACT: Current industry developments are pushing automotive component companies to continuously improve and maintain product quality to remain competitive. This research aims to identify the types of defects that arise during the production process, analyze the causes of these defects, and formulate improvement proposals to reduce potential defects in P4head products. Seven Tools was used in this study to analyze data obtained from production reports for the period April to September 2025. The identification results showed that there were three types of defects in the P4head part, namely Sunpoudashi, ID 14.8 Topatsu, and ID 16.4 Mushire. Based on the Pareto diagram, Sunpoudashi defects were the most dominant type of defects with a percentage of 47% and ID 14.8 Topatsu at 39%. Root cause analysis of the two dominant defects, namely Sunpoudashi and ID 14.8 Topatsu, showed that factors contributing to the occurrence of defects based on the fishbone diagram included man, material, machine, method, and measurement. The proposed improvements focused on improving material quality control through incoming hardness and dimension inspections, strengthening the accuracy of the measurement system through routine calibration and method equalization, and stabilizing tool and machine conditions through the implementation of tool life management and preventive maintenance. Through this series of improvements, the potential for defects is expected to be minimized to improve overall product quality.

KEYWOARD: Defect, Product, P4Head, Quality, Seven Tools

I. INTRODUCTION

The production process within a company, whether in manufacturing, services, or other fields, always prioritizes quality. Furthermore, quality can be a key differentiator between one product and another, including when compared to competitors [1]. The quality of the products produced by a company is also a crucial element that influences the success and sustainability of the company in facing market competition [2]. Under these conditions, quality can be considered a non-negotiable aspect. Producing products that do not meet quality standards is essentially the same as pushing a company towards failure, either quickly or slowly [3]. In the manufacturing industry, quality plays a very vital role because it is used as a benchmark to assess the level of readiness of an industry [4]. In production activities, output often falls short of established standards, resulting in the product being declared damaged or defective. To prevent and reduce the occurrence of these defects, companies need to undertake continuous improvement efforts. Defective products are products that are deficient or do not meet specifications, resulting in decreased quality [5].

One of the automotive component manufacturing companies located in the Jababeka industrial area has been established since May 2011. With a strong dedication and commitment to the automotive component industry, this company focuses on the manufacturing process of motor vehicle components, both for four-wheeled and two-wheeled vehicles. Various superior products have been produced, including Retainer, Tappet, P4Head components, and several other types of parts used in the automotive industry. During the production process from April to September 2025, not all production results were able to meet the quality standards set by the company. One of the products experienced problems, namely the P4head product, which was known to have several types of defects. Defective products can cause problems for consumers due to receiving damaged products and not meeting agreed expectations [6]. This condition must be addressed immediately so that the company can maintain its competitiveness.

One step to maintaining product quality is through quality control analysis activities. This process is part of a series of managerial actions aimed at ensuring that each product meets predetermined quality standards [7]. This study uses the Seven Tools method as an approach to quality control in the P4Head spare part production process. Seven Tools, often referred to as 7 Tools, are seven types of graphic-based quality control tools and techniques that function to analyze, identify, and understand various quality-related issues in a production process [8]. To overcome quality issues, a set of seven QC tools is employed, including the Pareto chart, cause-and-effect diagram, histogram, control chart, scatter plot, various types of graphs, and check sheets. [9]. All of these tools play a crucial role and are widely used in the manufacturing industry to monitor overall process performance and support continuous improvement efforts.

This research was conducted to identify various types of defects that appear during the production process, analyze the factors that trigger defects, and develop recommendations for improvements that can help companies reduce defect rates and improve product quality sustainably so as to maintain competitiveness in the automotive industry.

II. MATERIALS AND METHODS

This research began with a preliminary study that included a literature review and direct observation in the automotive components industry. Both steps were carried out to gather relevant information about the research object, both through reference sources such as books, articles, and related documents, as well as through direct observation of actual conditions in the field. Data collection was carried out through observation, interviews with the production and quality control departments, and documentation of production reports from April to September 2025. Next, the data was processed to evaluate the level of defects and formulate recommendations for improvements to reduce the number of non-conforming products. In this study, the Seven Tools method was used as an approach to product quality control [10]. With the following stages:

a. Flow Chart

A flow chart is a problem solving tool that visually illustrates the series of actions and decision points involved in carrying out a process. [11]. Flowchart is a chart that describes the steps of one process to another process that is easy to understand [12].

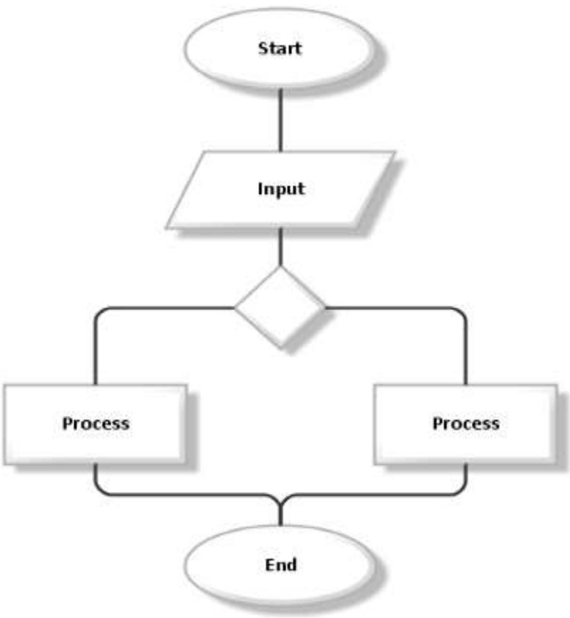
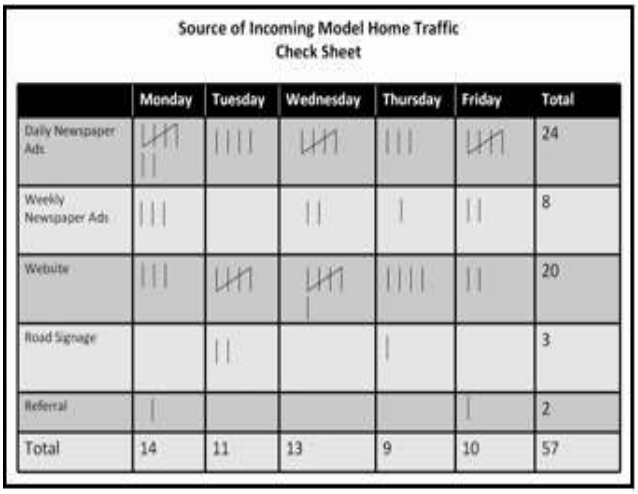


Figure 1. Flow chart

b. Check Sheet

A check sheet is a recording form used to simplify the data collection process, so that the information obtained can be arranged neatly and systematically [13]. Check sheets were developed to collect or mark defect data for further analysis. Check sheets are specially designed forms that allow data to be gathered easily by placing check marks on the provided fields [14].



Source of Incoming Model Home Traffic
Check Sheet

	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Daily Newspaper Ads	卌 II	IIII	卌	III	卌	24
Weekly Newspaper Ads	III		II	I	II	8
Website	III	卌	卌 I	IIII	II	20
Road Signage		II		I		3
Referral	I				I	2
Total	14	11	13	9	10	57

Figure 2. Check sheet

c. Histogram

Histograms also known as frequency distribution diagrams, are bar charts that display how data are distributed by grouping observations into appropriate class intervals and arranging them based on their magnitude [15]. Frequency distribution describes how ofte eachdifferent values appear in a data set.

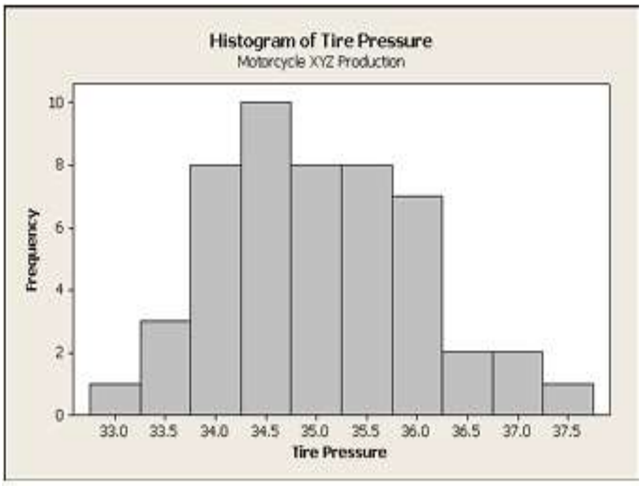


Figure 3. Histogram

d. Scatter Diagram

A scatter diagram plots pairs of numerical values, placing one variable on each axis, to examine whether a relationship exists between the two [16]. Scatter diagrams can be created with pen and paper, a spreadsheet, or other statistical software tools. They are useful for identifying relationships between two pairs of points. Scatter diagrams typically require regression analysis, but without regression, the potential relationships identified by a scatter diagram can still provide a basis for further investigation [17].

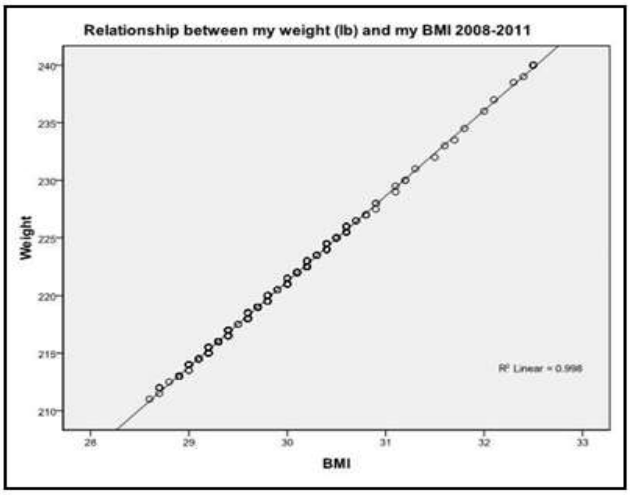


Figure 4. Scatter diagram

e. Control Chart

Control charts are used to monitor the movement of a process over time and determine whether the process is within stable control limits [18]. Control charts can be used for single data points, groups of measurements, counts of defective items, or the number of defects found [19]. A control chart consists of three horizontal lines, one of which is the central line (CL), which serves as the center line. This line shows the sigma value of the quality characteristic, which describes the condition of the process when it is under control [20]. The Upper Control Limit (UCL) is one of the two control limits located on the upper side of the chart [21]. Lower Control Limit (LCL) is the control limit value at the bottom of the graph obtained through calculations based on standard values or process standard values [22].

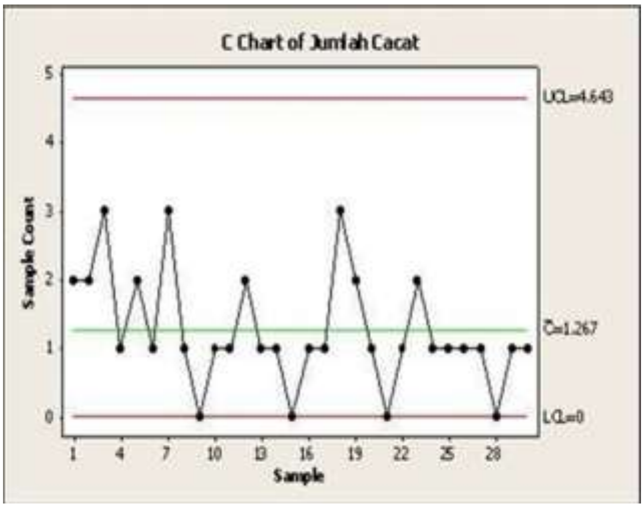


Figure 5. Control chart

f. Diagram Pareto

A Pareto diagram is a tool that helps prioritize improvement efforts by highlighting the most significant causes of a problem, enabling actions to focus on the issues that have the greatest impact [23]. This diagram presents data grouped by rank. The factor at the top is considered the most crucial issue, thus having a high level of urgency and requiring immediate action.

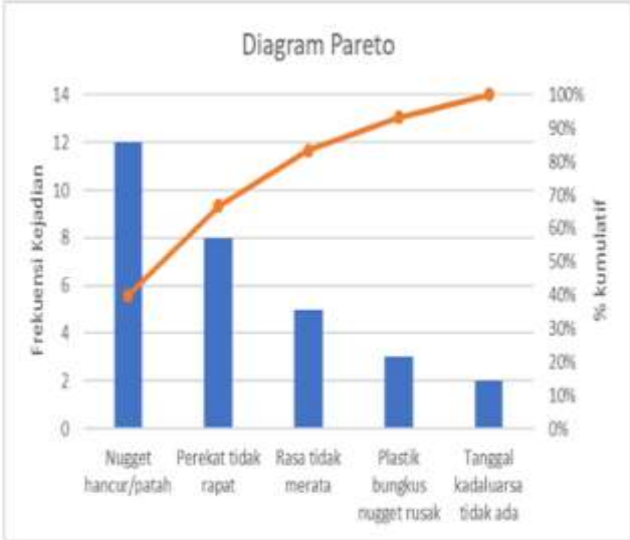


Figure 6. Pareto diagram

g. Fishbone Diagram

Fishbone diagrams are used to find various factors that cause a particular problem or effect, and to analyze them through brainstorming discussions [24]. his diagram helps in problem solving by methodically identifying and analyzing every potential or real cause behind a single effect [25]. Fishbone diagrams help illustrate the relationship between a type of defect and its causative factors, making it easier to formulate appropriate corrective steps [26]. The problems to be solved are categorized into human, machine, material, method, and so on [27].

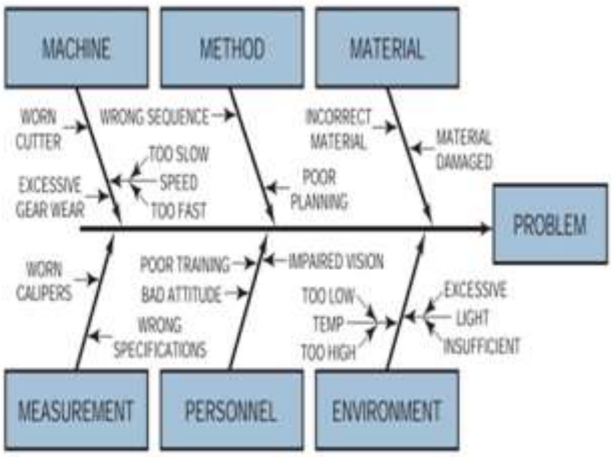


Figure 7. Fishbone diagram

III. RESULTS AND DISCUSSION

This research was conducted in the automotive components industry by selecting one product as the focus of the study. This product was selected due to the high urgency of the analysis, considering the significant frequency of defects. Based on the observation results, the P4Head part was recorded as having the highest number of defects and required analysis so that immediate repair efforts could be carried out. In actual production, the P4Head part experienced three types of defects: sunpoudashi, ID 14.8 topatsu, and ID 16.4 mushire. These parts can be seen in the following figure 8.

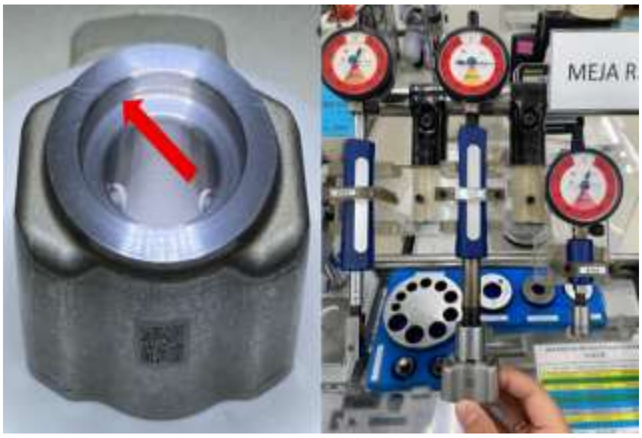


Figure 8. Sunpoudashi defect
Source: Data processing, 2025

Figure 8 shows a sunpoudashi defect. A sunpoudashi defect is a type of defect related to a product's dimensions or measurement and dimensioning process, either early in the production process or during production.

Figure 9. ID 14.8 topatsu defect
Source: Data processing, 2025

Based on figure 9, it shows the topatsu defect ID 14.8. So, the Topatsu defect ID 14.8 is an abnormality in dimension 14.8 that occurs suddenly and unpredictably, where the size of the dimension suddenly drops significantly and is far outside the tolerance limit.

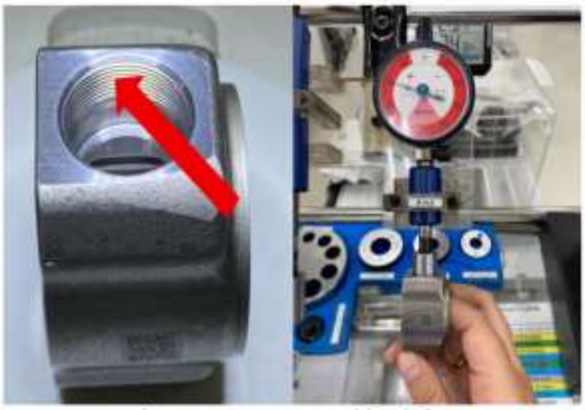


Figure 10. ID 16.4 mushire defect
Source: Data processing, 2025

Based on figure 10, it shows defect 16.4 mushire, so defect ID 16.4 mushire is a defect on the surface of ID 16.4 in the form of tears, peeling, or erosion of material due to the process, causing the size to deviate far from the standard tolerance limit.

Defect analysis on the P4Head part was then carried out using the Seven Tools method, with the following results obtained.

a. Flow Chart

P4Head spare parts undergo several production stages before becoming finished products, starting with receiving raw materials, the shotblasting process, and the subsequent stages. These parts are made from steel bars, which are then processed according to the production stages.

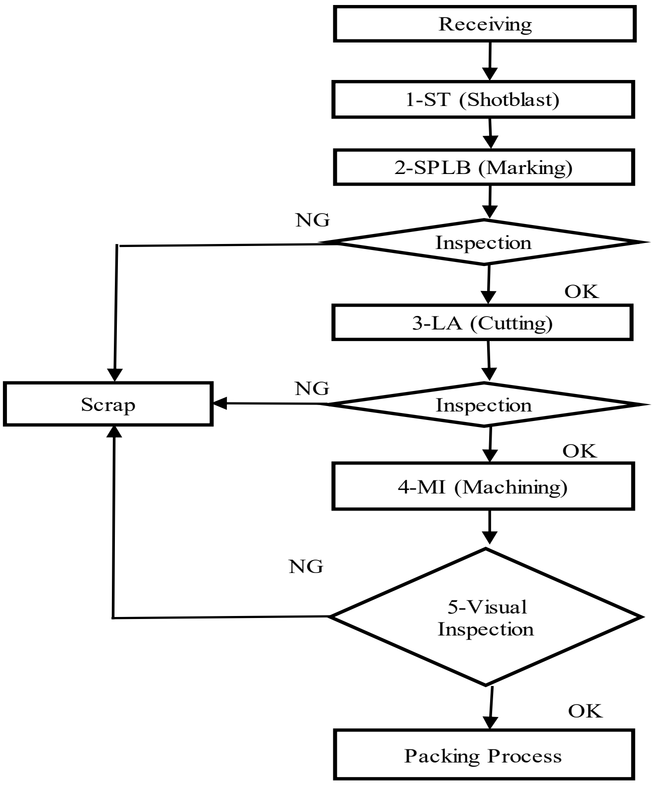


Figure 11. P4Head part production flow chart
Source: Data processing, 2025

b. Check Sheet

This study used production data from April to September 2025 in the automotive components industry. The data was categorized by defect type and organized into a checklist for ease of interpretation, as shown in table 1.

Table 1. Recapitulation of P4Head Part Production Check Sheet

Month	Production	*Defect*			Number of *Defect*
		Sunpoudashi	ID 14.8 Topatsu	ID 16.4 Mushire	
April	313663	730	678	178	1586
Mei	350953	825	913	242	1980
Juni	406309	813	734	191	1738
Juli	416133	841	701	197	1739
Agustus	380984	1100	850	394	2344
September	367379	1143	676	434	2253
Total	2235421	5452	4552	1636	11640

Source: Data processing, 2025

Histogram

The results of the data collection are arranged in the check sheet table 1 and visualized through a histogram that displays the number of defects per type, as seen in figure 12.

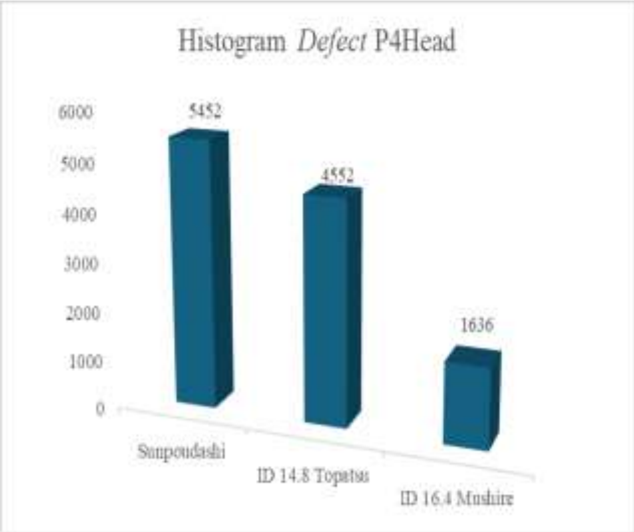


Figure 12. Histogram results of P4Head part production
Source: Data processing, 2025

Based on the Part P4Head defect histogram, it can be seen that the number of defects in the three types of processes or categories shows quite significant differences. Sunpoudashi produced the highest number of defects, namely 5,452 units, followed by ID 14.8 topatsu with 4,552 units. Meanwhile, the ID 16.4 mushire category had the lowest number of defects, namely 1,636 units. This pattern indicates that the most dominant quality problems occurred in the sunpoudashi and topatsu processes, so that both areas require more intensive attention and corrective actions. Conversely, although Mushire has the lowest defects, the process still needs to be monitored to maintain stable quality. Overall, this histogram illustrates that the distribution of defects is uneven between processes, so further analysis such as identifying dominant causes and process improvements are needed to significantly reduce the number of defects.

c. Scatter Diagram

The next stage is the use of scatter diagrams to assess the distribution pattern of defects during the production period, as shown in figure 13.

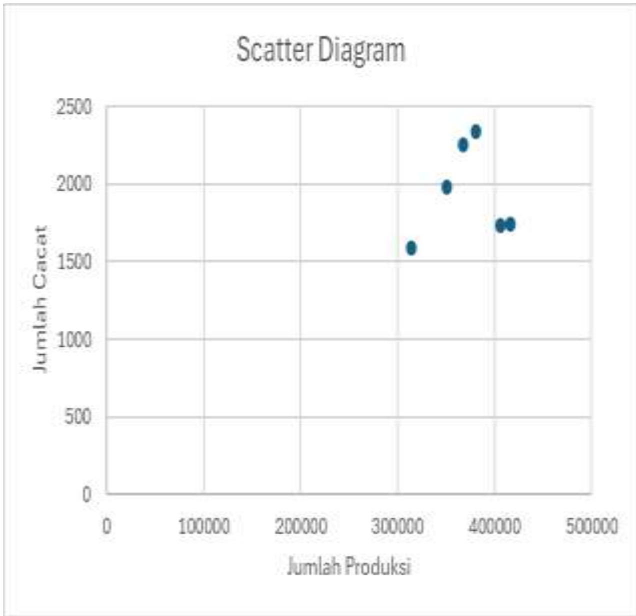


Figure 13. Scatter diagram of P4Head part production
Source: Data processing, 2025

Based on the scatter diagram of P4Head's part production, there is an increasing pattern between production volume and the number of defects. As production volume increases, the number of defects also increases, indicating a positive relationship between the two variables. The distribution of points in the diagram is not too wide, indicating that the production process is relatively stable, but the defect rate remains at a fairly high level. Furthermore, the data does not show any significant outliers, so the process conditions can be said to be consistent throughout the observation period. However, the visible variation in defects indicates that there are still factors causing defects that are not fully controlled, such as machine conditions, process parameters, or material quality. Therefore, this scatter diagram indicates that the P4Head production process requires further quality control efforts to reduce the number of defects sustainably.

d. Control Chart

Next, the data distribution was analyzed using a control chart to evaluate process stability. This chart displays the LCL, UCL, and the proportion of defects. The variables used were determined first, then calculations were performed as shown in table 2.

Table 2. P4Head product control chart

Month	Production	Number of Defects	Defect Proportion	CL	UCL	LCL
April	313663	1586	0.0051	0.0052	0.0056	0.0048
Mei	350953	1980	0.0056	0.0052	0.0056	0.0048
Juni	406309	1738	0.0043	0.0052	0.0056	0.0048
Juli	416133	1739	0.0042	0.0052	0.0056	0.0048

Agustus	380984	2344	0.0062	0.0052	0.0056	0.0048
September	367379	2253	0.0061	0.0052	0.0056	0.0048
Amount	2235421	11640	0.0052	0.000128508		

Source: Data processing, 2025

Based on the calculation results in table 12, a control chart is then created and displayed in figure 14 below.

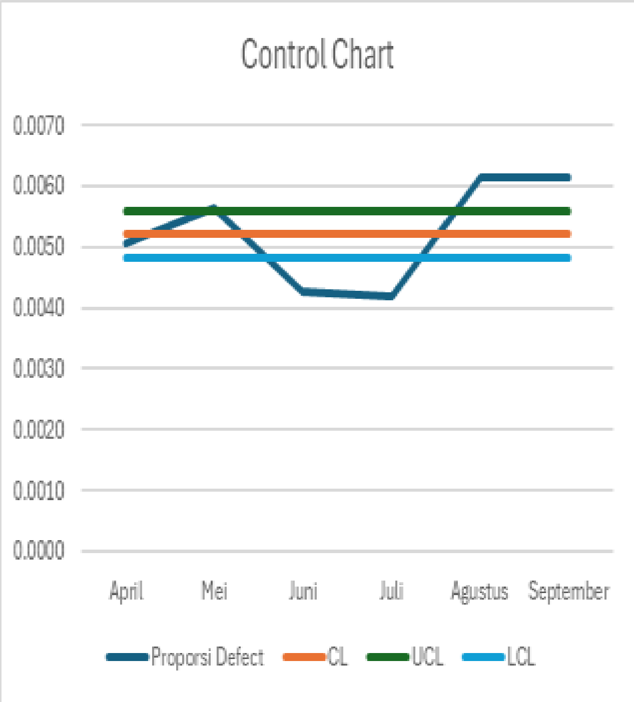


Figure 14. P4Head production control chart map
Source: Data processing, 2025

e. Pareto Diagram

The next stage involves analyzing dominant defects through a pareto diagram, with production data from April to September 2025. The cumulative calculation and percentage of defects are shown in table 3 before the diagram is created.

Table 3. Cumulative production defects of P4Head

Defect	Total *Defect*	Kumulatif	Presentase Kumulatif
Sunpoudashi	5452	5425	47%
ID 14.8 Topatsu	4552	9977	86%
ID 16.4 Mushire	1636	11613	100%
Total		11640	

Source: Data processing, 2025

The data from table 3 was then converted into a Pareto chart to identify the most frequently occurring defects. The results are shown in figure 15.

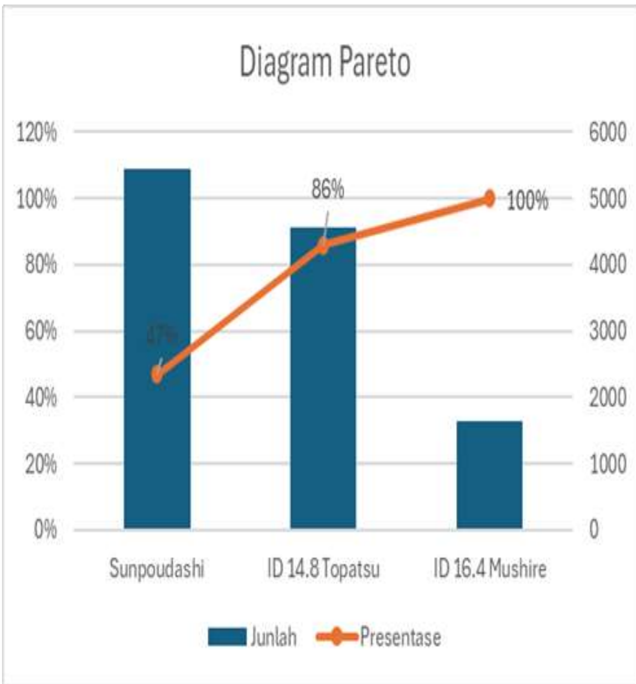


Figure 15. Pareto diagram of P4Head part defects
Source: Data processing, 2025

Based on the results of the Pareto diagram in Figure 15, it was found that sunpoudashi defects had the highest percentage of 47% with a total of 5,452 defects, followed by ID 14.8 topatsu at 39% with a total of 4,552 defects, and ID 16.4 mushire at 14% with a total of 1,636 defects. From these results, it can be concluded that sunpoudashi defects are the main priority to be repaired. These findings also serve as a reference for the next stage of analysis, focusing on dominant defects, namely sunpoudashi and ID 14.8 topatsu.

f. Fishbone Diagram

From figure 15, it can be seen that the defect rate for sunpoudashi reached 47%, while the defect rate for ID 14.8 topatsu was 39%. Therefore, a cause-and-effect analysis was conducted on these two defects to identify the causal factors and formulate improvements. The fishbone diagram for sunpoudashi is shown in figure 16.

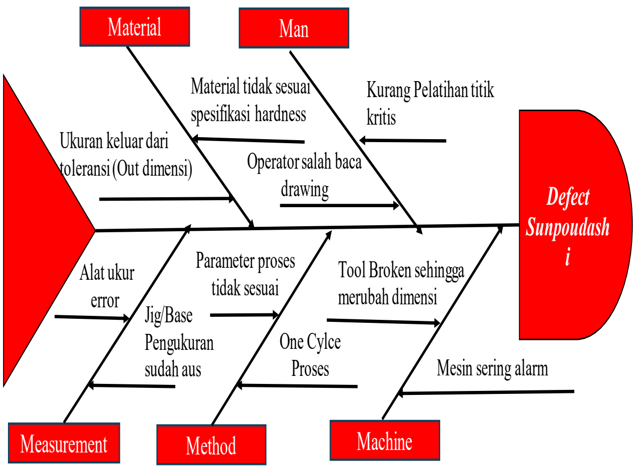


Figure 16. Results of the sonpoudashi fishbone defect
Source: Data processing, 2025

Based on the results of the cause mapping using the fishbone diagram in figure 16, it can be seen that sonpoudashi defects are influenced by various factors from the aspects of man, material, method, machine, and measurement. Each of thesefactors has potential causes that require further analysis to determine appropriate corrective actions. Therefore, the following table presents details of the identified causes along with proposed improvements that can be implemented to reduce the possibility of sonpoudashi defects in the production process see table 4 below.

Table 4. Improvement recommendations based on sunpoudashi defect analysis

Factor	Reason	Proposed Improvements
Man	Operator misreads drawing	Retraining in reading drawings and providing examples of critical dimension areas
	Lack of training critical point	Create a Sunpoudashi critical point training module and conduct regular training.
Material	Material does not meet hardness specifications	Perform hardness inspections on incoming materials and establish material acceptance hardness standards.
	Size out of tolerance (Out dimension)	Add dimension checking before machining and perform sorting of OOT materials
Machine	Tool Broken so that it changes the dimensions	Implement tool replacement schedules (tool life), tool condition monitoring, and tool wear alarms.
	The machine frequently alarms	Perform preventive maintenance, repair damaged parts, and stabilize machine parameters.
Method	Process parameters are not appropriate	Standardization of machining parameters and validation through trials and benchmarking.
	One Cycle Proses	Review the “one cycle process” work method and break it down into multi-cycles if necessary to avoid excessive machining load.
Measurement	Error measuring tool	Perform periodic calibration & replace measuring instruments whose precision has decreased.
	The measuring jig/base is worn out	Repair or replace jig/base; schedule jig condition inspections

Source: Data processing, 2025

After completing the root cause analysis and proposed improvements for the sonpoudashi defect, the next step was to identify the root causes of other dominant defect types. Therefore, the subsequent analysis focused on the defect with ID 14.8 topatsu, which is visualized through the fishbone diagram in figure 17 below.

Figure 17. Fishbone diagram results for defect ID 14.8 topatsu

Source: Data processing, 2025

Based on the results of the root cause mapping using the fishbone diagram in figure 17, it can be seen that the Topatsu defect was triggered by a number of factors originating from the aspects of man, material, method, machine, and measurement. Each of these factors has a source of non conformity that needs to be examined in more depth in order to formulate effective corrective steps. Thus, the following table presents the causes that were successfully identified along with recommendations for corrective actions that can be implemented to reduce the potential for topatsu defects in the production process, as can be seen in table 5 below.

Table 5. Repair recommendations based on defect analysis ID 14.8 topatsu

Factor	Reason	Proposed Improvements
Man	Misreading the tolerance value	Training in reading drawings, labeling critical tolerance areas, and creating visual examples of OK/NG
	Wrong offset size	Create offset setting standards, checklist settings before start, and interlock offset verification by the leader.
Material	Material does not meet hardness specifications	Perform hardness inspections on incoming materials, audit suppliers, and establish material acceptance standards (hardness ranges).
	Size out of tolerance (Out dimension)	Add dimension checking before machining, perform OOT material sorting, and strengthen incoming quality gate
Machine	Machine	Tool Broken so that it changes the dimensions
	Temperatur mesin meningkat	Engine temperature increases
Method	SOP is not clear	Revise the SOP to be more detailed, include images, and conduct outreach to operators & QC.
	There is no specific standard measurement method yet.	Develop new standards for critical areas, establish mandatory measuring tools and specific tolerances for Topatsu defects.
Measurement	Error measuring tool	Perform periodic calibration, replace measuring instruments with decreasing precision, and implement verification between measuring instruments.
	Differences in measurement techniques	Create WI (Work Instruction) for measurement techniques, standardize methods between operators, and conduct basic metrology training.

Source: Data processing, 2025

IV. CONCLUSSIONS

In its production process, the automotive component industry still often experiences failures that result in defective final products, especially in the production of P4Head components. To improve product quality, analysis using the Seven Tools method is considered effective as a solution to identify the causes of defects and formulate improvement proposals to reduce the potential for defects. The analysis results show that there are three types of defects in the P4Head part, namely sunpoudashi, ID 14.8 topatsu, and ID 16.4 mushire. Based on the Pareto diagram, the two most dominant types of defects are sunpoudashi at 47% and ID 14.8 topatsu at 39%.

From the fishbone diagram, the causal factors of both types of defects can be identified, namely, man, material, machine, method, and meansurement. The proposed improvements in this study are overall for both types of defects through improving material quality control, strengthening the accuracy of the measurement system, and stabilizing the condition of tools and machines. Improved material quality control is carried out by tightening incoming material inspections, both in terms of hardness and dimensions, and conducting regular supplier audits to ensure that the material received always meets specifications. Strengthening the measurement system is carried out through routine calibration of measuring instruments, equalizing measurement methods between operators, and cross verification to maintain the consistency of measurement results. Meanwhile, stabilization of tool and machine conditions is realized through the implementation of tool life management, tool inspections at each shift change, the use of tool wear alarms, and optimizing preventive maintenance to maintain stable machining parameters. Through this series of improvements, the root causes that recur in both types of defects can be minimized so that overall product quality can be improved.

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