



Product Quality Analysis Safety Belt to Reduce Disability Using Six Sigma Method and Repair with Kaizen in PT XYZ

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A B S T R A C T

PT XYZ is a company engaged in the automotive spare parts sector. In carrying out production activities, there is a problem, namely defects in the safety belt product because of rust defects. From September 2022 to February 2023, the company produced safety belts amounting to 32,611 units and there are product defects rust of 1,709 units or around 5.24% of the total production. The product defect This will cause losses to the company and can reduce consumer confidence in the products produced by the company. Given this problem, research was carried out using the Six Sigma method and improvements to Kaizen the Five M Checklist also the Kaizen Five-Step Plan. The research aim is to reduce defects and make improvements to achieve near-perfect results. From September 2022 to February 2023, there is a DPMO of 51,856 and is at a sigma level of 3.1616. To reduce defects in safety belt production, the proposed improvements are based on the implementation of kaizen to improve product quality, namely getting used to working according to Standard Operating Procedures (SOP), applying strict sanctions when making mistakes repeatedly, carrying out periodic machine maintenance, facilitating air circulation by making air vents and others.

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1. INTRODUCTION

Over the years, the auto industry has been constantly robbed by vehicle recalls due to manufacturing defects. Because auto manufacturers' recalls have been associated with one form of "flaw" or another, vehicle recalls can pose serious problems for manufacturers. Defect problems in any production activity will contribute to residual problems and therefore unwanted additional costs will be incurred. It can come in all shapes

and sizes. This problem can significantly affect the company's performance and profitability (Dasig, 2017). PT XYZ is a company engaged in the auto parts sector with an OEM standard. The company will try to gain the trust of its customers by producing products according to the best specifications by paying attention to quality aspects, cost aspects, and delivery aspects which must be by the agreement. In carrying out production activities, PT XYZ experienced problems, namely the occurrence

of defects in the product safety belt Because of rust defects. From the product defect. This will cause losses to the company and can reduce consumer confidence in the products produced by the company. This needs to be evaluated to reduce or even eliminate defective products produced so that the company can realize its vision and mission.

The studies carried out, (Susetyo, Winarni & Hartanto, 2011) observed research was conducted at PT Mondarin which is engaged in connection with the results in the form of t-shirts. The problem faced by this company is that in its production on average per week there are 5.72% defective products. From the existing problems, to find out the process capability based on existing defective products, namely the DMAIC approach which is then controlled by analyzing the causes of defects and seeking improvement with Kaizen implementation tools in the form of Kaizen Five step plans and Five-M checklists. After processing the data, the DPMO value is 4509.384, which means that out of one million opportunities, there will be 4509.384 possible defects in the product produced. The company is at the 4.11 sigma level with CTQ (Critical to Quality) which causes the most defects, namely the deck of 20.76% of the total 22517 defects. The conclusion is main defects causes by human factors and Kaizen improvement is must be carried out by control in all fields or the company's greater supervision.

From September 2022 to February 2023, the company produced safety belts amounting to 32.611 units and there are product defects rust of 1.709 units or around 5.24% of the total production. The product defect This will cause losses to the company and can reduce consumer confidence in the products produced by the company. Given these problems, then conducted research using the method Six Sigma and Kaizen. expectations from research with methods Sigma and Kaizen this is reducing defects and making improvements to achieve near-perfect results. In addition, it can help to make continuous improvements by involving all workers, tools, and production support components to serve as a reference whose results greatly affect the quality safety belt.

2. LITERATURE REVIEW

Product is a key element in the market offer marketing planning begins with formulating offers to meet targeted customer needs or wants. While product quality is the key to competitive advantage, namely the ability of a company to achieve market advantage and an important factor that influences consumers in purchasing a product or service (Rasyid, 2019). According to Vincent Gasperz in (Ahmad, 2019), quality control is an important tool for management to improve product quality, when necessary, maintain quality, which is already high and reduce the number of damaged goods.

Quality control is quality maintenance which is an effort to maintain the quality of products produced to meet product specifications set by company management policies (Nurhayani, Putri & Darmawan, 2023). Six Sigma has a structured and systematic method that uses the standard DMAIC (define, measure, analyze, improve, and control) as a process flow to solve problems (Ashari & Nugroho, 2022). Six Sigma must be towards the goal of 3.4 failures per million opportunities (DPMO) for the vision of quality improvement in both goods and services. The higher the target sigma, the better the performance of the industrial system. Six Sigma can also be seen as a customer-focused control of industrial processes, through an emphasis on process and as a capability breakthrough that allows companies to make extraordinary improvements (Sya'roni & Suliantoro, 2019). According to (Gaspersz, 2011) the first operational step in a Six Sigma method is define. At this stage the most important thing is to identify the product and/or process to be improved. We must set top priorities regarding which problems and or quality improvement opportunities will be addressed first.

The second operational step in the Six Sigma method is measure. The p control chart has the benefit of helping to control production quality and can provide information about when and where the company must make quality improvements (Fadilah & Hastari, 2019). The formula are:

$$P1 = \frac{np1}{n1} \tag{1}$$

$$CL = \bar{p} = \frac{\sum np}{\sum n} \tag{2}$$

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

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

Where:

- P : Proportion
- CL : Control line
- UCL : Upper control line
- LCL : Lower control line
- n : Defect value
- np : Delivery value

Failure measures are calculated in the Six Sigma Quality Improvement Program, indicating the number of defects or failures per opportunity. Calculated using the formula:

$$DPMO = \frac{\text{sum of the defect}}{\text{sum of the delivery} \times CTQ} \times 1.000.000 \quad (5)$$

In the analyze, data analysis is carried out and data processing is carried out based on the root causes that cause sigma performance in the process to decrease (Bahauddin & Arya, 2020).

The Improve stage is the fourth stage, namely by identifying and describing corrective actions or activities that constitute recommendations for solving problems at the process to obtain new ways to improve quality to make it better and more efficient (Paulin, Ahmad & Andres, 2022). Then, it is necessary to determine an action plan for quality improvement using kaizen (Bachtiar, Dahdah & Ismiyah, 2020).

Kaizen is a focused and structured continuous improvement process. Reducing defective products can be done by controlling the quality of products quality in increasing productivity because quality assurance is a basic factor that will increase consumer satisfaction (Rusdiyana & Soediantono, 2022) Kaizen is implemented at all levels of employees, both at the Top Management and Low Management levels (Prasetyo, Lukmandono & Dewi, 2021). Kaizen Five M Checklist focuses on the five keys that are visible in each process, Man, Machine, Milieu, Material, and Methods. In each process, improvements can be made by examining these aspects (Nabila & Rochmoeljati, 2020).

The final operational stage in a Six Sigma method is control. At this stage, quality improvement results are disseminated and documented. The successfulness of best practices in process improvement, as well as process ownership or responsibility. It is used as standard work guidelines (Silmiasi, Asdi & Maiyastri, 2018).

3. RESEARCH METHOD

This study uses the Six Sigma method with the initial stage of collecting data on rust records on safety belt products. This data was obtained from the company archives from September 2022 to February 2023. Then a solution to the problem will be made with kaizen five M. Both methods are carried out based on literature studies obtained from journals and previous research as well as direct observation of the safety belt production process. The analytical method can be seen in Fig.1.

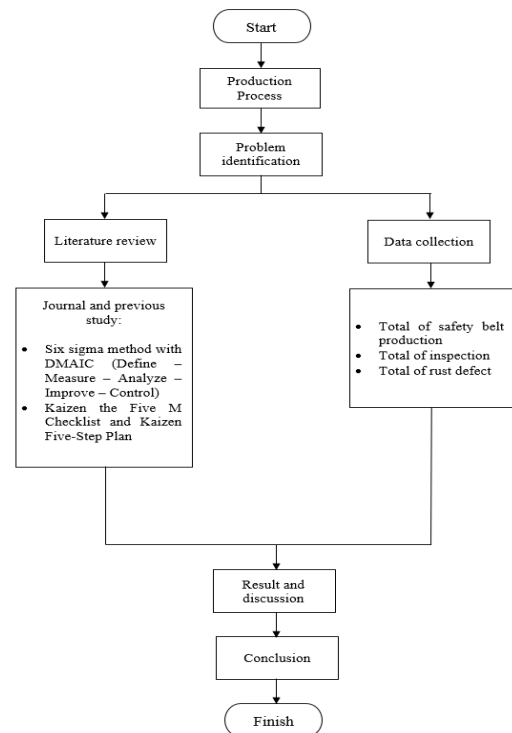


Fig. 1. Flow chart of the study

4. RESULT AND DISCUSSION

4.1 RESULT FOR DATA ANALYSIS

Based on the observation and data from the company, one of the products by PT XYZ that has the most defect is the safety belt. The safety belt has many defects because of rust. The data to be used in this study is data for 6 months from

September 2022 – February 2023 which is shown in the following Table 1.

Table 1. Defect of safety belt because of rust

Month	Defect of rust
September '22	269
October '22	390
November '22	515
December '22	189
January '23	137
February '23	209
Total	1709

Based on the table above, it can be seen the total product defect product highest safety belt because of rust which occurred in November 2022 of 515 units. As for total defects, the lowest occurred in January 2023 of 137 units.

4.2 Define

This stage is the first operational step in a quality improvement program Six Sigma. At this stage, the most important thing is the identification of the product and or process to be repaired. histogram defects that occurred in September 2022 – February 2023 can be seen in the following Fig. 2.

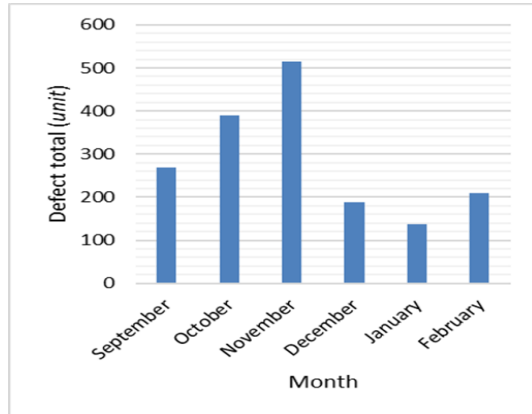


Fig. 2. Histogram defect of rust

From the Fig. 2, it is easier to make a summary

Table 2. The proportion of the rust defect

Month	Inspection total	Defect of rust	P	\bar{P}	UCL	LCL
September '22	5536	269	0.049	0.052	0.061	0.043
October '22	5256	390	0.074	0.052	0.062	0.043
November '22	5812	515	0.089	0.052	0.061	0.044
December '22	5441	189	0.035	0.052	0.061	0.043
January '23	5039	137	0.027	0.052	0.062	0.043
February '23	5527	209	0.038	0.052	0.061	0.043
Total	32611	2741	0.052			

of the dispersion distribution that displays the frequency of the data. The number of rust defects that occurred from September 2022 – February 2023 has increased and sometimes decreased.

4.3 Measure

This stage is the second operational step in the DMAIC, where at this stage measure is carried out on the research object. The measure was made in terms of the level of disability as well as measuring baseline performance in the period September 2022 – February 2023.

a. P-Chart

The p control chart has the benefit of helping to control production quality and can provide information about when and where the company must make quality improvements Calculating the proportion of the rust defect

$$\begin{aligned}
 P1 &= \frac{np1}{n1} \\
 &= \frac{269}{5536} \\
 &= 0,049
 \end{aligned} \tag{7}$$

$$\begin{aligned}
 \bar{P} = CL &= \frac{\sum np}{\sum n} \\
 &= \frac{2741}{52611} \\
 &= 0,052
 \end{aligned} \tag{8}$$

$$\begin{aligned}
 UCL &= \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} \\
 &= 0,052 + 3\sqrt{\frac{0,052(1-0,052)}{5536}} \\
 &= 0,061
 \end{aligned} \tag{9}$$

$$\begin{aligned}
 LCL &= \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} \\
 &= 0,052 - 3\sqrt{\frac{0,052(1-0,052)}{5536}} \\
 &= 0,043
 \end{aligned} \tag{10}$$

The summary of the proportion value of the rust defect can be seen in Table 2.

Based on the results above, it will produce a graphical form according to Fig. 3.

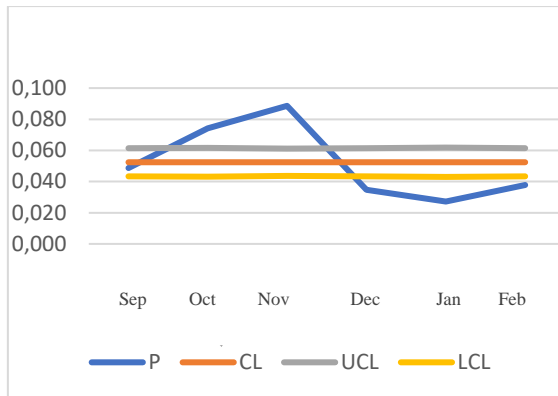


Fig. 3. P chart for rust defect

From the results of the graph above, five points are out of the upper and lower control limits, namely October, November, December, January, and December. This shows that the control of rust defects is still experiencing many problems. Therefore, further analysis is needed regarding the causes of the deviations seen in the P control chart.

c. DPMO Value and Sigma Level

Following are the results of DPMO calculations and sigma levels for safety belt products from September 2022 – February 2023:

$$\begin{aligned}
 \text{DPO} &= \frac{\text{total of defect product}}{\text{total of inspection} \times \text{CTQ}} \\
 &= \frac{269}{5536 \times 1} = 0,048591 \quad (11)
 \end{aligned}$$

Table 3. The results of DPMO and levels sigma on rust defect

Month	Inspection total (unit)	Rust (unit)	CTQ	DPMO	Sigma Value
Sep	5536	269	1	48591	3.1587
Oct	5256	390	1	74200	2.9452
Nov	5812	515	1	88609	2.8494
Dec	5441	189	1	34736	3.3154
Jan	5039	137	1	27187	3.4239
Feb	5527	209	1	37814	3.2767
Total	32611	1709		311137	

From the table above, the average DPMO value and the average value sigma in January to December 2022 are as follows:

$$\begin{aligned}
 \text{Average of DPMO} &= \frac{\text{total of DPMO from september – February}}{6}
 \end{aligned}$$

$$\begin{aligned}
 \text{DPMO} &= \text{DPO} \times 1,000,000 \\
 &= 0.048591 \times 1,000,000 \\
 &= 48,591 \quad (12)
 \end{aligned}$$

From the calculation above, in September 2022 there were 5536 products with a total of 269 rust products. Whereas Opportunities or quality characteristics (CTQ) is 1, so the probability of failure occurring in one million products is 48.591 times. To measure levels sigma can use a tool in the form of a DPMO conversion table to value sigma. Because the DPMO value is not in the sigma conversion table, an interpolation calculation is performed to determine the sigma value, there is:

$$\begin{aligned}
 x_1 &\rightarrow 49,471 & y_1 &\rightarrow 3.15 \\
 x &\rightarrow 48,591 & y &\rightarrow (\text{unknown}) \\
 x_2 &\rightarrow 48,457 & y_2 &\rightarrow 3.16
 \end{aligned}$$

$$\begin{aligned}
 \frac{x-x_1}{x_2-x_1} &= \frac{y-y_1}{y_2-y_1} \\
 \frac{48591-49471}{48457-49471} &= \frac{y-3.15}{3.16-3.15} \\
 \frac{-880}{-1014} &= \frac{y-3.15}{0.01} \\
 y &= 3.1587 \quad (13)
 \end{aligned}$$

From the DPMO value of 48.591 it is at the level of 3.1587 sigma which means that currently, the company is still at level 3 sigma. The table 4 is a summary of the results of DPMO calculations and levels sigma on rust defect in September 2022 to February 2023.

$$\begin{aligned}
 &= \frac{311137}{6} \\
 &= 51,856 \quad (14)
 \end{aligned}$$

$$\begin{aligned}
 \text{Average of sigma value} &= \frac{\text{total of sigma from September – February}}{6}
 \end{aligned}$$

$$= \frac{18,9693}{6} = 3,1616 \quad (15)$$

4.4 Analyze

This stage is the third operational step in the

DMAIC cycle, where at this stage an analysis of the results of the measure that have been carried out in the previous stage is carried out and determines the root cause of each CTQ by using a causal diagram tool (fishbone diagram) in Fig. 4.

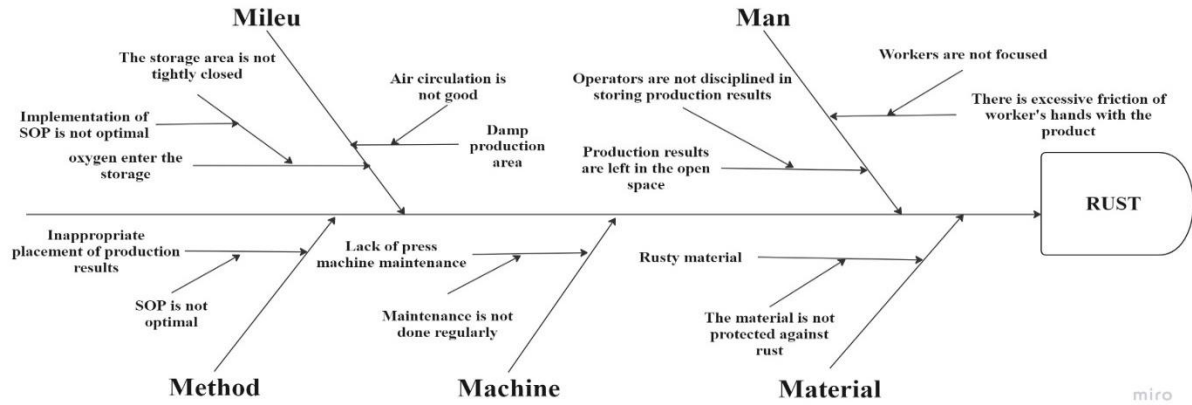


Fig. 4. Fishbone diagram of the root problem of rust defect

The following is an explanation of the diagram analysis fishbone:

1. Milieu factor
On the milieu factor, namely the product storage area is less closed and the production area is damp which causes the product to become rusted.
2. Man factor
In the human factor, namely and worker errors in storing production results in open spaces and excessive friction of the worker’s hand with the product which causes the product to rust easily
3. Method factor
On the method factor, namely the lack of precision in the method of storing

4. Machine factor
On the machine factor, namely the lack of machine maintenance press.
5. Material factor
On the material factor namely, the material obtained from the supplier is not given anti-rust so during the delivery process from the supplier to the company the material is easily rusted.

4.5 Improve

After the sources and root causes of the problem are identified, it is necessary to make an improvement plan to reduce the total rust defect by using the Kaizen Five M Checklist and Kaizen Five-Step Plan in Table 5.

Table 4. Kaizen Five M checklist and Kaizen Five-Step plan

Factors causing the problem	The root of the problem	The impact of the root cause	Troubleshooting (proposed improvements)
Man	Too much friction between workers' hands and their products Production results are left in the open by workers	The product is easily rusted. The impact of the lack of discipline of the workers is that the product is placed in an open space so that the product can rust.	Get used to working accordingly Standard Operating Procedure (SOP) Provide a place to store products in a safe and sterile place.
Machine	Lack of machine maintenance press	The impact on the production process is not running well and indicates defective production results.	Familiarize workers to carry out periodic checks

Milieu	Damp production area	In a humid production area, it can cause workers to be distracted which hinders the production process.	Streamlining air circulation by creating air vents
Method	The product storage area is not tightly closed	Air can enter and cause the product to rust	The head of production provides a closed storage area
	Inappropriate placement of production results	The impact of production is easy to rust	Provide a safe storage place for produce.
Material	Material not coated with anti-rust	Because the material is not coated with anti-rust during the production process from raw materials (materials) to finished products it is easier to rust.	Instruct material suppliers to provide anti-rust coatings.

4.6 Control

This stage is the last operational stage in the DMAIC cycle. But this study does not do. Implementation Control is performed by the company and stage improvement only a suggestion.

5. CONCLUSION

The results of research that has been done on the quality control process at PT XYZ with the Six Sigma method with improvements to Kaizen the Five M Checklist and Kaizen Five-Step Plan can be concluded according to the research objective to analyze the number of rust defects in safety belt products. The results obtained are from September 2022 to February 2023, there is a product defect of 5.24% a DPMO of 51,856 and is at a sigma level of 3.1616. At the improve stage using Kaizen consists of several improvement proposals, including used to working accordingly Standard Operating Procedure (SOP), providing a place to store products in a safe and sterile place, familiarizing workers to carry out periodic checks, facilitating air circulation by creating air vents, the head of the production provides a closed storage area, provide a safe storage place for production, and instruct material suppliers to offer anti-rust coatings. In this study, it was only limited to improving proposals, for the control stage it was returned to the company. Future research is expected to be able to combine other methods of making improvements with the Six Sigma method and can be analyzed for other problems.

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