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Product Reject Analysis of 40d-H2103-00 Terminal Motorcycle Spare Parts Using Statistical Quality Control Methods at CV Biru Karya Pratama

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ABSTRACT

CV Biru Karya Pratama is a company engaged in manufacturing that produces Terminal 40D-H2103-00. The problem found at CV Biru Karya Pratama is related to the number of rejects found every month which affects the results that do not reach the target. This study uses the Statistical Quality Control method where based on the calculation results there are 5 data within the control limits and 7 data outside the control limits with 3 data below the LCL and 4 data above the UCL on the P-Chart. This shows the need for more effective and efficient quality control improvement proposals. After conducting a fishbone analysis, the proposed improvements are implementing Standard Operating Procedures (SOPs), training employees and operators, conducting supervision during the production process, and conducting regular performance audits.

Keywords: Statistical Quality Control, Sparepart, Reject

INTRODUCTION

As the era develops with technological advances, business competition is getting tighter between one company and another. One of the company's efforts in considering its products to compete with other products is to pay attention to product quality so that consumers consider buying these products compared to buying products from other companies. (Margareta & Nugroho, 2022).

Regarding the quality of these products, every company will always try to produce quality goods that can satisfy all consumers (Adawiyah & Donoriyanto, 2022). In the process of improving quality, the company has carried out various methods or special strategies in quality control so that products can compete with products from different companies. (Alfie Oktavia, 2021).

Quality control is carried out by measuring real products and then comparing them with existing standards (Montgomery, 2019). If in the comparison process, there is a discrepancy between the real product and the existing standards, the company needs to decide to take appropriate corrective action until it can meet the standards by the wishes or satisfaction of consumers (Soebandono, 2023).

The quality control applied at CV Biru Karya Pratama is fairly ineffective in controlling the number of product defects that occur per month. This results in the production of many products with product defects such as 0.44% dents, 0.46% overcutting, 1.27% large scratches, and 1.45% rust.

Figure 1. Product Defect Types

The number of defects found each month has an impact on the company's image to consumers who are starting to decline due to the company's financial problems such as increased costs incurred for product repair and reduced revenue due to decreased demand from consumers. So based on this background, this research will focus on knowing the types of rejects found, the factors that cause these rejects, and the proposed improvements for each reject found.

Tekletsadik (2023) research highlights the importance of quality improvement in meeting market demand and reducing economic losses due to rejected goods. Using SQC tools, specifically Pareto analysis and cause-and-effect diagrams, this study identified six major defects that accounted for 81.18% of the total defects in the company. The root causes of these defects were analyzed, and solutions were suggested and implemented. Implementation of these solutions for one month resulted in a 67.3% reduction in export rejected shirts, which significantly increased the company's revenue.

Research by Raut & Verma (2017) explores the application of quality control methods to improve product quality and reduce rejection rates in manufacturing. The focus is on a specific industry involving CNC cutting processes and identifies five prominent defects: cutting taper, oversize, undersize, rough surface, and burrs. Raut & Verma emphasize the need for a systematic approach using various quality control tools to diagnose and minimize these defects, ultimately leading to increased productivity and operational excellence.

While the existing literature provides valuable insight into quality control methods for reducing defects in CNC cutting processes, it does not specifically address the application of these methods to the production of terminal motorcycle parts, specifically terminal 40d-H2103-00 at CV Biru Karya Pratama. The focus of the previous research was on aluminum shear insert bolts used in passenger vehicles, which present a different set of challenges and operational context compared to motorcycle parts.

Cutting-edge quality control for manufacturing involves the integration of advanced statistical quality control (SQC) methods, lean six sigma approaches, and continuous improvement frameworks (Sutrisno, 2022). These methodologies are able to address complex and diverse defects by using data-driven techniques and real-time monitoring to improve product quality and operational efficiency. However, the adaptation and specific application of these methodologies to different types of products and manufacturing settings, such as motorcycle parts, remains largely unexplored. This is a new area of investigation where customized quality control strategies can be developed and validated for specific product lines and operational conditions.

The purpose of this study is to analyze and improve the quality control process at CV Biru Karya Pratama, specifically targeting the reduction of product rejects for Terminal 40D-H2103-00. This research aims to identify the root cause of rejects using Statistical Quality Control method and propose effective and efficient quality control improvements.

MATERIALS & METHODS

Experiment Site

CV Biru Karya Pratama is a manufacturing company engaged in the metal industry sector established on March 30, 2009. Starting from a welding workshop and manufacturer of stamping products, the company has grown to become a manufacturer of Public Street Lighting poles and electric poles. In addition, one of the activities of this company is the manufacture of motorcycle spare parts, namely Terminal 40D-H2103-00. This product is an order from PT ABBI to do a wiring harness on the surface of the product which will then be distributed to PT Yamaha.

Figure 2. Terminal 40D-H2103-00

The research was conducted in stages by the research procedures designed by the researcher. The first activity is to conduct a literature study and field study which aims to build a theoretical basis, obtain valid data in the field, and formulate problems. Furthermore, the data collection stage is carried out using observation, interview, and documentation methods. After analyzing the data from the data that has been collected, a conclusion is drawn at the end of the research process.

Research Methodology

Based on the data needed during the research process and also the objectives of this study, the research method used is the quantitative method.

The quantitative method is one type of research method that produces new knowledge that can be obtained using statistical methods and quantification techniques (measurement) so that the data generated in the processing process will be in the form of numbers (Ali et al., 2022). The data analysis used in this study uses the Statistical Quality Control (SQC) method. The steps taken in using SQC are as follows:

a. Attribute Control Chart

Proportional Control Charts, also known as P-Chart Diagrams, are used to statistically analyze data and control processes. This is done because product defects cannot be repaired.

1) Defect percentage

$$P = \frac{np}{n} \quad (1)$$

Description:
np = Total defects
n = Total Production

2) Central Line (CL)

The center line is the average defective product (p)

$$CL = P = \frac{\sum np}{\sum n} \quad (2)$$

Description:
$\sum$np = total number of defective products
$\sum$n = total number of production products

3) Upper Control Limit (UCL)

Used to calculate the upper control limit or UCL is calculated by the following formula:

$$UCL = P + 3\sqrt{\frac{p(1-p)}{ni}} \quad (3)$$

Description:
p = Average defective product
n = Total months examined

4) Lower Control Limit (LCL)

Used to calculate the lower control limit or LCL is calculated by the formula:

$$LCL = P - 3\sqrt{\frac{p(1-p)}{ni}} \quad (4)$$

Description:
p = Average defective product
n = Total months examined
Notes: If LCL < 0 then LCL is considered equal to 0.

b. Diagram Pareto

A Pareto diagram is a visual representation of the Pareto principle. It is a type of combination chart that shows the distribution of causes of a problem (Ivančić, 2014).

The steps taken in making a Pareto diagram are to sort each type of defect from the largest number of defects to the smallest. Then calculate the percentage of defects and the cumulative percentage of each type of defect (Ishak, 2020).

c. Diagram Fishbone

The Fishbone Diagram or Ishikawa diagram is a diagram used to find potential sources of a problem. Because its shape resembles a fishbone, it is called a fishbone diagram (Wong et al., 2016).

RESULT

Basic Literature Study

a. Statistical Quality Control

Statistical Quality Control (SQC) is a method used to solve company problems to analyze, monitor, and control the process and quality of production results by using statistical tools (Rahayu, 2020). In addition, Statistical Quality Control (SQC) can be used by companies as a tool to help find products within the control limits or outside the control limits and determine problems in production due to products that are rejected due to damage or do not meet the standards set by the company so that the company can take steps to overcome the problems found (Syarifah Nazia et al., 2023).

Statistical Quality Control (SQC)

a. Checksheet

The first thing to do in processing the data from this research is to create a checksheet with Microsoft Excel tools containing production data and defective product data on brass terminal products.

Table 1. Cheksheet

No	Produksi	Penyok	Overcutting	Scratch Besar	Karat	Total NG
1	48000	465	310	1085	1240	3100
2	48000	468	312	1092	1248	3120
3	52000	498	332	1162	1328	3320
4	46000	588	392	1372	1568	3920
5	44000	288	192	672	768	1920
6	22000	232	348	812	928	2320
7	52000	213	320	746	852	2131
8	50000	351	526	1227	1402	3506
9	48000	313	470	1096	1252	3131
10	52000	416	624	1456	1664	4160
11	50000	283	424	991	1133	2831
12	48000	412	618	1442	1648	4120
Total	560000	4527	4868	13153	15031	37579

Judging from the table above, the largest number of defects is rust, followed by large scratches, overcutting, and dents. After making the next checksheet, a histogram is made which is presented in the form of a bar chart to make it easier to see the number of defective products.

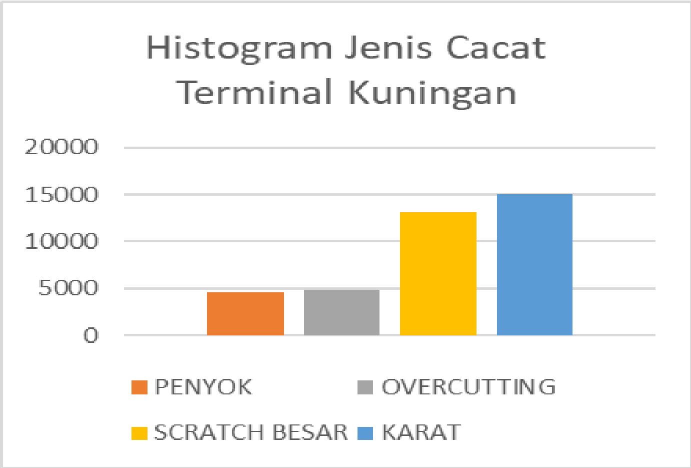

Figure 3. Histogram of Defect Types

b. Defective Product Control Chart

Furthermore, the P-chart is used because the data obtained is attribute data, in addition, the P-chart is also designed to track and control processes that produce outputs that are considered defective or non-defective. In other words, the P-Chart is specifically designed for attribute data where the output is considered defective or non-defective, rather than a continuous number.

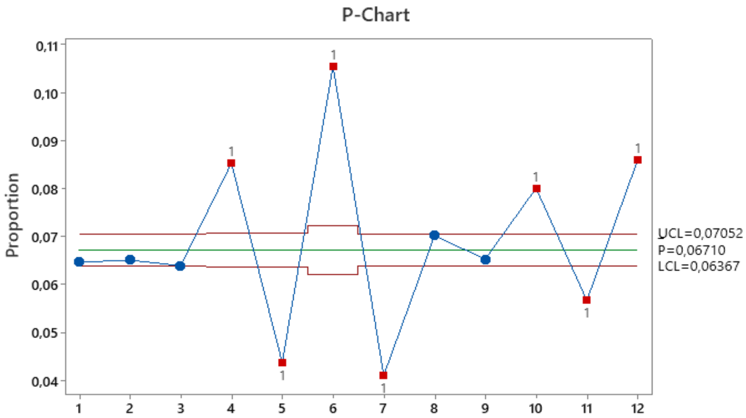

Figure 4. P-Chart

After examining the P-Chart, it can be seen that several samples are far above the UCL and below the LCL, to be precise 7 data are outside the control limits. With so much data out of the control limits, it shows that the production process is still not effective so further handling is needed to reduce the number of defective products.

Table 2. P-Chart Count Table

No	Month	Total Production	Total Reject	Percentage	Proportion	UCL	LCL
1	Jan-23	48000	3100	6,46%	0,0646	0,0705	0,0637
2	Feb-23	48000	3120	6,50%	0,0650	0,0705	0,0637
3	Mar-23	52000	3320	6,38%	0,0638	0,0704	0,0638
4	Apr-23	46000	3920	8,52%	0,0852	0,0706	0,0636
5	May-23	44000	1920	4,36%	0,0436	0,0707	0,0635
6	Jun-23	22000	2320	10,55%	0,1055	0,0722	0,0620
7	Jul-23	52000	2130	4,10%	0,0410	0,0704	0,0638
8	Aug-23	50000	3505	7,01%	0,0701	0,0705	0,0637
9	Sep-23	48000	3130	6,52%	0,0652	0,0705	0,0637
10	Oct-23	52000	4160	8,00%	0,0800	0,0704	0,0638
11	Nov-23	50000	2830	5,66%	0,0566	0,0705	0,0637
12	Dec-23	48000	4120	8,58%	0,0858	0,0705	0,0637

In the table above, it can be seen the upper limit and lower limit of terminal brass production, then the proportion and percentage of defects from monthly production can be easily read so that it will be easier to analyze and determine the improvements that will be proposed.

c. Pareto Diagram

The Pareto diagram is a tool that serves to find out the most types of production defects from January 2023 to December 2023. The first step in making a Pareto diagram is to sort the types of production defects that have the highest to lowest number and then calculate the percentage of defects and the cumulative percentage of each type of defect. The Pareto diagram can be seen in the figure below:

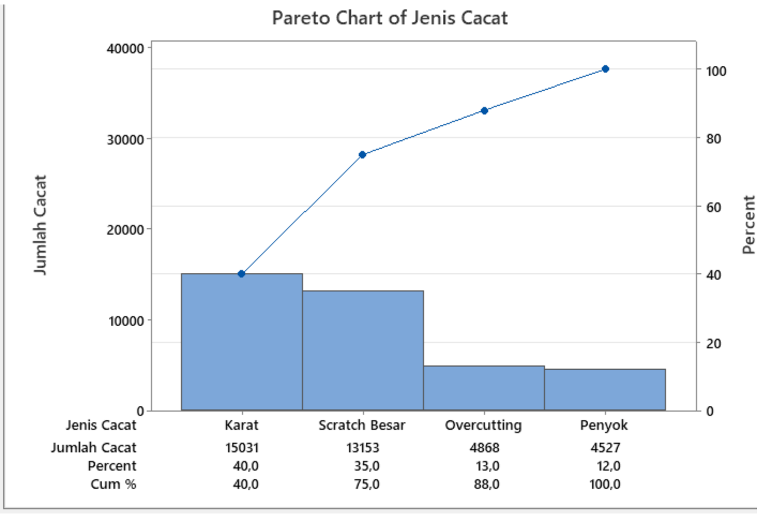

Figure 5. Pareto Diagram

d. Fishbone Diagram

The next stage is to make a fishbone diagram from the results of observations and related interviews that have been obtained previously. A fishbone diagram is one of the quality control tools that serves to find out and categorize the causes of problems from the production of Terminal 40D-H2103-00 itself.

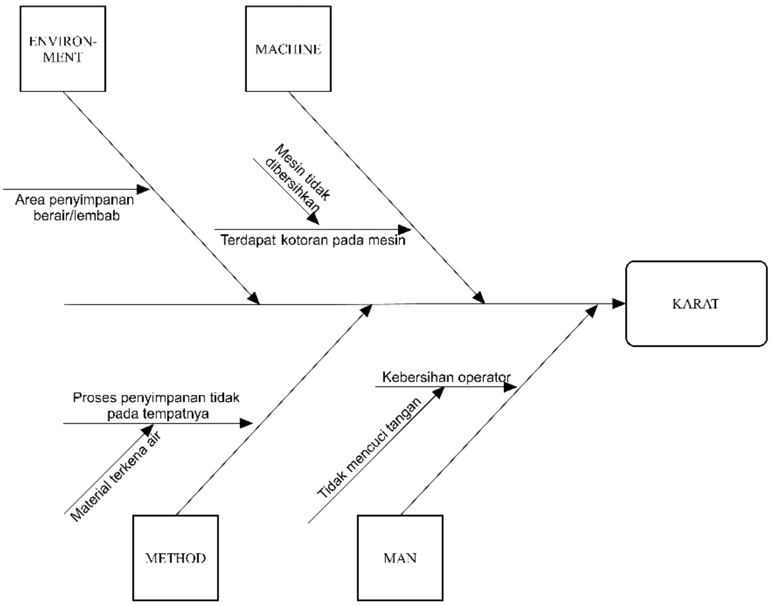

Figure 6. Fishbone Diagram of Rust

Based on Figure 6 the type of rust reject has 4 main causal factors derived from man, machine, material, and environment factors. Each cause includes operator hygiene where they do not wash their hands before the production process begins, there is dirt on the machine because the machine is not cleaned either before or after use, and the storage process does not follow Standard Operating Procedures so the material is exposed to water, and the last cause is a watery or humid storage area so that the material is easier to rust.

Meanwhile, based on Figure 7, the type of large scratch reject has 3 main causal factors which come from the man, machine, and method factors.

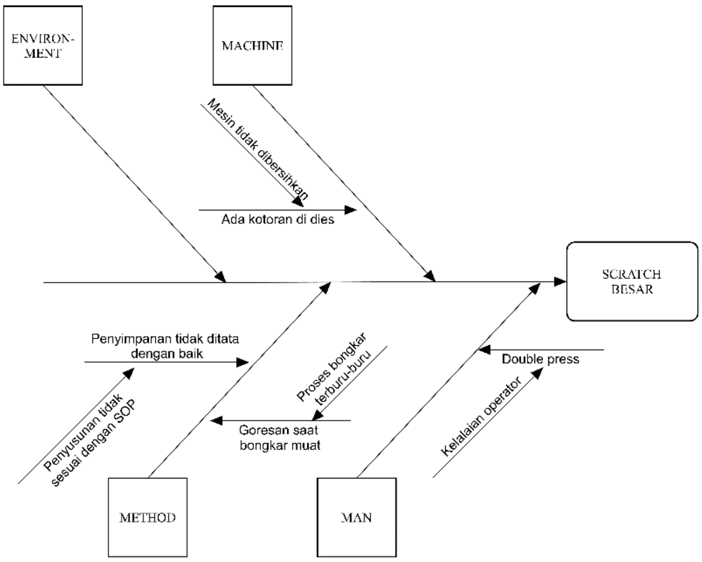

Figure 7. Fishbone Diagram of Large Scratch

Each of the causes includes the product being pressed twice due to operator negligence, there is dirt on the dies because it is not cleaned first, the storage is not properly organized, and the last cause is scratches during the loading and unloading process of raw materials which are carried out in a hurry.

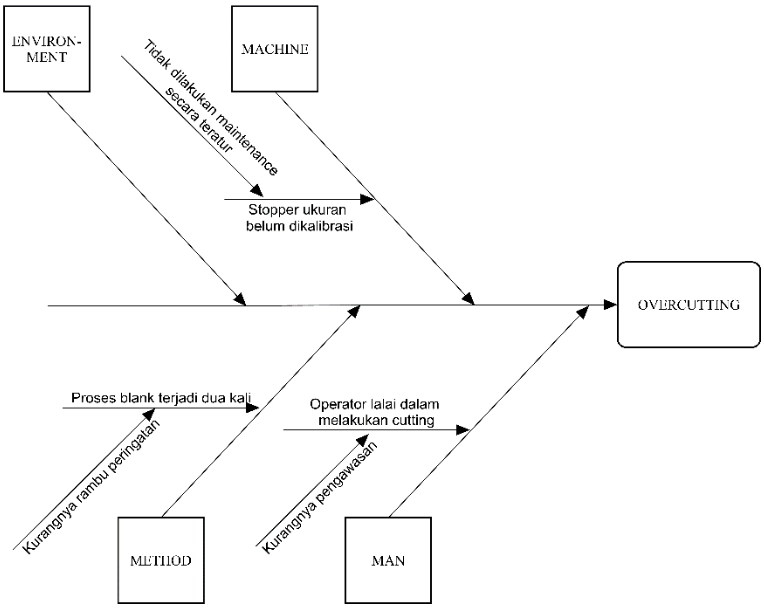

Figure 8. Fishbone Diagram of Overcutting

Based on Figure 8 the type of overcutting reject has 3 main causal factors derived from man, machine, and method factors. Each cause includes negligent operators in cutting due to lack of supervision, the size stopper not being calibrated because maintenance is not carried out regularly, and the blank process occurring twice.

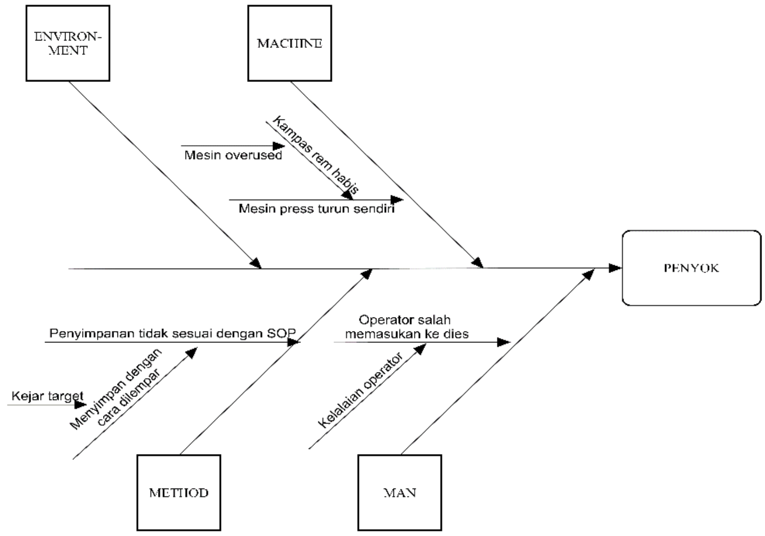

Figure 9. Fishbone Diagram of Dent

Based on Figure 9 the type of reject dents has 3 main causal factors which come from the man, machine, and method factors. Each of the causes includes the wrong operator entering the dies, the press machine going down itself because the brake lining runs out and the machine is still used even though it is time for maintenance, and storage is not by the SOP because it is stored by throwing it.

e. Proposed Improvements

Table 3. Proposed Improvements

No	Defect Type	Causes	Proposed improvements
1	Dents	The operator put in the wrong dies	Add clear markings/guidance on the dies that can be in the form of drawings.
2		The press machine descends by itself	1. Schedule machine maintenance. 2. Clean the press machine of dust and other dirt that can interfere with the performance of the machine including the components inside regularly. 3. Check machine spare parts thoroughly and always use original parts so that they are not easily damaged..
3		Storage not according to SOP	1. Train employees on how to properly handle and store materials. 2. Post warning signs to remind employees to be careful when carrying materials.
4	Rust	Operator hygiene	1. Provide training to operators on the importance of maintaining cleanliness while working. 2. Provide adequate hygiene facilities, such as easily accessible handwashing stations, hand sanitizers, and easily accessible trash bins. 3. Establish clear and firm hygiene procedures.

5		There is dirt on the engine	1. Perform regular cleaning of the engine and its components. 2. Provide tools specifically used for engine cleaning 3. Use clean lubricants and do not use used lubricants.
6		Storage out of place	1. Store materials in a dry and clean place. 2. Separate materials affected by rust so that it does not spread. 3. If the material is exposed to water immediately dry it with a dry cloth that can absorb water.
7	Large Scratches	Double press	1. Provide press training to employees regularly. 2. Provide warning signs to prevent double presses. 3. Make sure the dies are always clean from distracting workpieces.
8		There is dirt on the dies	1. Perform regular and thorough cleaning of the dies. 2. Provide training to operators on how to properly clean and maintain the dies. 3. Provide a vacuum to suck up dirt on the dies.
9		Storage is not organized properly	1. Revise the box storage layout and ensure that the layout that has been designed can store the boxes neatly. 2. Provide sufficient lighting by following the rules that have been set in the storage room for the process of storing and retrieving goods. 3. Provide training to employees who are responsible for handling boxes.
10		Scratches during material unloading	1. Provide training to employees on proper unloading of materials. 2. During the handling process, comply with the applicable SOP’s.
11	Overcutting	The operator is negligent in cutting	1. Provide cutting training to operators. 2. Provide signs or warnings in the control room to prevent overcutting.
12		The size stopper has not been calibrated	1. Calibrate the cutting machine to maintain cutting accuracy and precision. 2. Perform maintenance on the cutting machine regularly to ensure the machine is working optimally. 3. Make sure the jig/stopper is by the dimensions of the workpiece, loose stopper should be replaced immediately.
13		The blank process occurs twice	1. Perform blank inspection before the blank process occurs only once. 2. Install specific signs or markings to remind operators not to perform the blank process twice.

Based on Table 3 of the proposed improvements to overcome the various problems caused in the production process, 4 main things must be applied to overcome all existing problems, namely by implementing a clear Standard Operating Procedure (SOP) that must always be applied more organized, conducting training for employees and operators to improve employee expertise in certain fields so that they are more proficient at work, conducting routine supervision will make employees work more carefully and ensure that the Standard Operating Procedure (SOP) can be carried out by all employees, and conducting regular audits to identify problems caused and prevent errors that have occurred before from recurring.

DISCUSSION

The purpose of this study is to analyze and improve the quality control process at CV Biru Karya Pratama, with a particular focus on reducing product rejects for Terminal 40D-H2103-00. This study aims to identify the root causes of rejections using the statistical quality control method and propose effective and efficient quality control improvements.

Initially, a checksheet was created using Microsoft Excel to record production data and defective products, which identified rust as the most prevalent defect, followed by large scratches, overcuts, and dents. P charts, used to monitor and control the process, revealed that 7 data points were outside the control limits (UCL and LCL), indicating significant inefficiencies in the production process. Histograms provided a visual representation of the frequency of defects.

Pareto analysis, which was conducted to identify the most frequent defects from January to December 2023, confirmed that addressing rust, large scratches, over-cuts, and dents could substantially reduce the overall defect rate. Root cause analysis using fishbone diagrams identified specific causes related to human, machine, material, method, and environmental factors. For example, rust defects are related to operator hygiene, machine cleanliness, improper storage practices, and humid storage conditions, while large scratches are caused by operator negligence, unclean molds, disorganized storage, and mishandling while loading and unloading materials. Overcutting and dent defects were also analyzed, which revealed causes such as operator negligence, uncalibrated stopper size, process errors, improper die usage, machine maintenance issues, and improper storage methods.

Based on these findings, four key improvements were proposed: implementing clear Standard Operating Procedures (SOPs), conducting regular employee and operator training, ensuring regular supervision, and conducting regular audits. These recommendations aim to address immediate and systemic problems in the production process. The findings of this study are consistent with existing literature, which emphasizes the importance of systematic data collection, root cause analysis, and continuous improvement in quality control (Gangidi, 2019). This is in line with Raut & Verma (2017) research which emphasizes the need for a systematic approach using various quality control tools to diagnose and minimize these defects, ultimately leading to increased productivity and operational excellence.

By systematically identifying and addressing the root causes of defects, this research provides a clear roadmap for improving product quality and reducing reject rates. This has the potential to improve operational efficiency, save costs, and increase customer satisfaction. The practical implications of this research include improved production processes, improved product quality, increased operational efficiency, and improved employee skills and morale.

Future research could explore the long-term impact of the proposed improvements, investigate more advanced quality control tools and techniques, conduct cross-industry comparisons to identify best practices, and examine the role of automation and technology in further reducing defects and improving quality control processes.

CONCLUSION

From the research that has been carried out using the Statistical Quality Control (SQC) method on the production of 40D-H2103-00 terminals at CV Biru Karya Pratama, it is found that there are 4 types of rejects, namely rust, large scratches, overcutting, and dents. Each reject in 2023 has a percentage of dents at 0.44%, overcutting at 0.46%, large scratch at 1.27%, and rust at 1.45% with a total production of 560,000 pcs.

Each reject is caused by 4 main factors namely man, machine, method, and material, such as storage processes that are not by the Company's Operational Standards (SOP), machines that are not cleaned before and after production, to cutting that does not match the size. These causes are mostly due to operator negligence while working from the inbound process to the production process of terminal product 40D-H2103-00.

From the various causes of rejects, suggestions are given, namely implementing clear Standard Operating Procedures (SOPs), conducting training for employees and operators, conducting routine supervision, and conducting regular audits to identify problems and prevent previous errors from recurring.

Declaration by Authors

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