Total Productive Maintenance (TPM) Analysis on Lathe Machines using the Overall Equipment Effectiveness Method and Six Big Losses

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Abstract. C.V. Oni Jaya is a company engaged in manufacturing by producing / modifying motorcycle parts. This company is inseparable from problems related to the effectiveness of equipment or machinery. One of the causes of the disruption of the production process is the lack of maintenance management on the machine. Measurement of the level of effectiveness of the machine by using the Overall Equipment Effectiveness (OEE) method, the OEE calculation starts from January 2017 until December 2017. In the data processing, it can be seen that the setup and adjustment factors, Reduced Speed Loss and Breakdown Loss have the largest percentage of the six factors causing losses that affect the effectiveness of the machine. Analysis is done by looking at the cumulative percentage of six big losses factors against the total time loss caused by each factor of the six big losses.

Keywords: Overall Equipment Effectiveness (OEE), Maintenance (Maintenance), Six Big Losses, Total Productive Maintenance (TPM).

1. Introduction

C.V. Oni Jaya is a company engaged in manufacturing by producing or modifying motorcycle parts. This company is inseparable from problems related to the effectiveness of equipment or machinery. One of the causes of the disruption of the production process is the lack of maintenance management on the machine.

According to [1], maintenance activities are focused on the research of facilities and equipment that can support the smooth production process, especially by pressing or reducing congestion to be as small as possible or not at all. Maintenance is a maintenance activity for production facilities, so that it can provide several important benefits [2].

Total Productive Maintenance (TPM) is a program concept about maintenance that involves all workers through small group activities [3]. According to [4] identified overall equipment effectiveness (OEE) has important parameter for success in implementing TPM within firm. The study evaluates areas like reduction of manufacturing cycle time, customer complaints, handling autonomous groups on their skills and confidence levels and derived recommendations and conclusions to improves equipment efficiency and effectiveness. Identified correlations between various attributes of TPM to improve manufacturing efficiency by applying overall equipment effectiveness (OEE) in boiler plant in Ethiopia. Major success factors of TPM identified in this study to improve performance enhancements [5].
Research on the use of the OEE method in TPM has been used to determine the OEE value [6] - [10], determine the analysis of the six big losses against the effect of production [11]. This study adopts the Total Productive Maintenance (TPM) study with the aim of knowing the OEE value and determining the analysis of the six big losses against the influence of the production process.

The definition of ideal OEE values according to [3] is preferable as follows:

| Description | Value |
|-------------|-------|
| Availability| 90%   |
| Performance | 95%   |
| Quality     | 99%   |
| OEE         | 85%   |

Six Big Losses are six losses that should be avoided by any company that can reduce the effectiveness of a machine. Six Big Losses consists of [3] Breakdown Los, Setup and adjustment stoppage, Idling and minor stoppages, Reduced speed, Process defect, Reduced yield losses.

2. Methods
The steps taken to achieve the research objectives are as follows:
A. Analyze the general condition of the company and maintenance system
B. Data Collection. Based on interviews and observations according to the general conditions of the company and the maintenance system in the company, then the data collected for TPM implementation:
   - Production Capacity
   - Available Working Hours
   - Causes of Delay (Machine Wash, Planned downtime, Machine break, Schedule shutdown)
   - Good product
   - Defective Products
C. Data Processing:
   - Determination of Availability Ratio, Performance Efficiency Calculation, Calculation of Rate of Quality Product
   - Calculation of Overall Equipment Effectiveness
   - Calculation of Six Big Losses
D. Analysis
Tools used for data analysis and interpretation
   - Histogram
   - Pareto chart
   - Cause and Effect Diagram

3. Results and Discussion
3.1. Calculation of Overall Equipment Effectiveness (OEE)
Data needed in measuring effectiveness with the overall method equipment effectiveness (OEE) is taken from reports on maintenance and production activities on the lathe. This lathe is the object of research because of the high level of damage to the machine. The data used is January - December 2017. After all the necessary information is collected through the company's historical data, brainstorming, and interviews, data processing is carried out. For the first stage the three ratio measurement is Availability, Performance efficiency and Rate of quality product on lathe is done by processing data using the help of Excel 2007 software while the results of availability calculation, Performance efficiency and Rate of quality product on the lathe can be seen in Table 2.

Overall Equipment Effectiveness (OEE) =
Availability x Performance Efficiency x Rate of Quality Products.

**Table 2.** Calculation of Overall Equipment Effectiveness on lathe machines from January to December 2017.

| Month     | Availability (%) | Performance Efficiency (%) | Rate Of Quality (%) | OEE (%) |
|-----------|------------------|----------------------------|---------------------|---------|
| January   | 84.6             | 93.6                       | 99.0                | 78.4    |
| February  | 85.2             | 95.2                       | 99.3                | 80.6    |
| March     | 85.2             | 93.5                       | 99.3                | 79.0    |
| April     | 83.6             | 92.8                       | 99.0                | 76.8    |
| May       | 82.8             | 93.5                       | 99.1                | 76.7    |
| June      | 83.3             | 94.5                       | 98.6                | 77.6    |
| July      | 83.8             | 94.4                       | 99.4                | 78.6    |
| August    | 84.6             | 94.0                       | 99.2                | 78.9    |
| September | 84.3             | 94.2                       | 98.7                | 78.4    |
| October   | 84.2             | 92.0                       | 97.9                | 75.9    |
| November  | 83.4             | 93.7                       | 99.3                | 77.6    |
| December  | 84.2             | 93.6                       | 98.7                | 77.8    |

From table 2 it can be seen that the OEE of the machine is below the standard OEE value (85%). The lathe availability value is between 82.8% - 85.2%, this value is below the ideal availability value of 90%. This shows that the level of readiness of the lathe to be used at any time is below 90%. In addition to the availability level, a machine like this means there is no balance between operating time and load time, where operating time is affected by machine downtime. Performance efficiency or performance of the lathe is below the standard performance value of 95%. This shows that the use of the machine is not efficient because it does not match the capacity of the machine that should be. The rate of quality product is also below the standard value (99%), meaning that the production runs not according to the optimal point (relatively low) with regard to the operating time available, this indicates that the product produced by the machine is not good. The effectiveness of lathe 75.9% - 80.6% which is still below the ideal effectiveness of 85%. meaning that the lathe has not been effective. In addition, the factors causing the low OEE value in January - December 2017 are the magnitude of Equipment failure, loss of set up and adjustment losses and Reduced speed losses caused by the length of the machine breakdown time so that the engine work is not optimal.

For this reason, it is necessary to analyze the effect of the six big losses that affect OEE.

### Table 3. Calculation of Time and Percentage of Six big losses on lathe machines.

| No | Six Big Losses            | Total Time Loss (hour) | Percentage (%) |
|----|---------------------------|------------------------|----------------|
| 1  | Breakdown Loss            | 93.0                   | 18.5           |
| 2  | Set up and Adjustment Loss| 202.5                  | 40.3           |
| 3  | Reduced Speed Loss        | 99.7                   | 19.9           |
| 4  | Idling Minor Stoppage     | 88.2                   | 17.6           |
| 5  | Rework Loss               | 19.0                   | 3.8            |
| 6  | Scrap or Yield Loss       | 0.0                    | 0.0            |
|    | Total                     | 502.4                  | 100            |
Analysis of the six big losses calculation is done so that the company knows the size contributions from each factor in the six big losses that affect the level of effectiveness of the use of machines in the production process in the lathe. The time loss percentage on the lathe of the six factors will also be clearer as shown histogram shown in Figure 1.

![Figure 1. Graph of Percentage Histogram Effect of Six big losses on the effectiveness of the lathe](image1)

| No. | Six Big Losses                | Total Time Loss (hour) | Percentage (%) | Cumulative Percentage |
|-----|-------------------------------|------------------------|----------------|-----------------------|
| 1   | Set up and Adjustment Loss    | 202.5                  | 40.3           | 40.3                  |
| 2   | Reduced Speed Loss            | 99.7                   | 19.9           | 60.2                  |
| 3   | Breakdown Loss                | 93.0                   | 18.5           | 78.7                  |
| 4   | Idling Minor Stoppage         | 88.2                   | 17.6           | 96.2                  |
| 5   | Rework Loss                   | 19.0                   | 3.8            | 100                   |
| 6   | Scrap or Yield Loss           | 0.0                    | 0.0            | 100                   |
|     | Total                         | 502.4                  | 100            |                       |

From the results of the sequencing of the six big losses factor percentage, a pareton diagram will be drawn so that it is clear that the order of the six factors influencing the effectiveness of the lathe machine.

![Figure 2. Pareto Diagram Cumulative Percentage Effect of Six Big Losses on a Lathe Machine](image2)
From the analysis carried out, it will be obtained the factors that are the main priority for improvement in improving effectiveness. By making a pareto diagram, the percentage of each factor is big losses against the total time loss caused by the six factors. Pareto diagrams for the influence of the six big losses on the lathe can be seen in Figure 2. From the figure 2. Histogram and pareto diagram on the lathe process can be seen that the factor that gives the biggest presentation of the low effectiveness of the lathe of the six factors is Speed Reduce 40.3% with a total time loss 202.5. To see the percentage sequence of the six factors, the biggest one can be seen in table 4.

3.3. Fishbone Diagram

Through the Pareto diagram it can be seen that the factor that gives the biggest contribution to the lathe from the six big losses factor is the set up and adjustment of 40.3% followed by Reduced speed losses by 19.9% and Breakdown loss by 18.5%. According to the pareto rule (80% rule) the cumulative percentage value close to or equal to 80% becomes the priority of the problem which will be discussed next. Therefore, from these factors that will be analyzed using cause and effect diagrams.

In the causal diagram in Figure 3 the following will be known to cause the high set up and adjustment factor, reduce speed loss, and breakdown loss for the lathe.

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**Figure 3. Lathe Machine Fishbone Diagram**

### 4. Conclusion

Based on the results of the analysis and description of the OEE measurement results in the lathe machines, some conclusions can be drawn, namely:

1. Measurement of the level of effectiveness of the machine by using the Overall Equipment Effectiveness (OEE) method in C.V. OJM (Oni Jaya Motor) whose OEE calculation starts from January to December 2017 with the highest percentage of Lathe machine in February 2017 it was 80.6% and the lowest in October 2017 was 75.9%.

2. Factors that have the largest percentage of the factor of Six Big Losses on the lathe machine are Set Up And Adjustment by 40.3%, Reduced Speed Losses by 19.9%, Breakdown Loss by 18.5%, Idling Minor Stoppage by 17.6%, Rework Loss by 3.8%, and Scrap or Yield Loss of 0%.

3. A good way to reduce or eliminate the six big losses that are most influential in the production process is by making a machine maintenance plan using a predictive maintenance approach, providing training about the maintenance of production machine equipment and setting-up of production...
machine equipment, effective for employees, as well as implementing improvements to machine tooling equipment.

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