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Quality Control Analysis of Metal Baseplate Finishing process using Statistical Process Control (SPC) and Failure Mode and Effect Analysis (FMEA): A Case Study of Indonesia Company

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ABSTRACT

Pt. Anugerah Putra Plating is one of the service companies engaged in the metal finishing industry or, more precisely Zinc Plating (zinc coating process that uses electricity) where the coating process is most widely used for small-sized goods with an extensive production scale and one of the products processed at PT. This Plating Son Award is a baseplate. Problems arising from defects are not up to the specified standards, triggering a decrease in product quality. The company produced baseplate from January 2020 to December 2020 of 53145 pcs, in that period, there were defects of 2980 pcs or 5.60%. The percentage exceeded the company's disability target of 3.50%. Based on direct observation of spaciousness and data processing using FMEA, it can be known that 4 types of defects are contained in baseplate products, namely White Rush, Oily, Black Spot and also Imperfect Coating. The most dominant defects are ranked 1 and 2, with the highest score is White Rush with a Risk Priority Number (RPN) score of 392. For this type of baseplate defect, the root of the problem is (1) Improper rounding distance, (2) unscheduled maintenance of the machine, (3) Improper chemical solution, and (4) a Dirty working environment. Proposed improvements based on the results of the analysis are as follows the types of defects White Rush: (1) Making hook hangers at a distance so that the hcl process is organized, (2) Made sterile storage space and also repair/inspection of routine machines, (3) Making the inspection sheet of chemical solution monitoring if this proposal can be carried out properly, the potential enough results that can be obtained is very - very more efficient and structured time, for the waste of costs can be emphasized to a minimum, as well as improve the quality of the product produced, so that it is expected that (estimate) the cumulative value of the company can increase by 1.8 from 5.6 - 3.8 (4)Apply pickets in the respective line - each after business hours.

Keywords: Baseplate, Quality, Defective, FMEA, SPC.

1. INTRODUCTION

The industry is a process in which all economic activities manage raw materials or utilize resources to create goods with higher added value and benefits. In meeting human needs, the role of industry is so significant and based on data from the ministry of industry, the industrial sector is the most critical contributor to the nation's economy with its contribution reaching more than 20% to enter the world's top ten in the manufacturing velue edit category in 2017. Therefore companies compete strictly to create products or services of the highest quality to meet the needs of society. Quality can interpret the level of good and bad products produced so that to maintain that quality, the company uses its way of controlling the quality of its production.

PT. Anugerah Putra Plating is one of the service companies engaged in the metal finishing industry or more precisely, namely Zinc Plating (a zinc plating process that uses electricity) where this coating process is most widely used for small-sized goods with an extensive production scale and one of the products that are processed at PT. This Putra Plating Award is a baseplate. It is a mounting plate for the PLN kwh meter component that functions as a place where the kwh meter component is assembled before being attached to a wall or pole, it is made of metal which is good for helping to conduct electricity for the kwh meter component. Zinc plating is a process carried out on the surface of metal products to increase corrosion resistance, improve heat resistance appearance, and other types of defects—the sales system used by PT. Anugerah Putra Plating is a Pre Order system. Therefore quality plays a very important role in the products we produce and must always be maintained by PT. Putra Plating Award to be able to maintain competitiveness and also maintain customer trust. However, significant numbers of defective products are often

found every month, as shown in table 1 data on the number of products and the number of defects for the January - December 2020 period:

Table 1 Baseplate Production January – December 2020

Month	Production Quantity (PCS)	Number of Defects (PCS)	Percentage
Jan-20	4258	264	6.21%
Feb-20	5206	173	3.32%
Mar-20	4109	205	4.98%
Apr-20	4772	239	5%
May-20	5459	525	9.61%
Jun-20	2848	168	5.89%
Jul-20	5241	267	5.09%
Aug-20	4289	198	4.61%
Sep-20	4813	256	5.31%
Oct-20	3970	261	6.57%
Nov-20	4170	197	4.72%
Dec-20	4010	227	0
Total	53145	2980	5.60%
Average	4428.75	248.3	6%

Based on the data in Table 1 above, the percentage of defects per item can be seen more clearly in the graph in Figure 1 below this :

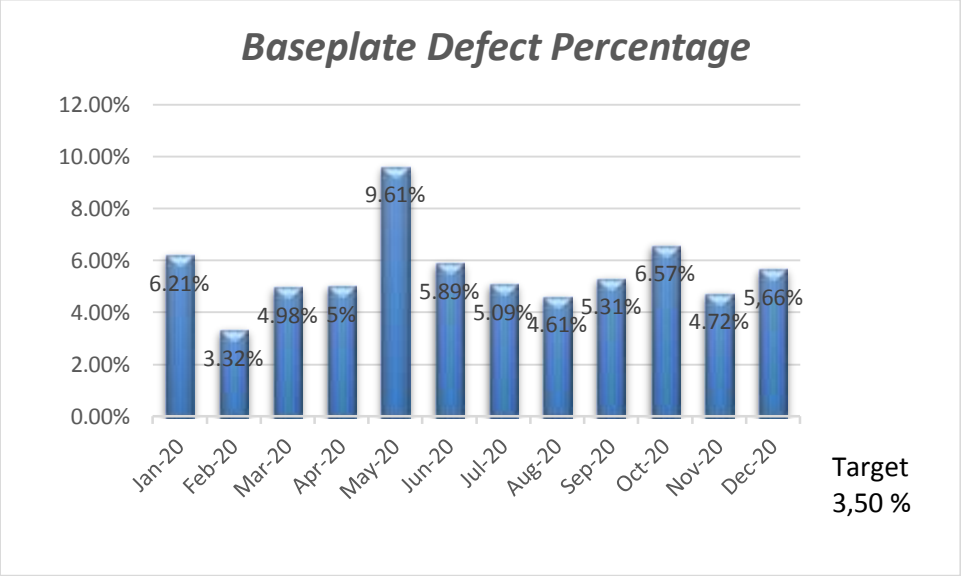

Figure 1 Baseplate Defect Percentage Graph for January – August 2020

From Table in January – December 2020 the Plating Process produced 53145 pcs. In that period, from 53145 pcs in a year produced, there were defects with the number of defects reaching 2980 pcs, which resulted in a longer repair time. So it can be seen that there are still defects that occur during the plating process. To maintain quality stability and minimize errors, strict quality control and supervision are necessary because high quality will make consumers satisfied and encourage the company's progress.

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According to Mursyidi (2008), a damaged product is a tennis failure product, or economically it cannot be repaired into a product that complies with the established quality standards; in contrast to the rest of the material, damaged products have consumed all elements of production costs (materials, labor, and costs). Factory overhead). Product defects that occur can be normal or abnormal. In planning the quality control of the quality of a product, several ways or methods can be done by applying these methods to ensure the quality of the goods produced. The quality control method used must be by what the problem is or with the method at least finding the factors causing the issue at hand and being able to solve the problem. The methods of quality control used in this research are Statistical Process Control (SPC) and Failure Mode and Effect Analysis (FMEA).

Failure Mode and Effects Analysis (FMEA) is the stage of identifying the severity of product defects (severity), the incidence of product defects (occurrence), and the level of detection of product defects (detection), then calculating the value of the Risk Priority Number (RPN), namely by multiplying the severity value, the occurrence value, and the detection value. After calculating the value of the risk priority number (RPN), the RPN value will be obtained from the results of multiplying the severity, occurrence, and detection values of each failure mode obtained and then sorting the RPN values from the largest to the smallest to take corrective steps according to the value. The largest RPN (Ardiansyah & Wahyuni, 2018). After analyzing the RPN value, then doing SPC to explore improvements. Statistical Process Control (SPC) is used to monitor standards, make measurements and take corrective actions while a product or service is being produced. One of the methods used for quality improvement and control is SPC. This method is an accurate method which can minimize and eliminate defects (zero defects) in products and maintain and maximize the success of a company (Kartika, 2013).

2. RESEARCH METHOD

The method used to support this research is using FMEA analysis and also the SPC method, following the stages of data processing and analysis in this study:

1. Failure Modes and Effects Analysis (FMEA) method

Initial data processing using the Failure Modes and Effects Analysis (FMEA) method, this time it aims to determine the highest defect in the production process of Baseplate products at PT Anugerah Putra Plating. By finding the highest RPN (Risk Priority Number), the RPN value itself is obtained by multiplying the results of the FMEA Table scoring results for baseplate products such as Severity (Severity), Occurrence (Frequency), and Detection (Detection Level) to get the RPN ranking.

2. Create a Control Map

To analyze the results of the data that has been collected, a control chart is used as a tool for statistical process control. If the data obtained data that is outside the control limits that have been set, this means that the data taken is not uniform. It states that the quality control carried out in the plating process still needs to be improved. This can be seen on the p-chart if points fluctuate irregularly, which indicates that the production process is still experiencing deviations. The control chart can also show the types of damage and products produced.

3. Cause and Effect Diagram

Used to identify various potential causes of an effect or problem and analyze the situation through brainstorming sessions. Problems will be broken down into several related categories, including people, materials, machines, procedures, policies, etc. Each category has reasons that need to be explained through a brainstorming session.

4. Approach 5W + 1H

Next, a corrective action plan is carried out to overcome the most dominant defects in the plating process using the help of the 5W + 1H approach by identifying each cause of the existing failure factors by clarifying the stage of improvement that will be taken, why it needs to be repaired, and where the repair must be repaired, who what to fix and how to fix it.

3. RESULT

FMEA (Failure Mode And Effect Analysis) results

The initial stage is an analysis using FMEA to identify problems in the baseplate product production process by finding the highest RPN (Risk Priority Number) value. The following are the results of the FMEA scoring to determine the problems that occur in the baseplate production process and also determine the highest defect from the existing issues as follows:

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Table 2 Rank of Dominant Disability

Failure Mode	Failure Mode	*RPN*	*RANK*
Production Baseplate	White Rush	392	1
	Greasy	180	2
	Imperfect Coating	150	3
	Black Spot	150	4

Based on table 2, the rank of dominant defects above can be seen with the most significant percentage in the production of baseplate products is the type of White Rush defect with the scoring carried out. The highest Rank of RPN value is obtained with a rank of 1 which is 392 with the location of the problem that is often obtained in the chromating process. The rank of 2 is 180 with the type of oily defect, and the location of the process where this type of defect occurs is in the HCL liquid immersion process. The 3rd rank is 150 which is the type of imperfect coating defect with the location where the process occurs in the chromating process. In the 4th rank with a value of 150 which is the type of black spot with the occurring location, is the plating process. So based on the Rank of RPN, 4 types of defects occur in the baseplate production process where the chromating process has a dominant occurrence in the occurrence of the defect, therefore to overcome the number of defects in the production of this baseplate product, it must be repaired on an ongoing basis.

3.1 P Control Map Calculation Results

After we know the dominant defect, which is the main focus, then the calculation of the UCL, CL, and LCL values on the Baseplate product defects and to find out whether the baseplate product is still within the control limits or not, the results of the calculation of the control chart p can be known that the value of Control Limit (CL) of 0.05607, then the Upper Control Limit (UCL) value of 0.06697, then the Lower Control Limit value of 0.04517. From the 12 months, 2 months came out within the control limits, namely in the 2nd month period and also the 5th month, therefore to improve the quality of a proportion of defects in a product, of course, a proposal that can develop and carry out continuous improvement so that it can achieve the company's goals, namely to produce a superior product and have high quality.

3.2 Fishbone Diagram Results

When viewed from the analysis of both data collection and the results from the FMEA table, it can be seen that the type of defect that most often occurs and dominates in Baseplate products during the January - December 2020 period is the White Rush defect type with an RPN value of 392. To find out and analyze further Again, the causes of the White Rush defect, a fishbone diagram is needed. Based on the fishbone diagram, to find out the grounds for the White Rush defect on the Baseplate product, it can be caused by several factors, including human factors, machines, materials, methods, and the environment. So that further analysis using 5 why logic is as follows:

Table 3 Five Why

	Why 1	**Why 2**	**Why 3**	**Why 4**	**Why 5**
Man	Operators work not according to SOP	Excessive individual targets	Less attention to the final result	Not keeping the work environment clean	Forcing the process in a rudimentary machine condition
Machine	Dirty machine	Draying machine is not optimal	The electric current in the plating process is weak	The machine has problems or is damaged	Machine overload

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Material	Oily base plate	Dirty base plate	Inappropriate chemical solution composition	Baseplate quality below standard	Dirty chemical solution
Method	Lack of knowledge regarding replacement of spare parts	Mixing composition Incorrect chemical solution	Incorrect machine settings	The lack of periodic machine checks	Work system
Environment	Dirty Production Site	High room temperature	Lack of self-awareness of workers about workplace comfort	Lack of worker discipline	Lack of concentration

After being analysed using the 5 Why logic regarding the dominant defect problem, namely white rush, the next thing to do is propose improvements using the 5W + 1H approach to hopefully reduce the number of defects in the production process of Baseplate products at PT. Plating Son Award.

4. RESULTS OF PROPOSED IMPROVEMENTS USING THE 5W + 1H APPROACH

Next, action is needed to determine the proposed plans to be taken to overcome the problem of the dominant defect, White Rush, by using 5W + 1H (What, Why, Where, When, Who, How) tools. The following proposed improvements are expected to minimize defects in the baseplate product, as follows:

4.1. Man Factor

In this factor, the dominant factor occurs from the negligence of the baseplate product production operator in the discipline in applying good work operational standards, such as inappropriate plating distances, failure in mixing chemical liquids, and undisciplined timing when plating. Here's how to solve it:

Figure 2 HCL acid treatment dyeing process

It can be seen in Figure 3 that the immersion in the HCL solution or degreasing process is not placed according to the procedure where the product is not spaced during the dyeing process, which can result in a chemical reaction to clean or neutralize the effect unevenly. Therefore it is necessary to seal every 5-10 times. Cm in the container for the process, the insulation can use a hanging hook or insulating clip. It can be seen in Figure 4 that the author recommends using a hanger hook to facilitate the dependent process and also so that it does not stick together again during the dyeing process so that production operators can minimize errors when working.

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Figure 3 Proposed improvement of HCL dyeing

2. Factor Machines

In this factor, the drying machine is often constrained, such as the engine suddenly turning off during the chromating drying process, caused by machine maintenance that is not carried out regularly. The proposed improvement is to make a routine machine maintenance schedule at least once a week. All those who work at PT Anugerah Putra Plating are expected to comply with the rules, routinely maintain cleanliness, and maintain machines in the production area. Regular machine repairs to prevent things that trigger defects.

Figure 4 Draying Machine Trouble

3. Material Factor

In the material factor that affects the potential for defects to occur, the baseplate material, which is still oily, occurs in the initial process of immersing the HCL, which is not good, as shown in Figure 3, therefore back to the initial process where the HCL dyeing process must take the right time and also maintain a distance. when the process occurs using a hanging hook, as suggested in figure 4

Figure 5 Oily Baseplate

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4. FACTOR METHOD

The method factor here is when mixing chemical solutions that are not right, the proposed improvement is to carry out routine checks every day (morning) before starting or carrying out plating activities using a monitoring sheet, which previously was only done when the results of the product had decreased which according to the author was inefficient. . By taking a sample of the chemical solution and then checking it using an electrolyte test diagnostic tool.

Figure 6 Chemical Solution Diagnostic Tool

5. ENVIRONMENTAL FACTOR

Dirty environment, where a dirty environment can damage the quality of chemical solutions so that they can interfere with chemical reactions to baseplate products. The suggested improvement is to clean and always put back the tools used after finishing work, right when you get home from work. At the baseplate plant, it is expected to create a special storage room for storing raw materials, sterile and proper place must be provided for storing raw materials so that the quality of the material is maintained.

Figure 7 Work Environment

As a follow-up, if the proposed improvement is implemented, it can reduce the number of defects that dominate the baseplate product, such as the white rush with its respective problems, so it is hoped that the proposed (estimated) form of chemical solution monitoring is expected to minimize the types of defects that dominate the baseplate product. The. Based on estimated production data for four months, starting in January - April 2021.

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Table 4 Comparison of data before and (estimated) after repair

Object of research	Before (Average January 2020 – December 2020	After (Average January 2021 – April 2021)
Total number of defects	2980	483
Average defect %	5.6 %	3,8 %

The following is a comparison table before making a proposed improvement and an estimate after the proposed improvement is implemented, which can increase by 1.8 from 5.6 - 3.8, which is a good capital for the future so that the proposal can be implemented by the company as soon as possible in stages. and sustainable.

6. CONCLUSION

6.1 Conclusion

Based on the processing and analysis of data on Baseplate products at PT Anugerah Putra Plating that has been carried out in this study, the following conclusions are obtained:

1. Based on direct field observations and data processing using FMEA, it can be seen that the most dominant defects are ranked 1 and 2, with the highest score being White Rush with a Risk Priority Number (RPN) value of 392, followed by oily defects with rank 3 having a score of 180, and rank 4, namely imperfect coating with a score of 150.

2. Based on the results of the analysis, it can be seen that for the type of defect that dominates, namely the Baseplate product, there are 4 types of root problems that are main and interrelated, so it is quite urgent to make improvements to each of these root problems. For this type of Baseplate defect, the root of the problem is (1) Improper plating distance, (2) unscheduled machine maintenance, (3) Inappropriate chemical solution, and (4) a Dirty work environment.

3. Proposed improvements based on the results of the analysis are as follows, namely the types of White Rush defects: (1) Making a hanging hook at a distance so that the HCL process is organized, (2) A sterile storage room is made and also routine machine repairs/inspections, (3) Making chemical solution monitoring inspection sheet if this proposal can be implemented well, possible results can be obtained, namely time is very – very more efficient and structured, for cost wastage can be minimized as much as possible, and improve the quality of the product produced, so it is expected (estimated) the cumulative value of the company can increase by 1.8 from 5.6 – 3.8 (4) Implement picket in each line after working hours are over.

6.2 Suggestion

The suggestions that can be given after making observations in the form of proposed improvements as consideration for improvements at PT Anugerah Putra Plating to reduce the level of defects that occur in Baseplate products are as follows:

1. For the defects contained in the Baseplate product to decrease, it is recommended to carry out routine supervision of production activities, then gradual and continuous improvement of the types of defects from the highest to the lowest both in terms of humans, machines, material selection, and even creating an environment as comfortable as possible, or you can also find a method that fixes the production process so that the company's goals are achieved, namely saving production costs and maximizing time as much as possible.

2. Always hold meetings every day for at least 10-15 minutes so that they consistently report each operator's progress and obstacles, so for corrective action by always warning or attention on each line so that output is not only pursued but all aspects are considered, so that the operator must comply with every step of the operational standard.

3. The company provides ongoing training and even counselling to internal operators with an expert head operator or invites other people from outside who are very knowledgeable in overcoming the occurrence of rejects or even other non-technical matters.

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4. Carry out regular machine maintenance and be diligent in cleaning the operator's work environment, then apply the rules of discipline and responsibility for the operator's work.

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