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Quality Control Of Electrical Panel Powder Coating Box Production Using The DMAIC Six Sigma Method at PT DMI Tangerang

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Abstrak

PT DMI adalah perusahaan yang memproduksi box panel listrik. Masih terdapat produk cacat yang melebihi target perusahaan pada hasil proses powder coating. Hasil dari powder coating pada PT DMI melalui CV XYZ. Penelitian ini menggunakan metode Six Sigma dengan lima tahap diantaranya Define, Measure, Analyze, Improve, dan Control (DMAIC) hasil fase define penelitian ini menunjukkan terdapat 3 CTQ pada hasil powder coating. fase measure rata-rata nilai DPMO 4107,496 dan rata-rata level sigma 4,175. fase analyze ditemukan 4 faktor dari jenis cacat diantaranya manusia, mesin, metode dan mesin. fase improve terdapat 3 rekomendasi yang telah diberikan yaitu membuat tabel 5w+1H, SOP dan DOE. fase control akan di lakukan dengan memberikan usulan perbaikan ini terhadap masing-masing perusahaan. Hasil dari penelitian ini mampu untuk meminimalisir masalah yang terjadi terhadap hasil powder coating di PT DMI.

Abstract

PT DMI is a company that manufactures electrical panel boxes. There are still defective products that exceed the company's target on the results of the powder coating process. The results of powder coating at PT DMI through CV XYZ. This study used the Six Sigma method with five stages including Define, Measure, Analyze, Improve, and Control (DMAIC). The results of the define phase of this study showed that there were 3 CTQs in the powder coating results. phase measure the average DPMO value is 4107.496 and the average sigma level is 4.175. the analyze phase found 4 factors of the type of defect including humans, machines, methods and machines. In the improve phase, there are 3 recommendations that have been given, namely making a 5w+1H table, SOP and DOE. the control phase will be carried out by providing this improvement proposal to each company. The results of this study were able to minimize problems that occurred with powder coating results at PT DMI.

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1. INTRODUCTION

The electrical panel box is a container in the form of a rectangular cube box where inside the box, there is a cable connection or electrical panel. The existence of the box is very important to protect against leakage of electric current which is certainly dangerous for workers or humans. PT DMI is a company that produces electrical panel boxes by providing services related to the manufacture of all types of electrical panel boxes needed based on customer requests. The production flow at PT DMI includes design engineering (Value Engineering), cutting and bending (Bending), welding and grinding, assembly (Assembly), and shipping until the product is ready for use by customers. In the production performance of a company, it cannot be separated from product defects or defective products produced. At PT DMI, there are still problems with the powder coating results from CV XYZ.

According to (Norawati & Zulher, 2019) every company, both service companies and industrial companies, quality control is very necessary. Then according to (Untoro & Iftadi, 2020) the determinant of a product that is a significant consumer choice for industrial products is quality. The concept that is currently developing, to achieve customer satisfaction with continuous improvement. The method used in this study is Six Sigma which aims to minimize the number of defective products at PT DMI from Powder Coating results at CV XYZ. According to (Utomo & Rimawan, 2020) Good quality control will result in constant quality results according to the specifications set by the company.

2. METHODS

The case study in this research was taken in the production of electrical panel boxes at PT DMI and CV XYZ in the Powder Coating production process within 1 year from March 2022 to February 2023. The type of data taken was primary data including the number of defects, the amount of production and data from previous sales that have passed the inspection stage by the person in charge of Quality Control (QC). Then the types of secondary data include observation, interviews and documentation. Observations in this study observed the Powder Coating process flow at CV XYZ, Interviews were conducted with the head of production and documentation was carried out to collect. According to (Subana et al., 2021) The application of the six sigma method can help companies improve the quality of their products by increasing the company's sigma value. Six Sigma can be used to measure the performance of industrial systems which allows companies to make improvements with a strategy as industrial process control that focuses on customers regarding process capabilities. The 5 stages that will be used in this study are,

1. Define
   This stage identifies Critical To Quality (CTQ) and describes the types of defects that occur. CTQ is a defect problem that significantly affects production (Abbes et al., 2018).
2. Measure
   This stage is the second stage of the DMAIC Cycle, in this measure stage calculations, measurements and processing of research data will also be carried out by calculating the DPMO and determining the sigma value to measure the performance of the company.
3. Analyze
   The purpose of this stage is to analyze or find the causes of failures or problems in the powder coating process at CV XYZ to reduce the number of defective electrical panel box products at PT DMI by using Pareto diagrams and Fishbone diagrams. In the Analyze stage, root cause and pareto diagrams are used to analyze the causes of problems resulting from production results (Wahyudin & Agung Apriliandi, 2021).
4. Improve
   At this stage, measurements are made of which types of defects will be controlled and provide recommendations for improvement with 5w+1h, Design Of Experiment and Standard Operational Procedure.
5. Control
   The last stage is to provide improvement suggestions to the company as a study to minimize the problems that have occurred so far.

3. RESULT AND DISCUSSION

There are 5 stages of six sigma as described above namely,

3.1 Define

At this stage determine Critical to Quality and describe the types of defects that occur. Based on this, it can be seen that Critical To Quality and the description of the types of defects in electrical panel box products can be seen in Table 1.

Table 1. Critical To Quality

No	Critical To Quality	Specification	Defect type
1	Paint that does not comply with the minimum thickness	Conditions where the size of the minimum paint thickness does not comply with company regulations, namely 80 micron meters	Thin Paint
2	Too much paint stuck to the surface	The condition where too much paint sticks to the surface due to the force of gravity being greater than the resistance to flow.	Clumping Paint
3	Paint with unequal shape	Conditions where the shape is uneven because it is caused by dry paint grains before the coating is evenly distributed or like an orange peel	Uneven Paint

3.2 Measure

At this stage, the calculation of defects per million opportunities (DPMO) is carried out and the company's performance is measured by determining the sigma value.

No	Production Total	Defect	CTQ	DPO	DPMO	DPMO Average	Sigma Value	Average Sigma Value
1.	360	6	3	0,556%	5555,556	4107,496	4,04	4,175
2.	540	12	3	0,741%	7407,407		3,94	
3.	500	8	3	0,533%	5333,333		4,05	
4.	750	10	3	0,444%	4444,444		4,12	
5.	420	8	3	0,635%	6349,206		3,99	
6.	530	4	3	0,252%	2515,723		4,31	
7.	640	5	3	0,260%	2604,167		4,29	
8.	570	7	3	0,409%	4093,567		4,14	
9.	720	4	3	0,185%	1851,852		4,40	
10.	460	3	3	0,217%	2173,913		4,35	
11.	510	3	3	0,196%	1960,784		4,38	
12.	400	6	3	0,500%	5000,000		4,08	
Total					**49289,952**	**4107,496**	**50,09**	**4,175**

Fig. 1. DPMO Calculation And Sigma Value

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From the results of the calculation of the DPO, DPMO and sigma level values on the results of the powder coating box of the electrical panel, the results of the sigma level 4 are obtained. This means that the results of the powder coating from CV XYZ can be categorized as quite satisfactory for PT

DMI. However, there are still 2 levels above sigma level 4 to achieve perfection, namely sigma levels 5 and 6 or even achieve zero defects.

3.3 Analyze

The purpose of this phase is to analyze or find the cause of the failure or problem in the powder coating at CV XYZ to reduce the number of defective electrical panel box products. The methods used in the analyze phase of this research are Pareto Diagrams and Fishbone Diagrams.

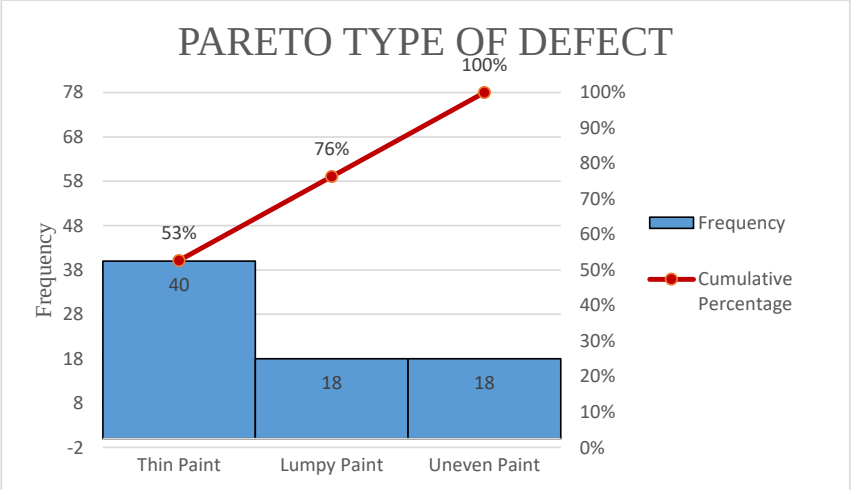

Fig. 2. Pareto Diagram

Result of pareto diagram above, it shows that the priority for the type of defect from the highest powder coating results at PT DMI falls on thin paint. Thus, thin paint will be the focus of control in this study. Furthermore, to find out the cause of this type of thin paint defect, it will be analyzed using a Fishbone Diagram as shown in Figure 3 below.

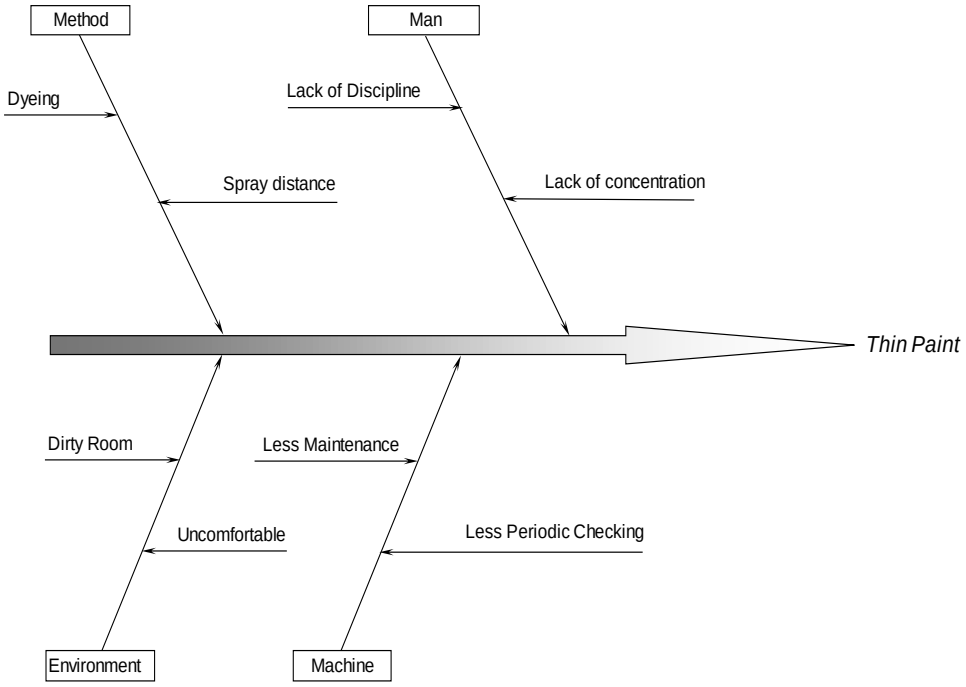

Fig. 3. Fishbone Diagram

3.4 Improve

There are several recommendations given, namely, the first is using 5w+1h, the second is using the Design Of Experiment (DOE) and the third is Standard Operational Procedure (SOP). The first recommendation given is 5w+1h as follows.

No	Cause	What	Why	Where	When	Who	How
1	*Man*	➢ Employees are less disciplined ➢ Employees lack concentration	➢ Lack of supervision from the company ➢ Lack of concentration at work.		➢ During the production process ➢ During the Coating process	Operator	➢ Implement supervision and provide sanctions to employees who lack discipline ➢ Supervisors have the right to reprimand operators who are less concentrated. ➢ The company can give punish and reward to the operator
2	*Method*	➢ Dyeing Process ➢ Spray Distance	➢ Lack of operator understanding of the ideal time for immersing hydrochloric acid and zinc phosphate coating so that it takes time ➢ Spraying distance is too far	Production Scope	➢ During the immersion process of Hydrochloric Acid and Zinc Phosphate coating ➢ Coating process	Operator	➢ Issuing written SOPs for the ideal time during the process of immersing hydrochloric acid and zinc phosphate coatings in order to minimize wasting time and the ideal distance when spraying is at least 20cm.
3	*Machine*	➢ Lack of checking ➢ Less Maintenance.	➢ Lack of checking the wind pressure on the machine to be used. ➢ Lack of maintenance on the machine which causes the spray gun to produce a less good spray.	Scope of Work	During the Coating process	Operator And The Company	➢ When it is about to be used, the operator is required to check the ideal spraygun wind pressure to regulate the amount of liquid that will come out ➢ It is mandatory to empty and clean the spray gun tube with a paint cleaner to eliminate the possibility that there is some paint powder that settles inside and makes the results of the spray less good ➢ The company performs maintenance on the machine on a regular basis
4	*Environment*	➢ Dirty Room ➢ Uncomfortable Room	➢ Dusty ➢ lots of stuff scattered around		During the production process	Operator And The Company	➢ The company makes or determines the picket schedule to the operator. ➢ The supervisor directs the operator to the components that have been used to be returned to their original place.

Fig. 4. 5W + 1H

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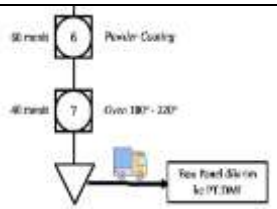
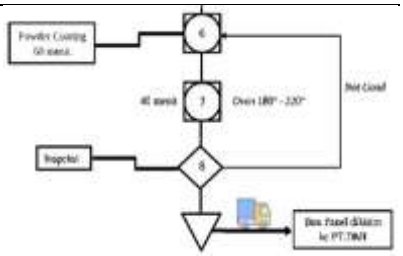
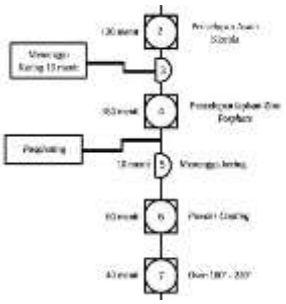
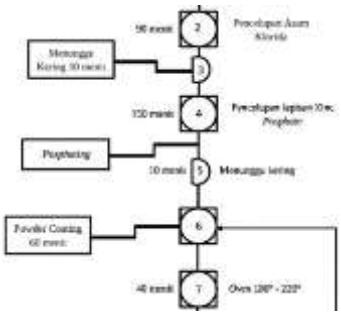
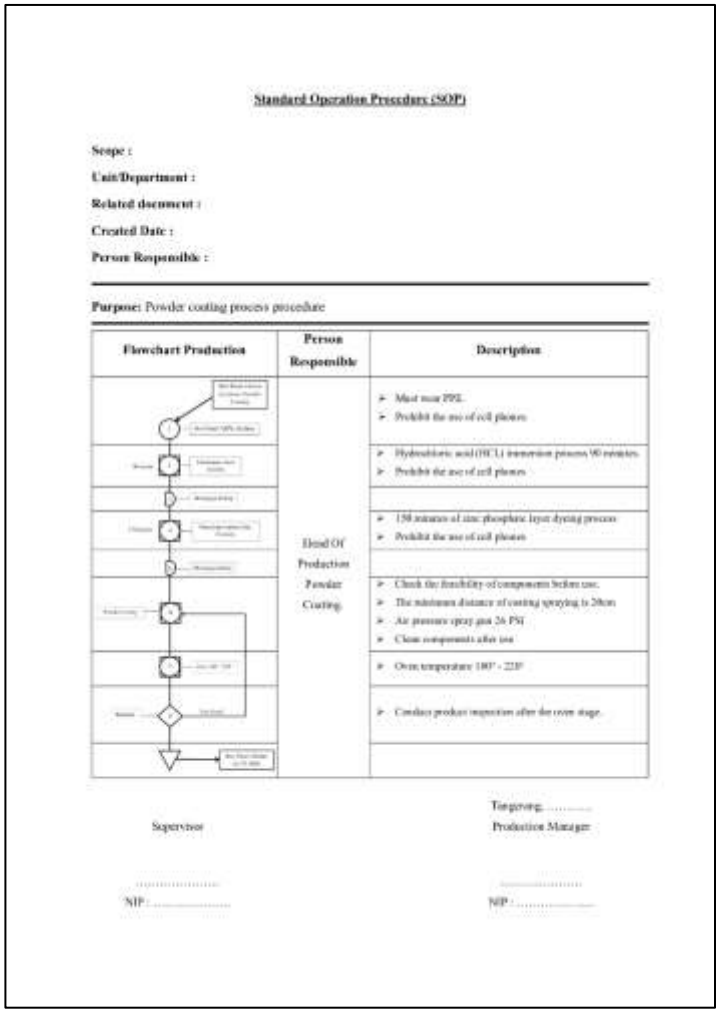
Next, provide recommendations for improvement by making a Design Of Experiment (DOE) of the Powder Coating process flow obtained from the following observations.

Table 2. Critical To Quality

No	Before	After
1		

No	Before	After
	Explanation : The flowchart of the powder coating production process prior to repair shows that there was no inspection process which resulted in products that were supposed to be unfit to be carried over to PT DMI to continue the next process.	**Explanation :** The flowchart of the powder coating process after repair shows an inspection process after the product has passed the oven stage. Carrying out this inspection process is very useful in selecting products that are not suitable for being returned to the coating stage or repainting before shipping to PT DMI.
		
2	**Explanation :** The flowchart before the repair shows the time for the hydrochloric acid immersion process is 120 minutes and the time for the zinc phosphate coating process is 180 minutes.	**Explanation :** The flowchart after repair shows the time in the hydrochloric acid immersion process, which is 90 minutes and zinc phosphate coating, 150 minutes. This time is obtained through brainstorming with the company or head of production. This is very useful for reducing wasted time in the powder coating process.

The last recommendation given was to make a Standard Operation Procedure (SOP) to be placed on the walls of the production area as follows.



Standard Operation Procedure (SOP)

Scope :
Unit/Department :
Related document :
Created Date :
Person Responsible :

Purpose: Powder coating process procedure

Flowchart Production	Person Responsible	Description
	Head Of Production Powder Coating	➢ Must wear PPE. ➢ Prohibit the use of cell phones ➢ Hydrochloric acid (HCL) immersion process 90 minutes ➢ Prohibit the use of cell phones ➢ 150 minutes of zinc phosphate layer drying process ➢ Prohibit the use of cell phones ➢ Check the feasibility of components before use. ➢ The minimum distance of coating spraying is 20cm ➢ Air pressure spray gun 26 PSI ➢ Clean components after use ➢ Oven temperature 180° - 220° ➢ Conduct product inspection after the oven stage.

Supervisor

NIP : .....

Tangerang, ...
Production Manager

NIP : .....

Fig. 1. Standard Operation Procedure

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3.5 Control

The last stage of the DMAIC Cycle is Control, this is the last Six Sigma quality improvement operation. At this stage, the data that has been processed above is submitted to both companies and control will be carried out within the next 1 year period to find out the results of the improvements described above.

4. CONCLUSION

There are 3 types of defects from the powder coating results, namely Thin Paint, Clumping Paint and Uneven Paint and the results of the data analysis obtained an average DPMO of 4,107.496 and an average sigma level of 4.175 for powder coating results. In the analyze phase, there is one type of defect that is a priority, namely Thin Cat caused by humans, methods, machines and the environment. The proposed improvements are 5w+1h, Design Of Experiment (DOE) and Standard Operational Procedure (SOP).

The suggestions given are, firstly it is hoped that CV XYZ can apply the recommendations that have been recommended to minimize the results of defects in PT DMI electrical panel box products. Second, it is hoped that in future research it can examine the entire production process with cost analysis. Third, it is hoped that each company can increase cooperation from the results of the improvements that have been given.

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