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Electrical Performance Test Design for Speed Sensor Torque Flow, Rear Brake, and Solenoid ECMV Power Train HD785-7 at PT. XYZ

Rancang Bangun *Electrical Performance Test* untuk *Speed Sensor Torque Flow, Rear Brake*, dan Solenoid ECMV *Power Train* HD785-7 di PT. XYZ

Setia Abikusna*, Diki Ramadhani, Leo Setiawan, Lukyawan Pama Deprian, Randy Putra Afani
Department of Mechanical and Industrial Engineering, Politeknik Astra, Jl. Gaharu Blok F3 No. 1 Delta Silicon II, Cibatu Lippo Cikarang, Cikarang Selatan, Cikarang, 17530, Indonesia

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Abstract

PT XYZ's Component Exchange (COMEX) Department has 8 Quality Assurance Processes, one of which is performance test (QA6). The performance test is conducted to evaluate the condition of overhauled components. From January to February 2024, the COMEX Department experienced issues with electrical components in the Power Train area, specifically the Electronic Control Modulating Valve (ECMV) solenoid, torque flow speed sensor, and rear brake speed sensor. Currently, the functional inspection tool for the solenoid only uses an Arduino as a power supply and an impact wrench as a substitute for the gear shaft to inspect the torque flow speed sensor and rear brake speed sensor. The results from these inspections are inaccurate, leading to rework on the transmission components and the brake final drive of the HD785-7. The 8-step method was used to address these issues. This method includes Determining Themes, Current Condition Analysis, Target Setting, Root Cause Analysis, Improvement Plan, Improvement Implementation, Result Evaluation, Standardization and Improvement Plan. Improvements included creating an electrical performance test tool, developing work instructions for using the tool, and establishing a reusable parts standard. The tool successfully reduced the rework of electrical parts, achieving a 100% reduction in rework from January-February 2024 to April-June 2024.

Keywords: electrical performance test, solenoid ECMV, speed sensor, power train.

***SDGs*:**

Abstrak

PT XYZ Departemen *Component Exchange (*COMEX) memiliki 8 Proses *Quality Assurance*, salah satunya adalah *performance test* (QA6). *Performance test* dilakukan untuk mengevaluasi kondisi komponen yang telah di-*overhaul*. Dari Januari hingga Februari 2024, di Departemen COMEX terjadi masalah pada komponen elektrik di area *Power Train*, yaitu *solenoid Electronic Control Modulating Valve* (ECMV), *speed sensor torqueflow* dan *speed sensor rear brake*. Saat ini, alat inspeksi fungsional *solenoid* hanya menggunakan Arduino sebagai *power supply* dan *impact wrench* sebagai pengganti *gear shaft* untuk inspeksi fungsional *speed sensor torqueflow* dan *speed sensor rear brake*. Hasil dari inspeksi tersebut tidak akurat, sehingga menyebabkan redo pada komponen transmisi dan *brake final drive* HD785-7. Untuk memecahkan permasalahan tersebut digunakan metode 8 step. Metode ini meliputi Menentukan Tema, Analisis Kondisi Terkini, Penetapan Target, Analisis Akar Penyebab, Rencana Perbaikan, Pelaksanaan Perbaikan, Evaluasi Hasil, Standarisasi dan Rencana Perbaikan. *Improvement* yang dibuat sebuah alat *electrical performance test*, pembuatan instruksi kerja cara penggunaan alat tersebut, dan pembuatan standar *reusable part*. Alat tersebut dapat menurunkan redo *electrical part* yang mencapai persentase penurunan redo dari bulan Januari-Februari 2024 hingga bulan April-Juni 2024 adalah sebesar 100%.

Kata Kunci: *electrical performance test, solenoid ECMV, speed sensor, power train.*

*Correspondence Author
email : setia.abikusna@polytechnic.astra.ac.id

1. INTRODUCTION

The COMEX department at PT. XYZ is responsible for overhauling and reconditioning components that have reached their maximum working hours, around 50,000 working hours. This condition can cause engine components to not function optimally, causing various problems, ranging from engine damage, decreased performance, to increased risk of accidents. Therefore, an overhaul or repair is needed. However, a long process can affect the repair process. The following overhaul process flow can be seen in Figure 1.

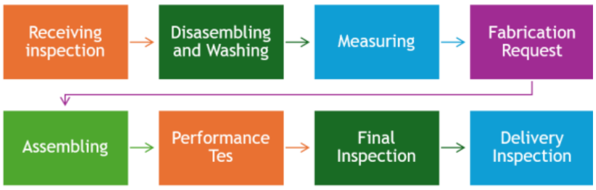

Figure 1. Overhaul flow process.

Figure 1 as shown the overhaul flow process carried out at the COMEX department. In this overhaul process, there are three special areas for performance tests, namely: hydraulic performance test, power train performance test, and engine performance test. This performance test is very important to evaluate the condition of the components after the overhaul. Currently, the results of the performance test on the transmission and brake final drive components of the Komatsu off-highway rigid dump truck HD785-7 show intermittent results, especially on the electrical components. This problem needs to be resolved because it affects the quality of the overhaul process results at the COMEX department. As an implementation of the problems that occur, the author created an electrical performance test to ensure that the Electrical parts function optimally according to their technical specifications, reduce the risk of component failure, and increase the effectiveness of electrical part inspections.

The purpose of this paper is to create a tool that can be used to measure, analyze, and verify the performance of electrical parts, thereby helping to detect component damage, increase efficiency, reduce the risk of damage, and ensure operational safety.

2. METHODOLOGY

The method used to solve this problem is by using eight steps which are 8 steps in making improvements which are usually called Quality Control Circle or QCC (Hernadewita *et al.*, 2019; Khamaludin and Respati, 2019; Utama, Supriyatna and Kusuma, 2020). This method is used as a quality control system through 8 continuous improvement step methods or kaizen (Rosyidi *et al.*, 2014; Sulaeman and Gusniar, 2023). This method includes Determining Themes, Current Condition Analysis, Target Setting, Root Cause Analysis, Improvement Plan, Improvement Implementation, Result Evaluation, Standardization and Improvement Plan using 7 tools including Pareto and fishbone diagrams (Rosyidi *et al.*, 2014; Hardono, Pratama and Friyatna, 2019; Erdhianto, 2021; Suparno and Susanto, 2021). So that it can solve problems faced by production, especially to improve process improvement capabilities (Utama, Supriyatna and Kusuma, 2020; Devani and Oktaviany, 2021; Inayah, Wahyudin and Herwanto, 2023). The use of the 8-step method in this improvement is expected to help detect damage to the speed sensor torque flow component, speed sensor rear brake, and solenoid ECMV Power Train Komatsu off-highway rigid dump truck HD785-7. This improvement begins with determining the theme based on Pareto data analysis, then setting targets until making the next plan (Rochman and Agustin, 2017; Hendra *et al.*, 2021; Fernando *et al.*, 2022; Setiawan *et al.*, 2024). The following can be seen as the flow process in this study can be seen in Figure 2 (Darmawan, Hasibuan and Purba, 2018; Debora, Prasetyo and Rosma, 2021; Arfan, Sugengriadi and Ropik, 2023).

Figure 2 as show the flow diagram carried out in this improvement which starts from determining the theme to making the next plan. Here are the details of the research steps carried out (Suratno and Ichtiarto, 2021; Sulaeman and Gusniar, 2023; Setiawan, Perdana and Aisa, 2024):

a. Determining the Theme

   In the step of determining the theme, the author determines the theme by analyzing internal Pareto data of the power train from

January to February 2024 and feedback from mechanics regarding the problems that occur.

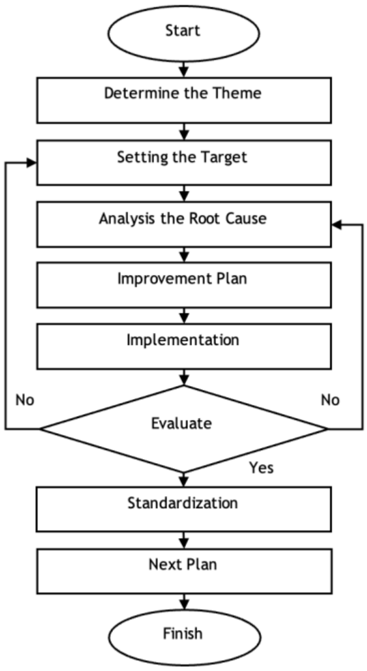

Figure 2. Eight Steps method flow process.

b. Determining Targets
In the target setting section, the author uses the principles of Specific, Measurable, Achievable, Reasonable, and Time-Bound commonly abbreviated as SMART (Setiobudi, 2017).

c. Analysis of Causal Factors
In the causal factor analysis, the author created a fishbone diagram to find the causal factors of the problems in the company (Darmawan, Hasibuan and Purba, 2018).

d. Determining an Improvement Plan
A repair plan is made to find solutions based on the problems that arise in the fishbone diagram.

e. Implementation of Improvement Plan
The implementation carried out by the author is to design and build an electrical performance test for the speed sensor torque flow components, rear brake speed sensor, and ECMV solenoid.

f. Evaluation of Improvement Results
At this stage, the author compares the performance before and after the improvement process on the electrical part of Power Train HD785-7.

g. Standardization and Next Plan
In this stage, the author creates standardization of the testing process and standardization of performance or results. Make an improvement plan for the next improvement.

3. RESULTS AND DISCUSSION

3.1. Determining the Theme

At this stage, the author identifies the problems that occur using Pareto data analysis (Dartawan and Setiafindari, 2023; Inayah, Wahyudin and Herwanto, 2023). Internal power train pareto data January-February 2024 can be seen in Figure 3.

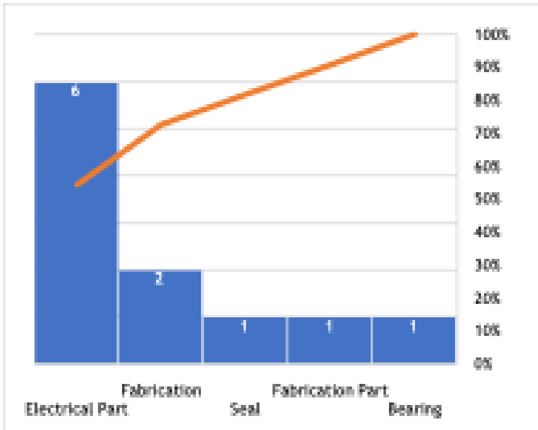

Figure 3. Internal power train pareto data January-February 2024.

Based on the Pareto data shown in Figure 3, what happened in the COMEX internal power train during January-February 2024, there were 6 redos on electrical parts, 2 redos on fabrication, 1 redo on seal, 1 redo on friction parts and 1 redo on bearings. Redo means repeating a previously performed repair or work process to ensure the quality and functionality of the heavy equipment is in accordance with the desired specifications. This can involve reworking components, adjustments, or additional repairs to achieve the desired results. Based on the data in Figure 3, the author made improvements to the redo of electrical parts.

3.2. Determining Targets

This study has set a target for redoing electrical parts from 54% before February 2024 to 0% after June 2024. This target can be seen in the Figure 4.

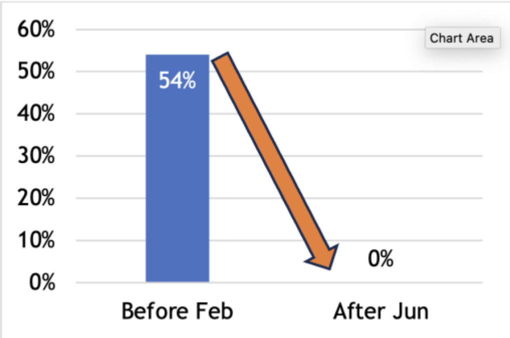

Figure 4. Target reduction % redo electrical part.

Based on Figure 4, it explains the improvement target to reduce the percentage of redo on electrical parts by 100%. The total average redo on electrical in January and February 2024 was 54% to 0% at the end of the project. In determining the improvement target, the researcher also used the Specific, Measurable, Achievable, Relevant, Time Bound (SMART) method.

The improvement target using the SMART method is as follows.

1) Specific
   Develop an electrical performance test system that focuses on the torqueflow speed sensor components, rear brake speed sensor, and ECMV Power Train HD785-7 solenoid.
2) Measurable
   Get inspection results with a measurement accuracy rate of 100% and ensure the accuracy of detecting damage to the torque flow speed sensor, rear brake speed sensor, and ECMV Power Train HD785-7 solenoid with a failure rate below 2%.
3) Achievable
   Making electrical performance test tools for the torqueflow speed sensor, rear brake speed sensor, and ECMV Power Train HD785-7 solenoid.
4) Relevant
   There needs to be an improvement in the quality of the performance test process in the Power Train area, especially electrical part inspection.

3.3. Analysis of Causal Factors

In the causal factor analysis stage, the author uses a fishbone diagram to describe the cause and effect of the existing problem. The following is a fishbone diagram that the author made based on field observations. Based on Figure 5, 3 factors cause the electrical part testing method for speed sensor torque flow, speed sensor rear brake, and solenoid ECMV to be inaccurate. The 3 factors are as follows:

1) Man
   This is because mechanics do not yet have the knowledge and expertise related to electrical part inspection. This causes the absence of a special PIC for electrical part inspection.
2) Machine
   In the engine factor is caused by the lack of adequate tools to conduct electrical part inspections that assess the functionality, accuracy, and performance of the speed sensor torque flow components, speed sensor rear brake, and solenoid ECMV Power Train HD785-7. This results in frequent intermittent components when they are installed into the transmission and rear brake final drive Komatsu off-highway rigid dump truck HD785-7.
3) Method
   In the method factor, with the actual field conditions until now there is no standard inspection process for speed sensor torque flow speed sensor rear brake components, ECMV solenoid and there is no standard parameter for reusable parts for speed sensor torque flow, speed sensor rear brake, and solenoid ECMV. This is a constraint for mechanics in conducting inspections and identifying damage to components in selecting components to be reused.

3.4. Determining an Improvement Plan

Next, improvement planning is carried out using the why and how methods for alternative solution. The following results can be seen in Table 1.

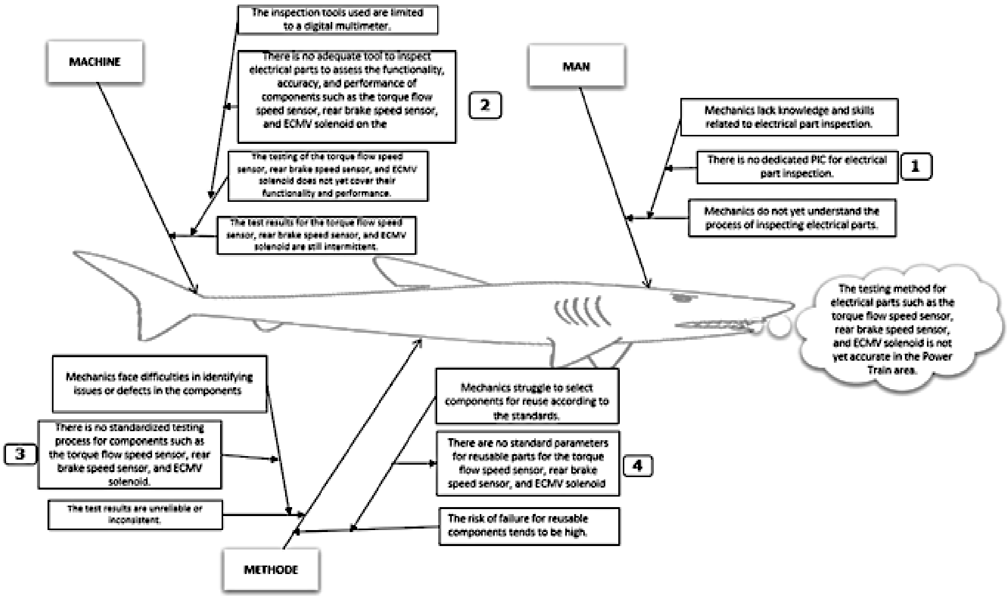

Figure 5. Fishbone diagram.

Table 1. Solution alternative.

Finalisasi Solution	What Rootcause	Why Target	How Stop & Activity
Machine	The absence of adequate tools by inspecting electrical parts to assess the funstionarity, accuracy and performance of components such as the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757	The inspect the performance, accuracy, and defect damage to the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757. component to be reused	Developing an electrical performance test for the the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757, as well as conducting tests and evaluations to determine wether these components meet the established reuse standard
Method	The absence of a standard process for inspecting components such as the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757	Ensuring that the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757	Developing a component inspection standard by implementing inspection procedures such a visual inspection of components, testing components and evaluating the results
Method	The absence a a standard parameter for reusable parts for the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757	a guideline for determining meusable parts for the torque flow speed sensor, gear brake speed sensor and EOW solenoid of the power train HC757	Developing a standard specification for reusable parts by conducting testing and validation between reused parts andnew parts
Man	The absence of a dedicated PIC for inspecting electrical parts	Ensuring that the inspection of electrical parts is camed out in accodance with estabished quality and safety standard	Apporting a dedicated PIC for electrical parts inspection by providing knowledge on electrical parts inspection procedures

After conducting an analysis in the field to find the factors causing the existing problems, an improvement plan is then made to overcome the existing problems. The following is the improvement plan made by the author.

3.5. Implementation of Improvement Plan

1) Electrical Performance Test Circuit Design Creation.

   The first fix is by creating a system circuit. This action can be seen in Figure 6. Figure 6 explains the creation of an electrical circuit that will provide a clear visual depiction of how the electrical components are connected and how the electric current moves through the system.

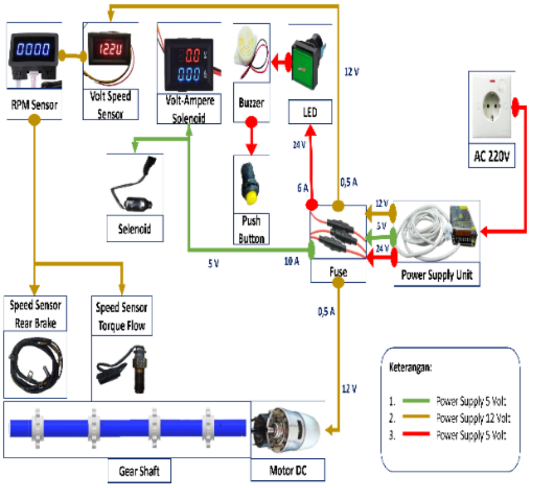

Figure 6. Electrical performance test circuit.

2) Circuit Implementation and Circuit Testing Electrical Performance Test.
   Next implement the Circuit and Test the Electrical Performance Test Circuit. This action can be seen in Figure 7.

Figure 7. Implementation of electrical circuit.

In Figure 7, the process of assembling electrical components on the workbench and conducting circuit testing by conducting experiments on the function of each electrical component such as a digital tachometer, indicator lights, voltage, and ampere displays that have been assembled on the workbench. In this experiment, the electrical components function properly according to their functions.

3) Component Inspection Standards Creation
   This section is used to create the solenoid inspection check sheet procedure which can be seen in Figure 8.

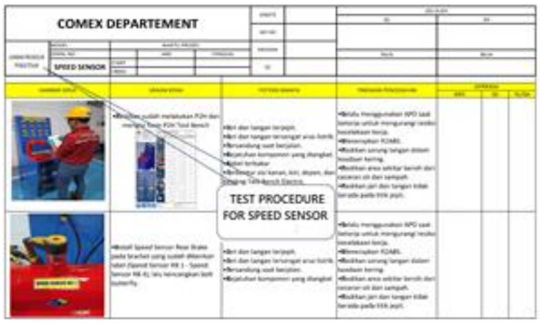

Figure 8. Solenoid inspection check sheet procedure.

The next stage is to create a Speed sensor check sheet procedure which can be seen in Figure 9.

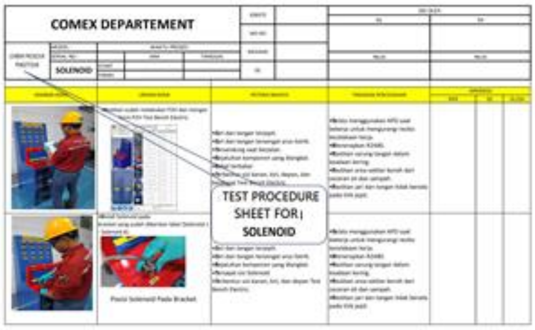

Figure 9. Speed sensors check sheet procedure

Based on Figure 8 and Figure 9, the creation of a check sheet for the inspection procedure for solenoid and speed sensor components, to provide clear and structured guidance in the testing process and document the results accurately and consistently. This test procedure check sheet helps mechanics in testing the ECMV solenoid components, speed sensor torque flow, and speed sensor rear brake power train HD785-7, thus ensuring that each test step is carried out according to the established standards.

4) Creating Reusable Component Standards.
   The creation of this check sheet serves as a guide to standard parameters of reusable ECMV solenoid components, speed sensor torqueflow, and speed sensor rear brake power train HD785-7. The standard parameters set such as resistance size,

tolerance, pressure, and performance that must be met by each component are made based on the results of a comparison between new components and reused components. Using this inspection check sheet helps mechanics identify damage, thereby improving quality and preventing problems in the next production stage.

5) Appointment of Special PIC for Electrical Part Inspection.
   Assign a Person in Charge (PIC) specifically for electrical part inspection with the aim of ensuring that each part tested meets the established quality and safety standards. The PIC is responsible for coordinating, implementing, and documenting the entire testing process, including problem identification and solution implementation. With the presence of a PIC, the testing process becomes more organized, efficient, and accountable.

3.6. Evaluation of Improvement Results

After the repair for redo electrical part was done, it dropped to 0% after April. The following data can be seen in the Figure 10.

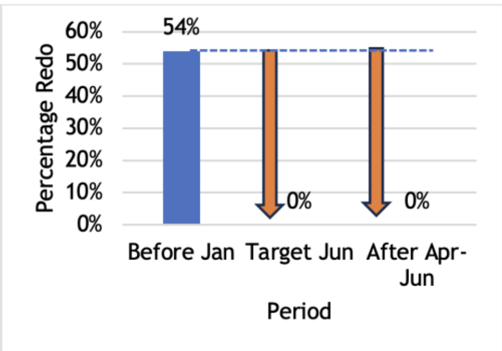

Figure 10. Percentage of redo decrease April-June 2024.

Based on Figure 10, there was a significant decrease in redo of electrical parts compared to the previous month. The total redo electrical parts that occurred during January-February (before repair) were 6 total redos and there was a decrease in redo electrical parts in April-June (after repair), which was 0 total redos. The percentage decrease in redo electrical parts from January-February to April-June was 100%.

This section elaborates the research results reviewed from the aspects of cost, quality, delivery, safety, moral and environment. The following can be seen in Table 2 Non-financial Benefits.

Table 2. Non-financial benefits.

Factors	Achievemet
Quality	No redo on the test bench powertrain
Cost	Cost saving of IDR 677603240/year
Delivery	Abile to reduce selenoid inspection lead time by 50% from 1 minute to 30 second
Safety	a. reduces injury risk by 100% b. Improve accuracy and quality by 100% c. Enhaces operator satisfaction and well-being by 100%
Moral	Increases customer trust with a Net promotor Score of 100%, Customer Effort Index of 95%, and Customer Satisfaction of 87% for COMEX Dept
Env.	Improvement the 5S in the small component working area the COMEX dept

3.7. Standardization of Improvement Results

To keep the improvement results consistent, standardization was created which can be seen in Figure 11.

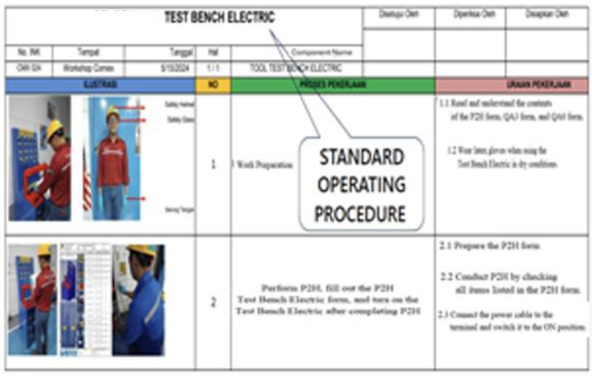

Figure 11. Standard operating procedure.

Based on Figure 11, the creation of standard operating procedures for electrical performance tests as a guide for mechanics in operating the equipment. The creation of a standard reusable part check sheet aims to help mechanics ensure that all inspection steps and quality criteria have been met. In addition, this check sheet also helps in monitoring consistency during the production process and preventing problems from arising in the next production stage.

3.8. Next Plan

The next repair plan is to replace the push button with a load sensor to know the value of the pressure force generated by each solenoid when it is active.

4. CONCLUSION

Improvements were made by creating an electrical performance test tool, creating work instructions on how to use the electrical performance test tool, and creating reusable part standards. The tool can reduce redo electrical parts which reached a percentage reduction in the percentage redo from January-February 2024 to April-June 2024 of 100%. In addition, during one year of using this tool, the company managed to save costs of Rp. 677,603,240/year.

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