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INCREASING OEE THROUGH SIX BIG LOSSES ANALYSIS IN THE MACHINING PROCESS OF AUTOMOTIVE COMPANY

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ABSTRACT

This research was conducted at PT. Delta Bekasi. This study aims to improve Overall Equipment Effectiveness (OEE) in machining process in an automotive company by conducting Six Big Losses analysis. The method used is a case study with a qualitative and quantitative approach. Data was collected through direct observation, interviews and documentation. Data analysis carried out using the Overall Equipment Effectiveness (OEE) and Six Big Losses methods. The results of the study show that the OEE in the machining process at the automotive company is still low. After analyzing the Six Big Losses, factors causing production failures were found, such as downtime due to machine maintenance, long preparation times , and product defects. Based on the results of the analysis, several improvement steps are proposed, including: the use of preventive maintenance on machines, increasing the skills of machine operators, and improving the production process. By making improvements to the factors causing production failures, the OEE in the machining process at the automotive company increased from 82.24% to 85.39%. This shows that Six Big Losses analysis can help increase production efficiency and reduce downtime in automotive companies.

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INTRODUCTION

The recent rapid industrial development requires companies to be able to increase productivity so as to produce maximum output. Productivity shows the results of measuring performance by paying attention to the resources used (Revila, 2014 in the journal Alfiani

Afifi et al 2015: 133). In this case especially on the productivity of the company's production system. One of the things that can support increased productivity is the readiness of production machines to carry out their duties. This makes the company must be able to maintain the reliability of production machines in order to achieve production targets.

PT. Delta Part is a company that already has a maintenance plan for every machine, starting from machining machines to assembling machines, which are structured and there are plans according to the machine operating manual, but in reality, there is still a lot of lost time caused by machine breakdowns such as inserts. chipped/broken, the automatic door jammed due to stuck scraps left over from the bury lathe in the machining machine and some damage caused by lack of machine maintenance. A company is said to be good if the company's machine gets maximum benefits in implementing and increasing resources, each company has its own way but has the same goal, namely creating maximum productivity.

Increasing Overall Equipment Effectiveness (OEE) in the machining process is very important for automotive companies. OEE is a measure of machine performance that combines machine effectiveness, production time efficiency, and product quality. Low OEE can result in decreased production efficiency and financial loss for the company. Therefore, this study aims to increase OEE in the machining process in an automotive company through the analysis of Six Big Losses.

The background of this research is the low OEE in the machining process in automotive companies which results in production failures and financial losses. Inefficient machines and production times that are not optimal can cause quite a long downtime. Long downtime can slow down the production process, reduce production output, and increase production costs. Therefore, research is needed to increase production efficiency in the machining process in automotive companies.

The following is a pareto diagram of lathe machine downtime from January to December of the previous year.

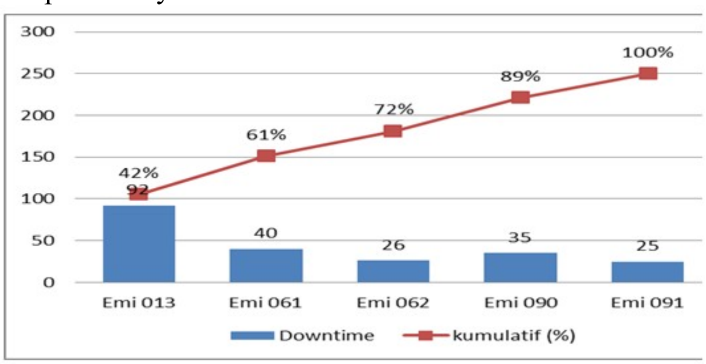

Figure 1. *Pareto chart Machine Downtime*

Based on the data in Figure 1.1, it can be concluded that the EMI 013 lathe is the machine that has the greatest downtime compared to other lathes, which affects the low productivity of the cubiage machining line. Referring to the data described above, the object to be examined in this study is the EM 013 machine which is in the cubiage machining line which has the greatest downtime value. The first stage in an effort to increase production efficiency and effectiveness at this company is to measure the effectiveness of the EM 013 machine by analyzing the application of TPM (Total Productive Maintenance) which is then followed by measuring OEE (Overall Equipment Effectiveness) to find the biggest cause that results in low machine productivity values.

There are several previous studies that are relevant to this research topic.’’Some of the studies that will be discussed include: "Overall Equipment Effectiveness (OEE) improvement in manufacturing systems using a systematic approach" by Tahir et al. (2018). This study discusses the improvement of OEE in manufacturing systems using a systematic approach. This research shows that OEE can be improved through three main factors, namely availability, performance, and quality. The results of this study can be the basis for this research in increasing OEE in machining processes in automotive companies.

"Analysis of Six Big Losses for improving OEE in a manufacturing industry: a case study" by Jadhav et al. (2018). This study discusses the analysis of Six Big Losses to increase OEE in the manufacturing industry. The results of this study indicate that Six Big Losses can be used to identify causes of low OEE and take appropriate remedial action. This study can be a reference for this research in using Six Big Losses analysis to increase OEE in machining processes in automotive companies.

"A study on Overall Equipment Effectiveness (OEE) measurement in a manufacturing company" by Sudhakar et al. (2015). This study discusses the measurement of OEE in a manufacturing company. The results of this study indicate that OEE can be measured accurately by measuring availability, performance, and quality. This study can be the basis for this research in measuring OEE in machining processes in automotive companies.

From the literature review above, it can be concluded that OEE can be improved through three main factors, namely availability, performance, and quality. Six Big Losses analysis can also be used to identify causes of low OEE and take appropriate corrective action. OEE measurement can also be carried out accurately by measuring availability, performance and quality. These things can be the basis for this research in increasing OEE in machining processes in automotive companies through the analysis of Six Big Losses.

Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a comprehensive measure that identifies the level of machine/equipment productivity and its theoretical performance.
This measurement is very important to determine which areas need to be increased in productivity or efficiency of production machines/equipment. (Nakajima, 1988 in Oktaria, 2016). The mathematical formula of OEE (Overall Equipment Effectiveness) is formulated as follows:

$$OEE = Availability \times Performance\ efficiency \times Rate\ of\ quality\ product \times 100\ \%$$

Availabilty is the ratio of the operation time to the loading time, so that to calculate machine availability, a value of:

1. operation time
2. Loading time
3. Downtime

availability value is calculated by the following formula:

$$AVAILABILITY = \frac{(Loading\ time - Down\ time) \times 100\%}{Loading\ time}$$

Performance Efficiency is the result of multiplying the operations rate and the net operation rate, or the ratio of the product quantity produced times the ideal cycle time to the time available to carry out the production process (operation time). Operation speed rate is a calculation between the ideal speed engine based on the actual engine capacity (theoretical/ideal cycle time) with the actual engine speed (actual cycle time). The net operation rate is the ratio between the number of products processed (process amount) multiplied by the actual cycle time with operation time. Net operation time is useful for calculating losses caused by minor stoppages and reduced production speed (reduced speed). Three important factors are needed to calculate performance efficiency :

1. Ideal cycle (ideal cycle time/standard time)
2. Processed amount (amount of products processed)
3. Operation time (engine operating time). (Nakajima, 1988 in Hamid, 2018: 53) Performance efficiency can be calculated as follows:

$$Performance\ efficiency = \frac{Processed\ amount \times actual\ cycle\ time}{Operating\ time}$$

Rate of Quality Product is the ratio of the number of products that are better to the total number of products that are processed. (Nakajima, 1988 in Triana 2019:215) So the Rate of Quality Product is the result of calculations using the following two factors:

a. Process amount (amount of product in process)
b. Defect amount (amount of product that disabled)

$$Quality\ Ratio = \frac{Output - Reduced\ Yield - Reject}{Output}$$

Six Big Losses

Losses that must be eliminated during the production process to implement TPM are often known as Six Big Losses. In theory (Nakajima, 1988) in the Wakhit journal (2018; 182) the low performance of machines and equipment is caused by 6 factors including:

1. Equipment Failure is a loss caused by the machine itself. Can in the form of a broken chisel, the automatic does not work, the cooling water runs out and the like.
2. Setup and Adjustment is a loss that is obtained due to improper installation, adjustment and adjustment. Can be in the form of tool settings not parallel to the axis of the flashlight, loose gear installation, etc.
3. Reduced Speed is the loss generated due to low operating speed, including the low rotation of the machine spindle rotation, feeding speed slow eating caused by lack of engine maintenance which causes one of the parts to wear out.
4. Idle and minor stoppage are losses due to machine stoppages, or idle machines which are included in this series, including tool changes , the location of the equipment warehouse is far away so you have to walk to pick it up.
5. Defects in Processes are losses generated during the production process. For example, the resulting surface processing results are not smooth, the size does not match the base of the object (tiknes).
6. Reduced Yield is a loss due to the low yield of the machine process.

Cause and Effect Diagram

Ishikawa (1943) in Oktaria (2016) Cause and Effect Diagram describes lines and symbols that show the relationship between effects and causes of a problem. The diagram is indeed used to determine the consequences of a problem for further corrective action to be taken. From these results, several possible causes were sought. The causes of this problem come from various sources, for example, work methods, materials, measurements, employees, environment, and so on. From the sources above, the causes can be derived into several smaller and more detailed sources, for example, from work methods, it can be reduced to training, knowledge, abilities, physical characteristics, and so on. To look for these various causes, all personnel involved in the process being analyzed can be used. To find the factors that cause deviations in the quality of work results, there are five significant main causal factors that need attention, namely:

a. Human
b. Work method
c. Machines
d. material

RESEARCH METHODS

The research methodology that can be used for the title "Improvement of OEE through Six Big Loss analysis in Process Machining of Automotive Companies" is as follows:

The first step is to conduct a literature study related to OEE (Overall Equipment Effectiveness), Six Big Loss, and Process Machining in automotive companies. This literature study aims to understand the basic concepts related to the research topic and to identify gaps in research that has been done before.

This research was conducted at PT. Delta from June 2021 to March 2022. Data collection was carried out by observing the production process at the automotive company, conducting interviews with the workforce and company management and measuring OEE and Six Big Loss in Process Machining. After the data has been collected, data analysis is carried out to identify the factors causing the Six Big Loss and evaluate OEE performance in Process Machining. Data analysis methods that can be used are Pareto Analysis, Fishbone Analysis.

Next step after identifying the factors that cause Six Big Loss and evaluating OEE performance in Process Machining, the next step is to choose the most appropriate solution to increase OEE in Process Machining. Solutions can be in the form of technology improvements, process improvements, employee training, or the use of production aids. After the solution has been selected, the next step is to implement the solution in the production process at an automotive company. In this stage, it is necessary to monitor and re-measure OEE and Six Big Loss to evaluate the effectiveness of the solutions that have been implemented.

Evaluation is done by comparing the performance of OEE before and after the solution is implemented. Evaluation results can be used to make recommendations and provide suggestions for further improvement. We hope the research methodology can help to identify the factors that cause Six Big Loss and improve OEE performance in Process Machining in automotive companies.

RESEARCH RESULT

Data analysis

According to Nakajima (1988) in Oktaria, and Susanti (2011), the ideal value of OEE i

OEE dan Fungsi-fungsinya	Nilai
Availability	> 90 %
Performance Rate	> 95 %
Quality Rate	> 99,9 %
OEE	> 85 %

Table 1. *OEE Ideal values*

Availability Ratio Analysis

Following are the results of data processing on the Avaibility Ratio Value on the EM 013 machine from June - May:

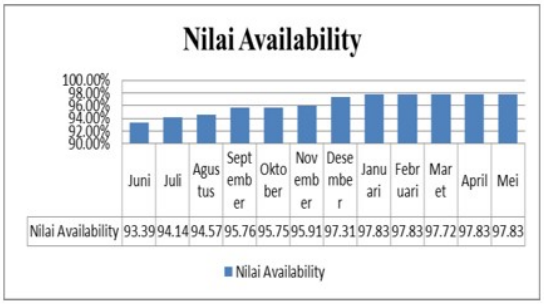

Figure 2. *Availability Ratio Value*

Base on the picture it can be seen that the availability ratio value on the emi 013 machine reaches 93.39%-97.83%, for the lowest availability value is in June, which is 93.39%, and the highest availability value is in January, February, April and May, namely 97.83%. The overall Availability value is 95.02%.

Judging from the standard availability value for analysis in this study, which is 90%, it can be concluded that the EM 013 engine being analyzed is still above the standard value for measuring Overall Equipment Effectiveness (OEE).

Performance Ratio Analysis

Following are the results of data processing on the Performance Ratio Value on the EM 013 machine from June – May

Figure 3. *Performance Ratio Value*

And from the picture it can be seen that the Performance ratio value on the emi 013 engine reaches 65.28% - 87.78%, for the lowest performance value is in May 65.28%, and the highest performance value is in December which is 87.78% . The overall Performance Ratio value is 85.37%.

Judging from the standard Performance value for analysis in this study, which is 95%, it can be concluded that the machine being analyzed is still below the standard value for measuring Overall Equipment Effectiveness (OEE). The difference between these values is 9.63% which is very much different.

Quality Ratio Analysis

The following are the results of data processing on the Quality Ratio Value on the EM 013 machine from June to May

Figure 4. *Value of Quality Ratio*

And from the picture it can be seen that the Quality Ratio value on the EM 013 machine reaches 99.26% - 99.97%, for the lowest quality value is in June, which is 99.26%, and the highest quality value is in January and February, namely 99. 97%. The Quality Ratio value of the whole is 99.61%. Judging from the standard Quality value for analysis in this study, namely 99.90%, it can be concluded that the machine being analyzed is still below the standard for measuring Overall Equipment Effectiveness Value

OEE Value Measurement Analysis

Based on the data processing that was carried out in the previous chapter, the OEE values obtained are as follows:

Month	Availibility Ratio (%)	Performance Ratio (%)	Quality Ratio (%)	OEE (%)
Juny	93,39	85,88	99,26	79,61
July	94,14	86,47	99,51	81,00
Agust	94,57	85,46	99,45	80,38
Sept	95,76	85,37	99,64	81,46
Oct	95,75	85,33	99,79	81,53
Nop	95,91	85,84	99,89	82,24

Table 2. *Analysis of OEE Value Measurement before analysis*

OEE achievement on the EM 013 engine in the period June - November 2021 was below standard, namely 79.61% - 82.24%, or an average value of 81.04%. The value for the OEE standard is 84%. And the value that really influences OEE is the performance value , namely 85.33% - 85.88% And mark the Still Far under standard mark OEE For performance that is >95%.

Analysis of Six Big Losses

The average loss for the machine can be seen in the following table below:

Month	Equipment Failure (%)	Set Up & adjustment (%)	Reduced Speed (%)	Idle &minor stoppage (%)	Defect loses (%)	Reduced Yield (%)
Juny	4,26	2,34	2,01	11,29	0,48	0,13
July	3,12	1,98	2,46	10,35	0,34	0,07
Agust	3,46	1,98	1,53	12,25	0,39	0,07
Sept	3,00	1,24	1,35	12,68	0,26	0,04
Oct	3,21	1,04	1,85	12,24	0,14	0,03
Nop	2,95	1,14	1,77	11,85	0,07	0,03
IMPROVEMENT						
Dec	2,43	0,26	1,10	10,81	0,03	0,01
Jan	2,17	0,00	1,54	11,46	0,02	0,01
Feb	2,17	0,00	1,30	11,36	0,02	0,01
March	2,17	0,10	1,26	11,70	0,03	0,01

Table 3. *Table of Average Value of Losses*

Can be seen that in the period June – November, the average loss for the largest companies is idle and minor stoppage losses, which are 11.80 %, then equipment failure losses are 3.33%, setup & adjustment losses are 1, 62%, defect loss of 0.27%, and the last is a speed reduction of 1.83%. Loss idle and minor stoppages and reduced speed are components of speed loss, so the total speed loss is 10.35% - 12.68 % which is the time available for the production process (Loading Time) which turns out to be wasted. And also, a loss that affects the low value of the Performance Ratio each the month.

And then in December – May the loss value decreases due to the company has made several improvements to increase the effectiveness of the machine. Improvement is done by analyzing the root causes in this case using 4M analysis.

Root Cause Analysis

The causal diagram above identifies causes based on 4 categories, namely humans, machines, materials and methods:

1. Man
   Every work in requires supervision, to see how much the work ability of employees and compliance with employee regulations, so that the work carried out can be well coordinated. From the results of observations, it has not been seen strict supervision from the company so that employees or for example machine operators who should be there to see or coordinate machines during the process, are not in place.
2. Machine
   Setting (installation) of the machine should be done effectively and efficiently, but because of the difficulty of setting (setting) of the machine it takes a long time and even the settings are done incorrectly, so requires resetting. From the results of observations, the wrong settings are often done.
3. Material
   The stability of the quality of raw materials should have standards before processing so that the results obtained have the same quality.
4. Method
   Standard time in doing something is needed to achieve work optimal. With a standard time, we can achieve the desired target in accordance with a predetermined time, and from the results of observations that have been made that there is no standard time for cleaning or setting up the machine, so the resulting time for cleaning or setting up is too long. In addition, in the handover between shifts when changing shifts is considered less than optimal because most do not do it in front of the production machine and the machine stops, sometimes it is done at the changing place which causes the delivery of information about production is not clear and can cause miscommunication.

The results of the improvements that have been made, resulted in a decrease in Losses included in the Six Big Loses, which can eventually increase OEE as follows:

Month	Availibility Ratio (%)	Performance Ratio (%)	Quality Ratio (%)	OEE (%)
Juny	93,39	85,88	99,26	79,61
July	94,14	86,47	99,51	81,00
Agust	94,57	85,46	99,45	80,38
Sept	95,76	85,37	99,64	81,46
Oct	95,75	85,33	99,79	81,53
Nop	95,91	85,84	99,89	82,24
IMPROVEMENT				
Dec	97,31	87,78	99,96	85,38
Jan	97,83	86,75	99,97	84,84
Feb	97,83	87,09	99,97	85,17
March	97,72	86,76	99,96	84,75

Table 4. *OEE*

After the improvement, starting in December, the Availability and Performance Ratio experienced a significant increase, this also increased the OEE value from the original Average OEE = 81.04% from June to November to = 85.04% from December to March. Or up by 4%.

CONCLUSION

Based on the data processing and analysis that has been described, several conclusions can be drawn as follows:

1. The factor that greatly influences the low OEE score is the low Performance Score, which is 85.37%. The average losses in the largest companies are Idle and minor stoppage losses which are 11.80%, then Equipment failure losses which are 3.27%, Reduced speed losses are 1.83%, Setup & adjustment losses are 1.62% , Defect loss of 0.27%, Reeduced Yield of 0.06%.
2. Application Six big loss analysis program on line machining at PT Delta Part, supported with several improvements, the OEE value can increase from an average of 81.04% to 85.04%, or an increase of 4%.

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