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Quality Control Analysis of Piston Gasoline Products using the DMAIC Approach

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ABSTRACT

The manufacturing company in this study is a company engaged in the automotive sector that produces pistons and non-pistons. The problem that occurs in the company is that the average percentage of defects exceeds the company's standard limit of 5% while the maximum defect limit is set by the company at 1%. Identify the dominant type of defect, identify the biggest factors causing the dominant type of defect and make suggestions for improvement. In this study using the DMAIC method (Define, Measure, Analyze, Improve and Control) in the production process of the type x gasoline piston, there are several types of defects, namely monoiri, misrun, coating loss. The types of defects that occur are based on the Pareto diagram, namely the type of defect monoiri with a percentage of 56%, misrun 28% and coating loss 16%, and the causal factors are known using a fishbone diagram, there are 5 factors, namely material, people, methods, machines and environment. Based on the results of the identification of FMEA and the calculation of the highest RPN, it is known that the monoirritic defects that occur in the causative factor of the material with an RPN value of 175. For proposed improvements, namely monitoring and creating monitoring forms to facilitate cleaning of materials on a scale, and to facilitate cleaning of larger materials. scheduled.

Keywords: Defect, DMAIC, FEMA, Quality Control, Piston, RPN.

1. INTRODUCTION

The quality of a product is one of the criteria considered by customers in choosing a product. Product quality is also an important indicator for a company to be able to stand in the midst of intense competition in the industrial world. Product quality is solely determined by consumers so that consumer satisfaction can only be achieved by providing good quality. The quality of a product is built by the company by taking into account the needs and desires of the customer because an industrial factory will not exist if the products made or ordered are not in accordance with the wishes of consumers. Having consumers who are satisfied with our products is something that is important for every company. To build consumer satisfaction, it is necessary to identify customer satisfaction factors (Haekal, 2023).

To remain competitive and survive in an industry, a company must be able to maintain the quality of the goods it produces, as well as the quality of these goods. Product quality has a significant influence on consumer ratings of a

company. The higher the quality we offer, the higher consumer ratings and vice versa. Control and supervision are activities carried out to ensure that production and operational activities are carried out in accordance with what was planned and if deviations occur, these deviations can be corrected so that what is expected can be achieved.

Defective products are goods or services that are made in the manufacturing process but have defects that make the value or quality lower or incomplete. According to the Big Indonesian Dictionary, products are goods or services that are produced or added to use value during the production process and become the end result of the production process. Defective products are products that do not comply

specifications. This also means not meeting the set quality standards. Defective products that appear during production are products that are not accepted by consumers (Haekal, 2022). Defective products are products that do not meet predetermined quality standards, but by incurring rework costs to repair them, these products can be economically upgraded to become even better products.

This research was conducted in the Foundry Department of the Quality Control (QC) division, which is responsible for ensuring that the quality of products produced is in accordance with standards and there are no defects. However, based on data verified by QC between February 2022 and July 2022, the type x gasoline piston product was found by QC to have an average defect of 5% while the maximum defect limit was set by the company, namely 1%. Quality control is carried out starting with providing quality standards for a product, which then continues into the production process and product management until it becomes a product that the customer wants. Several factors play a role in quality control, these factors include: Machine, Human, Method, Material, and Environment or commonly known as 4M + 1E. The following is a bar chart showing the number of product defects for the type x gasoline piston.

Based on the data, it can be seen that defects in the total product defect of the gasoline piston type x defect occur. In addition, it was also found that the company had a defect rate of 5.0% which had exceeded the maximum limit set by the company, namely: 1%. This causes a lack of attention in implementing quality during the production process and it is also found that there are several production operators who have to concurrently work to check product quality, causing them to not focus on doing their main job.

Therefore, it is important for this company to pay more attention to product quality control so that the quality of the products produced can compete in getting satisfaction and loyalty from customers, then a quality control analysis will be carried out so that they can make improvements using the Demine, Measure, Analyze, Improve method , Control (DMAIC) and identify failures that occur using the Failure Mode and Effect Analysis (FMEA) method. DMAIC (Define, Measure, Analyze, Improve, and Control) is a core component of the Six Sigma methodology, which is used to improve the performance of a process in identifying defects. Useful for business process improvement to reduce manufacturing errors [9-20] FMEA is a tool that systematically identifies the consequences or consequences of system or process failures, as well as reduces or eliminates opportunities for failure to occur (Haekal & Masood, 2023)

2. METHOD

The steps taken in this study using the direct measurement test and the DMAIC method, namely:

A. DMAIC Stages

1. Define

The Define stage will be explained using a pareto diagram used to determine the most dominant type of defect/failure, and Critical to Quality (CTQ).

2. Measure

The measure stage that will be carried out is the collection of data used to measure the performance of a process before repairs are carried out. What is done at this stage is the calculation of the DPMO value to find out the level before repair. DPMO is a failure measure that shows the number of defects per million opportunities.

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3. Analyze

In this step, determine the source of the cause of the defect. The tools used to determine the most dominant defects are fishbone diagrams. Fishbone diagram is used to analyze the factors that cause product defects in more detail.

4. Improve

At this stage, FMEA is used to determine priority improvement plans. FMEA is a systematic activity that identifies potential failure levels in a system, product or process, especially in the root functions of the product or process on the factors that affect the product or process.

At the improve stage, use the 5W + 1H tools to find the best solution from the existing statements with answers.

5.Control

At the Control or monitoring stage, it ensures that the improvements made are effective. This stage is the stage to control the process that has been improved. This control can be done by monitoring daily production after balancing the production line.

3. RESULT

1. Define Stage

At the define stage there are two tools used, namely CTQ (Critical To Quality), and Pareto Diagrams. CTQ (Critical To Quality) is to determine the CTQ defect of the resulting product, the product criteria that have been standardized as a benchmark for product quality to meet customer needs. The Pareto diagram serves to determine the most dominant type of defect in the type x gasoline piston product. So that for repairs can be focused on the type of defect obtained.

a) CTQ (Critical To Quality)

The first step that has been analyzed at the define stage is to determine the CTQ, it is known that there are 3 types of defects that occur in the casting process of type x gasoline piston products such as Monoiri, Misrun, and Coating Loss, after knowing the CTQ then the next step is using a Pareto diagram.

b) Pareto salt

Pareto diagrams are used to find the root causes of problems with a product by obtaining the highest damage data and to be able to focus repairs on the most dominant problems. Based on the results of data processing on pareto diagrams

Chapter 4 can be seen that the type of monoiri defect has a percentage of 56%, misrun defects are 28%, and coating defects fall off 16%. Furthermore, focusing on repairs on mono-efficiency defects because mono-efficiency defects are defects with the highest percentage.

2. Stage Measure

At the measurement stage in this research, it is done by calculating DPMO (Defects Per Million Opportunities), to determine the sigma value. This stage plays an important role in improving product quality, because after the calculation results are obtained, the current performance of the company will be known as material for consideration for analysis and improvement. The following is the result of calculations based on production data, the results of calculating the DPMO value obtained an average DPU result of 0.049942, a DPO value of 0.016647 and a DPMO value of 16.647, the sigma results obtained with an average of 3.63 so that the company is at the average sigma level – Indonesian industry average.

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Table 1. Production Data

NO	Month	Total	*Defect*	DPU	DPO	DPMO	Sigma
1	February	41769	1987	0.047571	0.015857	15857	3,65
2	March	26815	1414	0.052732	0.017577	17577	3,61
3	April	13072	1074	0.08216	0.027387	27387	3,42
4	May	25236	926	0.036694	0.012231	12231	3,75
5	June	29032	1134	0.03906	0.01302	13020	3,73
6	July	32896	1363	0.041434	0.013811	13811	3,70
total		168820	7898	0.049942	0.016647	16647	3,63

3. Phase Analyze

At the analyze stage, an analysis is carried out to find out what causes the existing problems, so that repairs can be carried out quickly and precisely, for this stage the tools used, namely the fishbone diagram are used to be able to find the causes - the causes of these defects. After knowing the type of defect with the highest percentage known from the results of the Pareto diagram, namely the type of defect monoiri with a percentage of 56%, the next step is to analyze the causes of failure using a fishbone diagram. Based on the data processing on the fishbone diagram, it can be identified several factors that cause monoiri defects in the type x Manufacturing gasoline piston product as follows:

a) Materials (Materials)

The causes that have the potential to cause failure in the material aspect are dirty material, and the composition of the material is not suitable which causes the material to mix with other materials so that the dirty material causes a monoiri defect during the casting process.

b) Man (Human)

The potential cause of failure in the human aspect in the casting process is the operator being undisciplined when drossing which causes work to become abnormal and one of them causes defects monoiri.

c) Method

The potential cause of failure in the method is that there is no reflacment method for pouring the correct material, which causes difficulties for the operator during the pouring/casting process, causing mono-efficiency defects.

d) Machine

The potential cause for the machine is turbulence during casting so that during the casting process it becomes imperfect and porous because the machine used experiences turbulence. So it can lead to defects monoiri.

e) Environment

Potential causes of failure in the environmental aspects of the casting process are dusty line roofs and lack of attention to line cleanliness which results in the material being mixed with dust which enters during the pouring/casting process resulting in mono-irrigate defects.

4. IMPROVED STAGES

After knowing the cause and effect of the fishbone diagram, then make suggestions for improvements using the tools FMEA (Failure Mode and Effect Analysis) and 5W + 1H (What, Why, Where, When, Who, and How). FMEA is used to identify the causes of failure of the type x gasoline piston product and to calculate the highest RPN (Risk

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Priority Number) value. After knowing the highest RPN value, the next step is to analyze using 5W + 1H to provide suggestions for improvements to the problems in the type x gasoline piston product. The following is the result of the analysis:

1. FMEA (Failure Mode and Effect Analysis)

Based on the results of the highest value that has been done when calculating the RPN with the first RPN value of 175, namely the dirty material problem, the second method of drossing the material is incorrect with a value of 168, the third, the skills for how to pour the material are different with a value of 144, then the the fourth is the occurrence of turbulence when pouring with an RPN value of 125, and finally the roof line is dusty with an RPN value of 100. Therefore from the calculation results it is known that the cause of failure is based on the highest RPN value of 175 on dirty material problems.

2. 5W + 1H (What, Why, Where, When, Who and How)

After obtaining the highest RPN value in FMEA identification, then the results of these calculations will be corrected using 5W + 1H, obtaining improvement proposals, namely monitoring and creating monitoring forms for material cleaning, monitoring forms to facilitate cleaning on a scale and schedule when cleaning takes place.

5 STAGE CONTROL

At this stage, namely control, to control the control over the proposed improvements or improvements that have been given previously in the improve stage using 5W + 1H. The following are proposed improvements:

1. Carry out regular monitoring of material cleaning. Monitoring is carried out using a monitoring form to facilitate cleaning of materials on a scale.

2. Make a monitoring form for material cleaning, making a monitoring form aims to make it easier when monitoring takes place and make it easier when cleaning materials that are more scheduled. This monitoring form contains information when cleaning must be carried out, in addition to this monitoring form there is a schedule for periodic material cleaning. With the monitoring form, it is hoped that it can reduce defects in the production process, so that productivity can increase.

4. CONCLUSION

From the results of the processing and analysis that has been carried out in the casting process of the type x gasoline piston product, it can be concluded as follows:

1. In determining the type of defect in the type x pitston gasoline product. obtained from the percentage results using a pareto diagram showing the types of defects that affect the product quality of the type x gasoline piston, namely Monoiri Defects having the largest percentage of 56%, Misrun Defects of 28%, and Defect Coating Loss of 16%.

2. Based on the analysis that has been carried out using the fishbone diagram tools, it can be seen that the causes of this type of defect monoiri are as follows: (1) Dirty Material (2) the composition of the material is not suitable which causes it to mix with other materials so that the material is dirty. The material factor is the factor causing the largest defect to occur, it is known from identification using FMEA and calculating the highest RPN value for each type of defect, such as there is no tool available to check material cleanliness with the largest score RPN 175, the second method of drossing material is not correct with an RPN value 168, the third is the skill of how to pour the material which is different with an RPN value of 144, then the fourth is the occurrence of turbulence when pouring with an RPN value of 125, and finally the roof line is dusty with an RPN value of 100.

3. After analyzing using the DMAIC method, the proposed improvements that can be given to the production department to overcome the problem of monoir defects, the proposed improvements are to carry out routine monitoring of material cleaning, and create monitoring forms for material cleaning, making monitoring forms aims to facilitate monitoring takes place and makes it easier to clean up more scheduled materials.

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