



ANALYSIS OF "HARD CHROME" PERFORMANCE IMPROVEMENT IN MAINTENANCE ENGINE SERVICES INDUSTRY

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Abstract - In this study, the company under study is an Industrial Maintenance and Repair Engine with Hard Chrome as the main service. In its activities, the problem is the increase in customer complaints regarding the results of repair work and the results of the process, so that the spare parts that have been repaired must return to the workshop for rework. In the step of making improvements, the DMAIC approach is carried out and evaluates it by calculating the Overall Equipment Effectiveness (OEE) and comparing it with OEE before improving. and then the analysis discusses the factors that affect the effectiveness of the Hard Chrome machine, which are found in the six major losses and other problems where the fishbone diagram analysis method is used. Based on the results of calculations using the analysis of six big losses, two dominant factors were found, namely defect losses and reduced speed losses, where the cumulative percentage value of defect losses was 70.14% and reduced speed losses was 27.91%. After that, a discussion was carried out using 5W1H as Improve with the results of the average OEE value for Hard Chrome machines for the period March to June 2020 of 70.26%, where the average value of Availability = 89.65%, Performance = 82, 02% and Quality = 98.38%.

Keyword: OEE, DMAIC, Hard Chrome, 5W1H

Introduction

The maintenance system is a very important aspect in the company and also the operation of a system because the goal is to restore the condition of the vehicle performance along with the time the condition of the vehicle has decreased its performance capability, extends the service life of the tool or machine, reaches maintenance cost levels effectively and efficiently and ensures the safety of people using tools or machines (Wastana, Fahtoni, and Minarsih 2016). For most organizations, it is now imperative that they take advantage of a maintenance management program to optimize their productivity, while maximizing Overall Equipment Effectiveness (OEE). Based on the Japan Institute of Plant Maintenance (JIPM), the ideal conditions for OEE are Availability > 90%, Performance Efficiency > 95%, and Rate of Product Quality > 99%. By multiplying Availability, Performance Efficiency, and Rate of Product Quality the result is OEE. So that the ideal OEE value is $0.90 \times 0.95 \times 0.99 = 85\%$

In order to increase the productivity of machines / equipment, Total Productive Maintenance is implemented (Manik 2018). Another important goal of TPM is to fight for OEE. To



achieve this, TPM works to eliminate "Six Big Losses" which are six losses that must be avoided by any company that can reduce the effectiveness of a machine, namely Down time: equipment failure; and setup and adjustment; Speed losses: idling and minor stoppages; and reduced speed; Defect: process defects; and reduced yield (Andersson and Bellgran 2015)

In repairing industrial parts and components at the Industrial Maintenance and Repair Engine, one of them is carrying out a metal rebuilt process to restore the original dimensions or adjust to the needs. Rebuilt is done by plating metal through a process of electroplating (Hard Chrome). Hardchrome is a metal surface coating commonly used for industry with the aim of increasing lifetime, for example, pistons, cylinder liners, pump shafts, hydraulic cylinders, oil and gas supporting equipment components, automotive components, components for dampers in aircraft wheel construction, components from mold and dies. In the case of applying hardchrome to a device, quality is required when operating the tool. Because in this case the quality of the hardchrome can have an impact on the performance of the machine when it operates.

In the industry studied, there are obstacles, namely the increase in customer complaints regarding the results of working on Repair Hard chrome and the results of the process. So that spare parts that have been repaired must return to the workshop and rework must be done in order to maintain customer trust. Analysis of improvements in terms of Hard Chrome quality, namely so that surface defects can be prevented. To overcome these problems the quality of the Hardchrome workmanship uses the DMAIC methodology. The DMAIC framework, namely Define, Measure, Analyze, Improve, and Control will be used to solve problems in this research which are often used as a principle of continuous improvement.

Material and Methode

Process		Material	Method
Pre-Inspection		-	Check Dimension & Surface Condition
↓			
Striping		Costic Soda	Alternating Current Variant
↓			
Pre-Grinding		-	Grinding Machine
↓			
Prepare			
a. Surface Prepare			
Vapor Blasting	Material Cast Iron	Alumunium Oksid 80 - 100	Alternating Current Variant
Sulpuric	Material Stainless/ spray colmomoy	H2SO4 Sulfuric Acid	Alternating Current Variant
Chrome Etching	Material Carbon Steel/ Stack of Chrome	Chrome Etch	Alternating Current Variant (for attracts Old Chrome)

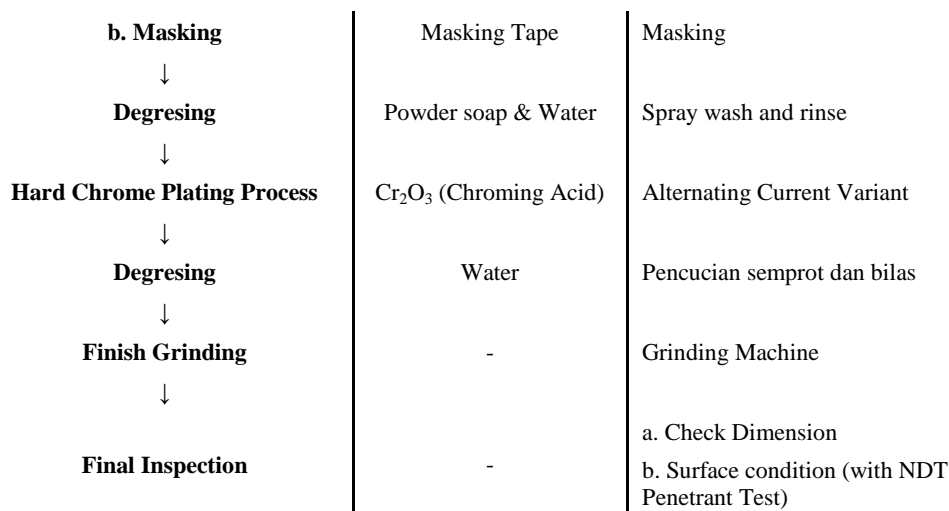


Fig 1. Flow process Hard Chrome

The equipment that is the object of research is the Hard Chrome machine which is the main machine in the Hard Chrome coating process, where the effectiveness of the machine has never been measured. To get the optimal value of the effectiveness of the Hard Chrome engine, it is necessary to measure the effectiveness of the machine using the Overall Equipment Effectiveness (OEE) method. Table 1. and Table 2 is a summary of repair data using the 2019 Hard Chrome engine.

Table 1. *Loading Time, Downtime, Cycle Time Operating Time, Output, dan reject Hard Chrome process in 2019*

month	Loading Time	Downtime	Cycle Time	Operating Time	Output	Reject
January	4200,00	480,00	3720,00	4680,00	15,00	0
February	11550,00	1320,00	10230,00	12870,00	42,00	0
March	4410,00	360,00	4050,00	4770,00	11,00	0
April	4200,00	480,00	3720,00	4680,00	14,00	4
May	2100,00	240,00	1860,00	2340,00	5,00	2
June	7350,00	600,00	6750,00	7950,00	17,00	4
July	5250,00	600,00	4650,00	5850,00	17,00	6
August	2100,00	120,00	1980,00	2220,00	3,00	0
September	3780,00	360,00	3420,00	4140,00	10,00	0
October	5880,00	480,00	5400,00	6360,00	15,00	1
November	3150,00	360,00	2790,00	3510,00	9,00	2
December	2100,00	240,00	1860,00	2340,00	6,00	0
Total	56070,00	5640,00	50430,00	61710,00	164,00	19,00
Averages	4672,50	470,00	4202,50	5142,50	13,67	1,58



Tabel 2. data of *setup, breakdown, Idling and Minor Stoppage dan Cycle Time per Operation*
Hard Chrome machine in 2019

Bulan	Setup time	Breakdown	Idling and Minor Stoppage	Cycle Time per Operation
Januari	20,00	20,00	42,00	1170
Februari	55,00	55,00	70,00	1170
Maret	6,00	9,00	20,00	1590
April	8,00	8,00	60,00	1170
Mei	4,00	8,00	20,00	1170
Juni	10,00	30,00	20,00	1590
Juli	15,00	35,00	56,00	1170
Agustus	3,00	8,00	0,00	2220
September	9,00	9,00	38,00	1380
Oktober	20,00	20,00	42,00	1590
November	6,00	27,00	12,00	1170
Desember	4,00	8,00	16,00	1170
Total	160,00	237,00	396,00	
Averages	13,33	19,75	33,00	

Results and Discussion

Define

At this stage, the results of the recapitulation of the cumulative percentage of product defect data from 2014 - 2019 are found with a Pareto diagram so that it is clear that the order of the 3 types of processes that produce many defects and the biggest is the Hard Chrome Process.

Measure

At this stage, calculate the Overall Equipment Effectiveness (OEE) value prior to seeing the effectiveness of using the Hard Chrome machine during the 2019 period.

- a. During the period of 2019, the OEE value of Hard Chrome machines before Improve ranged from 50.29% - 84.09%, Availability Rate 88.57% - 94.29%, Performance Rates ranged from 79.49% - 84.91 %, and Quality rate ranges from 60.00% - 100%
- b. The highest OEE value in the 2019 period was due to this because of the Availability Rate 94.29%, Performance Rate 84.91% and Quality Ratio 100%
- c. The lowest OEE value in the 2019 period was due to this because the value of Availability Rate is 88.57%, Performance Rate is 79.49% and Quality Ratio is 60.00%
- d. The average OEE value is 64.13% with an average Availability Rate of 90.02%, an average Performance Rate of 81.91% and an average Quality Ratio of 86.98% so it can be said that the measurement of the OEE value Hardchrome machines have not met the Standard Word Calss Manufacturing standard can be seen in Table 3.



Table 3. Percentage of Availability value, Performance Efficiency, Rate Of Quality, Standard Word Calss Manufacturing (SWCM)

Factor	Percent	SWCM
Availability	90,02%	90%
Performance Efficiency	81,91%	87%
Rate Of Quality	86,98%	99%
OEE	64,13%	85%

Analyze

At this stage using the six big losses analysis and after going through the cumulative percentage, two dominant factors are found, namely defect losses and Reduce Speed losses, where the cumulative percentage values for defect losses and Reduce Speed losses are 64.59% and 29.07%.

Two dominant factors, namely defect losses and Reduce Speed losses, were analyzed using the Fishbone Diagram and the 4M1E approach. After analyzing the factors causing the defective product, namely the defect losses: Machines, Methods, Materials, and Humans / Operators. Then on Reduce losses: Machine, Method, Environment, and Humans / Operators.

Improve

After doing the Analyze stage above, at the Improve stage this will help to improve and improve the quality of Hard Chrome. Improvements were made using the 5W1H analysis method, which was made based on discussions with resource persons and the 4M1E approach, namely Workshop Operators and Managers, following table 4 and table 5.

Table 4. 5W1H analysis of defect losses

Problem	What	Why	Where	When	Who	How
Machine	water replacement	no one is monitoring HardChrome water quality	Workshop	Last 4 years	Operator	Check With Chemical Lab Services
	No machine maintenance checksheet	there is no preventive maintenance	Workshop	has never been	Maintenance Division	Procurement of machine maintenance checksheets and Preventive Maintenance.
Method	water heating temperature setting	because the boiler panel display is damaged	Workshop	Last 1 year	Maintenance Division	Repair and calibrate boiler panels
	less clean when prepare	soap used liquid soap	Workshop	Last 1 year	Operator	Replace with soap powder



Material	Change the Chrome Acid / Material brand	The old brand is not in production	Warehouse	Last 2 year	Purchasing	ask to check the quality of other brand materials with lab services
	Defect (crack & Porosity)	Follow the old procedure	Workshop	Last 2 year	Workshop Department	Follow the brand new MSDS procedures
Man	Careless	No quality awareness training	Workshop	have never conducted quality training	Operator	The company provides Quality training
	Lack of Motivation	Missed the award	Workshop	Last 4 years	Operator	The company holds an award from employee appraisal

Table 4. 5W1H analysis of Reduce losses

<i>Problem</i>	<i>What</i>	<i>Why</i>	<i>Where</i>	<i>When</i>	<i>Who</i>	<i>How</i>
Machine	Reactifier's amperage is not optimal	Machine is old	Workshop	During the process	Maintenance Division	New Reactifier procurement.
Method	Have never done TPM	is not yet a priority	Workshop	has never been	Maintenance Division	The company held a TPM
Environment	Tools not cleaned and dirty work area	less of instructions	Workshop	The last 2 years	Operator	Provide hygiene procedures
Man	Lack of training on other supporting tools	From the previous senior	Workshop	change of position in the last 7 years	Operator	Provide internal training on support tools

Control

in the implementation of improvements made to research in this industry are as follows

1. Create Preventive Maintenance Schedule
2. Replacing the old reactifier
3. Repair the Tanky Hard Chrome temperature gauge
4. Follow current brand MSDS procedures
5. Keeping the Hard Chrome Plating process area clean

The results of the calculation after improving the OEE of Hard Chrome machines for the period March to June 2020 can be seen that the average OEE value for the Hard Chrome machines for the period March to June 2020 is 70.26%, where the average value of Availability = 89 , 65%, Performance = 82.02% and Quality = 98.38% The comparison between before and after can be seen in the following graph:

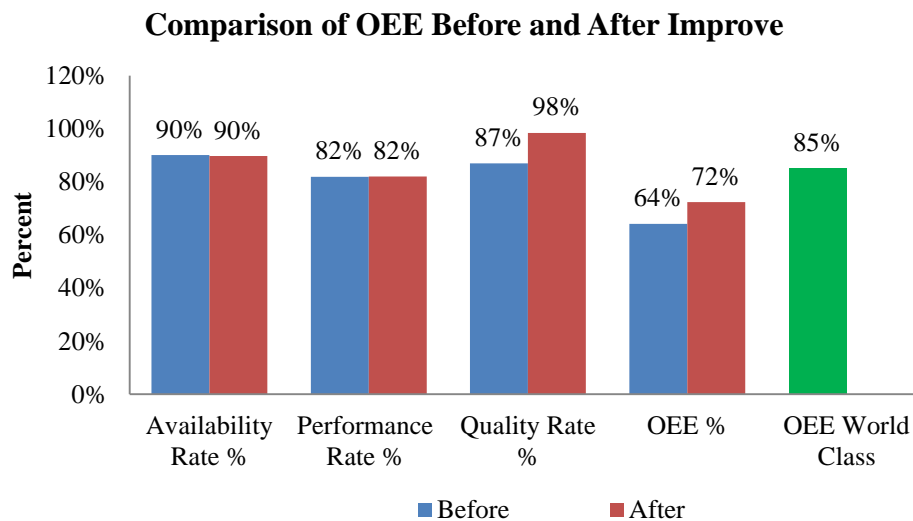


Fig 2. Comparison of OEE Before and After Improve

Conclusion

Based on the results of the calculation of Overall Equipment Effectiveness (OEE) on Hard Chrome during the 2019 period, the average Overall Equipment Effectiveness (OEE) value was 64.13%. This effectiveness value is classified as low because the standard value of the good world class OEE standard is ideally 85%.

Based on the results of calculations using the six big losses analysis and after going through the cumulative percentage, two dominant factors were found, namely defect losses and reduced speed losses, where the cumulative percentage values for defect losses and reduced speed losses were 70.14% and 27.91%. By using the Fishbone Diagram and with the 4M1E approach. After analyzing the factors causing the defective product, namely the defect losses: Machines, Methods, Materials, and Humans / Operators. Then reduce Speed: Machines, Methods, Environment, and People / Operators.

After improving the results of OEE calculations in improving the quality of Hard Chrome for the period March to June 2020, it can be seen that the average OEE value for Hard Chrome machines for the period March to June 2020 is 70.26%, where the average value of Availability = 89.65%, Performance = 82.02% and Quality = 98.38%

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