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Analysis of the Application of Total Productive Maintenance as a Support for Productivity by Measuring the Overall Equipment Effectiveness at PT Sumalindo Lestari Jaya Global TBK

Doddy Adhimursandi; Rio Haribowo; Ririn Novianti

Faculty of Economic & Business, Mulawarman University, Indonesia

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Abstract

This study aims to measure the value of equipment effectiveness, find the root cause of the problem and provide proposed improvements. The research was conducted on a Rotary Lathe machine that has a fairly high level of breakdown. This study began by measuring the achievement of the overall equipment effectiveness (OEE) value, then identified the six big losses that occurred. The results showed that the average OEE value on the machine Rotary Lathe was 80.17%; this effectiveness value was classified as not reaching ideal conditions for a world-class company, ideally 85%. The biggest factor influencing the OEE value is the percentage factor of six big losses on idling and minor stoppages of 53.44% and setup and adjustment by 41.75% of the all-time loss. The proposed remedial measures are to increase preventive maintenance activities on production machines, determine setup standards on machines, hold periodic worker and operator training programs, clean machines and work areas before and after the operation process and provide repair tools as needed.

Keywords: *Total Productive Maintenance; Overall Equipment Effectiveness; Six Big Losses; Fishbone Diagram*

Introduction

One of the supporting factors for success in a manufacturing industry is determined by the smoothness of the production process; so, what if the production process is smooth, the use of effective production machines and equipment will produce quality products with the right manufacturing completion time and low production costs. The process depends on the condition of the resources owned, such as humans, machines, and other supporting facilities; in this case, the conditions in question are the conditions used to carry out the production process, both accuracy, ability, and capacity. The cessation of a process in production is often caused by problems in production equipment; for example, if the machine stops suddenly, the speed of the production machine will cause losses to the company because, in addition to being able to reduce the level of efficiency and effectiveness of the production machine, it is also resulting in disruption of the company's production process due to damage to the machine. Many factors can cause losses due to the low productivity of machines or equipment; one of the causes is the ineffective and efficient use of the machine or equipment when operating.

PT. Sumalindo Lestari Global Tbk is a company engaged in the manufacturing industry of Plywood manufacture. In the production process, PT Sumalindo Lestari Jaya Global Tbk has several production products according to their respective functions and uses so that they can produce Plywood of various sizes. The engine that suffers damage with the fastest average time of damage is the Rotary machine because this machine is used for 24 hours and stops while waiting for the knife. A rotary machine is a stripping machine whose function is to speed wooden logs into veneer sheets (wooden sheets). One of the machines that are inseparable from problems related to the productivity of machines or equipment. Therefore, it is necessary to treat measures to prevent and address such problems. Rotary machines that have a large enough downtime, if there is damage, will stop for repairs so that production cannot run smoothly. The above problems can impact disrupting the production process and result in the quality of the product, which of course, can harm the company.

Therefore, it takes measuring the productivity of the machine to calculate and increase the level of machine productivity. Measuring machine productivity can be done by involving all parties and also using the Total Productive Maintenance (TPM) approach, which is a method of maintaining machinery and equipment that has evolved from traditional maintenance systems, which still involves everyone taking responsibility for the maintenance of machinery or equipment. To prevent or overcome these problems within the company, it is also necessary to improve production efficiency, which is carried out by using OEE as a tool used to measure and find out the performance of machinery or production equipment and see which of the Six Big Losses dominantly affects the hours when the machine stops operating. The goal to be achieved in this study is to analyze the application of TPM in PT. Sumalindo Lestari Global Tbk knows the OEE value based on availability, performance rate, and quality rate factors. By knowing the factors that cause the decline in effectiveness through measuring six big losses and analyzing the factors that contribute the most using fishbone diagrams, recommendations can be given to overcome the main problems of the six big losses factors.

Literature Review

Maintenance Definition

According to Benjamin S Blanchard (1995), maintenance is an activity that is directed to ensure the smooth running of a production system so that the system can be expected to produce output that is in line with expectations. Dhilon (1997), maintenance is a very important action to produce a good product or obtain a satisfactory condition. This is because if we have a machine or equipment, we usually always try to keep using the machine or equipment so that production activities can run smoothly Assauri (2008). Machine maintenance is an activity to take care of the machine so that it does not experience problems and the machine can be used longer. Machine maintenance is carried out periodically depending on the type of machine or tool and the level of operational function Indrajit, Richardus Eko, and Permono (2005)

Definition Total Productive Maintenance (TPM)

Nakajima (1984) defines TPM as an innovative approach to maintenance by optimizing the effectiveness of equipment, reducing or eliminating sudden breakdowns, and performing autonomous maintenance. TPM is a maintenance activity that includes all elements of the company, which aims to create a critical atmosphere in the industrial environment in order to achieve zero breakdown, zero defects, and zero accidents. TPM is a productive maintenance team and involves every level and function in the organization, from top executives to production operators Willmott (1994). Nakajima (1988) TPM is a program for the fundamental development of the maintenance function in an organization that involves all human resources.

Overall Equipment Effectiveness (OEE)

OEE is a method of measuring operating performance that focuses on how effectively a production operation has been carried out by taking into account the availability, operating performance, and quality of output Haming (2014). OEE is a combination of operations maintenance, equipment management, and existing resources that reveals the best TPM global approach Manzini (2010)

Productivity Analysis (Six Big Losses)

According to Nakajima (1984), the six big losses are the six major losses that are part of the TPM's actions to eliminate the six losses. The six big losses were:

1. Downtime (Decreased Time)
    a. Equipment failure or breakdowns (losses due to equipment damage). Failure of the machine to carry out a process (equipment failure) or damage (breakdown) that is sudden and not expected is a clear cause of loss because the damage will result in the engine not producing output.
    b. Setup and adjustment (losses due to installation and adjustment). Damage to the engine and overall maintenance of the machine will cause the machine to be stopped first before the machine is re-functioned and adjustments are made to the function of the machine, which is called the engine setup and adjustment time.

2. Speed Losses
    a. Idling and minor stoppages (losses due to operating without load or a momentary stop). Idling and minor stoppages occur if the machine stops repeatedly or the machine operates without producing the product. If idling and minor stoppages occur frequently, then it can reduce the effectiveness of the machine.
    b. Reduced speed (losses due to a decrease in production speed). Reduced speed is the difference between the actual production speed time and the ideal machine production speed.

3. Defects
    a. Process defect losses (losses due to defective products or due to the work of the product in the reprocessing). The product that does not meet the predetermined quality specifications can still be repaired or reworked.
    b. Reduced yielded losses (loss at the beginning of production time until it reaches a stable production time). Yield loss is a loss that arises during the production process because it has not reached a stable production state at the time the production process is started, so the products produced at the beginning of the process until the stable process state is achieved do not meet the expected quality specifications.

Cause and Effect Diagram

A causal diagram is a diagram that shows the relationship between cause and effect; a causal diagram is used to show the factors causing the decline in productivity and the characteristics of productivity Gaspersz (2007).

1. Man: anyone involved with the process
2. Work method: how the process is carried out and the specific requirements for its conduct, such as policies, procedures, rules, regulations, and laws
3. Machine/equipment: equipment, computers, equipment, and others needed to complete the work
4. Raw Material: raw materials, spare parts, pens, paper, and others used to produce the final product.
5. Work Environment: conditions, such as location, time, temperature, and culture in which the process operates.

Research Methods

Data Type and Source

The data in this study are primary and secondary data types. Primary data sources were obtained directly during interviews, observations, documentation, and dissemination of questionnaires as research instruments to Rotary machine technicians and to the maintenance department, while secondary data sources in the form of information in the form of Plywood production reports during October 2020 to September 2021, Machine Readiness Data during October 2020 to September 2021 and machine Downtime Data obtained during the study.

Data Collection Techniques

The data collection technique used in this study is to conduct an interview process with rotary machine technicians and maintenance departments to obtain more detailed information for the data needed in this study, observe directly by observing the work process of Rotary machine maintenance, and document it to collect data and information related to the research as a complement to the data and information needed.

Analysis Tools

Data analysis is the process of finding and compiling data obtained by organizing data into categories, describing it into units, compiling it into patterns, choosing which ones are important and which ones will be studied, and making conclusions so that they are easily understood by yourself and others Sugiono (2012). In this study, the stages of data analysis carried out were the results of calculations of Availability, Performance Rate, Quality Product Rate, Overall Equipment Effectiveness (OEE), OEE Six Big Losses, and Causal Diagram Analysis.

Results of Research and Discussion

Availability Calculation

$$\text{Availability} = \frac{\text{Operation time}}{\text{Loading time}} \times 100\%$$

Loading time = total available time – planned down time
Downtime = breakdown + set up
Operation time = loading time – downtime

Table 1 Availability of Rotary Lathe Engines for the Period of October 2020 – September 2021

Month	Loading time (hours)	Total downtime (hours)	Operation time (hours)	Availability (%)
October	185	83,95	101,05	54,62
ovember	1381	37,99	1343,01	97,24
ecember	1361	47,3	1313,7	96,52
January	821	14,57	806,43	98,22
February	1276	81,25	1194,75	93,63
March	1294	81,25	1212,75	93,72
April	653	64,8	588,2	90,07
May	1396	26,46	1369,54	98,10
June	1399	20,79	1378,21	98,51
July	1204	4,9	1199,1	99,59
Agustus	0	0	0	0
September	1418	10,95	1407,05	99,22

Performance Efficiency

$$\text{Performance efficiency} = \frac{\text{processed amount x ideal cycle time}}{\text{Operation time}} \times 100\%$$

Table 2 Performance Efficiency rotary lathe engine period October 2020–September 2021

Month	Total product processed (Kg)	Ideal cycle time (Hour/Kg)	Operation time (Hour)	Performance efficiency (%)
October	11154	0,005	101,05	84,26
November	11941	0,005	1343,01	83,34
December	10986	0,005	1313,7	81,62
January	10027	0,005	806,43	83,82
February	9131	0,005	1194,75	81,65
March	9394	0,005	1212,75	83,86
April	8649	0,005	588,2	80,17
May	726	0,005	1369,54	78,45
June	5685	0,005	1378,21	80,73
July	1029	0,005	1199,1	84,42
August	0	0	0	0
September	5685	0,005	1407,05	83,78

Calculation of Rate of Quality Product

$$\text{Rate Of Quality Product} = \frac{\text{Processed Amount – Defect Amount}}{\text{Processed Amount}} \times 100\ \%$$

Table 3 Rate of Quality Product Rotary Lathe Machine Period October 2020 – September 2021

Month	**Total Products Processed (Kg)**	**Total Scrap (Kg)**	**Rate Of Quality Product (%)**
October	11154	573	94,86
November	11941	625	94,76
December	10986	787	92,83
January	10027	262	97,38
February	9131	523	94,27
March	9394	538	94,27
April	8649	306	96,46
May	726	145	80,02
June	5685	641	88,72
July	1029	243	76,38
August	0	0	0
September	5685	787	86,15

Calculation of Overall Equipment Effectiveness (OEE)

OEE (%) = Availability (%) x Performance Rate (%) x Quality Rate (%)

OEE = (Availability x Performance Rate x Quality Rate) x 100%

Table 4 OEE Rotary Lathe Machine Period October 2020 – September 2021

Month	**Availability (%)**	**Performance Efficiency (%)**	**Rate of Quality Product (%)**	**OEE (%)**
October	54,62	84,26	94,86	42,62
November	97,24	83,34	94,76	76,79
December	96,52	81,62	92,83	73,13
January	98,22	83,82	97,38	80,17
February	93,63	81,65	94,27	72,06
March	93,72	83,86	94,27	74,09
April	90,07	80,17	96,46	69,65
May	98,10	78,45	80,02	61,58
June	98,51	80,73	88,72	70,55
July	99,59	84,42	76,38	64,21
August	0	0	0	0
September	99,22	83,78	86,15	71,61

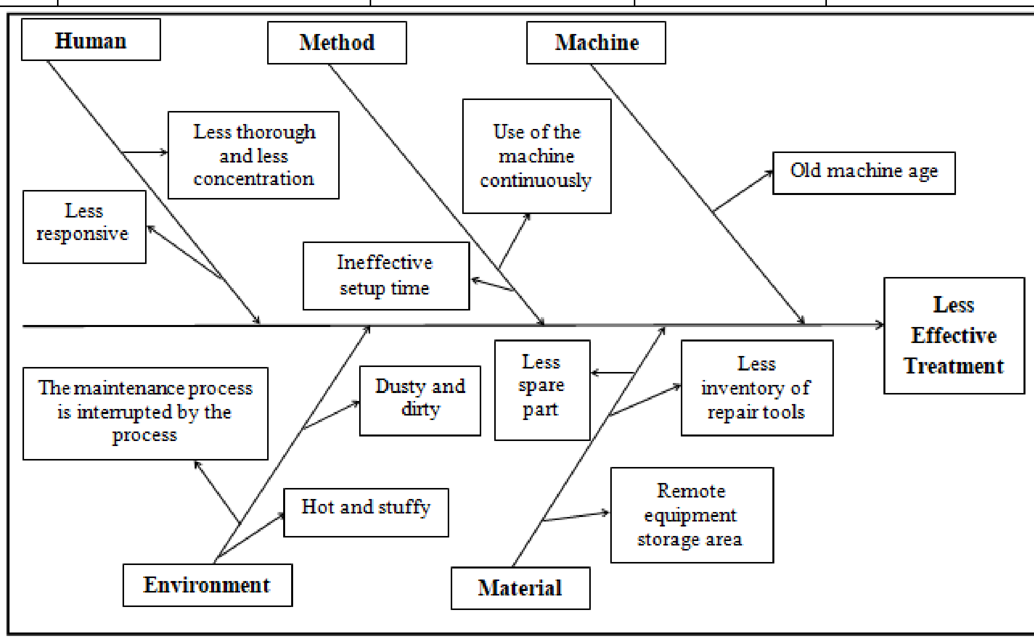
Analysis of OEE calculations was carried out to see the level of effectiveness of the use of Rotary Lathe machines during the period October 2020 to September 2021. This Measurement of OEE is a combination of factors of time, quality of machine operation, and engine production speed. During the period October 2020 to September 2021, the OEE value obtained by the Rotary Lathe machine was:

During the period October 2020 to September 2021, OEE value ranged from 42. 62% to 80.17%. The highest OEE value on the Rotary Lathe machine was only achieved in January at 80.17%, with an availability ratio of 98.22%, performance efficiency of 83.82%, and a rate of product quality of 97.38%.

OEE Six Big Losses Calculation Analysis

Table 5 Percentage of Factor Six Big Losses of Rotary Lathe Engines for the Period of October 2020 – September 2021

No	Six Big Losses	Total Time Losses (Hour)	Percentage (%)	Cumulative Percentage (%)
1	Idling/Minor Stoppages Losses	530,44	50,47	50,47
2	Breakdown Losses	77,19	7,34	57,81
3	Setup/Adjustment Losses	410,75	39,08	96,89
4	Yield/Scrap Loss Reduced	27,11	2,57	99,46
5	Reduced Speed Losses	5,264	0,50	99.96
6	Rework Loss	0,18	0,04	100
	Total	1.050,934	100	100



Causal Diagram Analysis

Conclusions and Suggestions

Conclusion

The implementation of Total Productive Maintenance uses the OEE method in an effort to increase production efficiency at PT. Sumalindo Lestari Jaya Global Tbk can be concluded, namely:

1. Equipment failure that occurred during the period October 2020 to September 2021 has caused the effectiveness of the use of Rotary machines to decrease, where the Percentage of breakdown loss that occurred in October 2020 of 10.16%
2. Setup and adjustment loss also affects the effectiveness of the use of machines or equipment during the period October 2020 to September 2021; the largest Percentage for setup and adjustment

occurred in October 2020, and the lowest occurred in June 2021 at 1.12%; this is because the machine stops every waiting for the knife which must be done once every 2 hours

3. The largest Percentage of engine effectiveness factors lost due to idling factors and minor stoppages was in January 2021 at 7.60%
4. As a result of the Reduced speed loss factor, the total time lost during the period October 2020 to September was the largest in October 2020 at 101.08%
5. The largest Percentage of Rework loss in October 2020 was 0.056%
6. The largest Percentage due to yield/scrap loss factors during the period October 2020– September 2021 was 1.54% which occurred in October 2020
7. The Percentage of each factor of six big losses that was dominant during the period October 2020 – September 2021 in Rotary machines was: Idling and minor stoppages of 53.44%; this value indicates that the machine often stops repeatedly – repeatedly experienced a time loss of 530.44 hours and followed by setup and adjustment of 41.75% this value indicates the high engine setup time and experienced a time loss of 410.44 hours
8. Based on the OEE calculation in rotary diving machines from October 2020 to September 2021, OEE value ranged from 42.62% to 80.17%. This condition shows that the ability of rotary machines to achieve targets and achieve the effectiveness of using machines has not reached ideal conditions (≥ 85%)
9. The resulting proposed improvements and analysis of the cause and effect diagram on the factors that are the top priority are:

   a. The factor of machinery or equipment: because the age of the machine has been long enough, the solution to the problem is to increase preventive maintenance activities on production machines so that the reliability of the machine becomes better and lasts a long time
   b. Method factors: Continuous use of the machine and ineffective setup time; the problem is that with planned maintenance activities need to be improved in order to keep up with the continuous production process and determine the standard setup time on the machine, including the adjustment time and also the time required
   c. Human or operator factor: Lack of thoroughness and concentration so that it is less responsive to solving the problem. Supervision of operators should be increased if necessary to impose stricter sanctions on workers. Organizing regular training programs for workers and operators
   d. Environmental factors: Dusty, dirty, hot, or poor air circulation. Process the solution to the problem is to clean the machine and work area before or after the operation, provide air conditioning such as a fan in the work area and create a maintenance schedule so as not to interfere during the process
   e. Material factors: Lack of repair equipment, inefficient equipment storage, and insufficient spare parts inventory. The solution to these problems is to provide equipment service that is in accordance with the needs so that the production process runs smoothly, move the equipment storage area so that it can be reached by workers, check the spare part inventory in the storage warehouse if it starts to decrease and notify the related parties to place an order again.

Suggestion

Some suggestions that are expected to provide input and be useful for the company based on the results of this study are:

1. Calculating OEE on each machine so that representative information is obtained for continuous maintenance and improvement in an effort to increase the effectiveness of machine use.
2. Conduct training for each operator and *maintenance* personnel in order to improve the operator's skills and expertise in overcoming problems that exist in machinery or equipment.
3. Increase awareness of all employees to play an active role in increasing company productivity and efficiency from the operator level to top management.

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