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Overall Equipment Effectiveness (OEE) Analysis to Minimize Six Big Losses in Continuous Blanking Machine

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A B S T R A C T

This paper describes the high downtime on continuous blanking machines. The result is that companies suffer losses in cost, human resources, and time. Therefore, companies need to implement Total Productive Maintenance (TPM). TPM aims to improve the overall efficiency and effectiveness of manufacturing companies. Then the TPM itself needs to be evaluated. One of the methods used is the Overall Equipment Effectiveness (OEE) as an indicator of the machine's effectiveness by calculating the six big losses to determine the factors that influence the six factors of the six big losses. Based on research that has been done, the machine availability ratio is 99%, performance efficiency is 84%, product rate of quality is 83%. While the value obtained on the OEE calculation is 71%, the value is below the world's ideal OEE standard value of > 85%. The highest loss values for six big losses are idle and minor stoppage losses with a percentage of 62.73%, setup and adjustment losses of 14.38%.

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1. INTRODUCTION

PT. AII is a company engaged in manufacturing components for the needs of electronic company spare parts. Products that are made are usually the parts related to Sound Dampers, Heat Dampers, Vibration Dampers, Electrical Insulation, Air Filters, Water, and Oil. Based on the results of interviews with PT. AII has been a problem in the production section, especially on the continuous blanking machine (Sakamoto Zoki PAL 500 Machine) because the performance of the continuous blanking machine is considered slow to produce high machine downtime. The result is that companies suffer losses in cost, human resources, and time.

One indicator to determine equipment reliability is to use Overall Equipment Effectiveness (OEE). OEE can describe the performance and work effectiveness of equipment (Wahid & Agung, 2016; Supriyadi, Ramayanti & Afriansyah, 2017). OEE can optimize equipment performance through a systematic approach to determine performance targets through a balanced increase in process availability, performance, and quality (Garza-

Reyes, 2015). and reveal hidden costs related to the efficiency of the equipment (Tsarouhas, 2019). The consistent implementation of OEE can increase the productivity and effectiveness of equipment (Tsarouhas, 2013).

This study aims to determine the value of Overall Equipment Effectiveness (OEE). This is because by implementing OEE, machine performance will be assessed based on availability, performance, and quality (Davis, 1995). Furthermore, determining the factors that cause a decrease in the effectiveness of equipment or plant as a whole can be seen from the six big losses to determine the six types of losses that can reduce the level of effectiveness of a machine that must be avoided by every company. Then, this study uses the fishbone diagram method to find out the causes that lead to the low productivity of the machine with a human perspective, machine, methods, raw materials, and the environment.

2. LITERATURE REVIEW

2.1 Overall Equipment Effectiveness

The performance of a machine can be calculated by calculating the Overall Equipment Effectiveness (OEE) value, which is a total measurement of performance related to the availability of the productivity and quality processes. OEE is a measuring tool to evaluate and improve the right way to ensure increased productivity in the use of machinery/equipment. OEE can be used in several types of levels in a corporate environment:

1. OEE can be used as a "benchmark" to measure a company's plans for performance.
2. OEE value, an estimate of production flow, can be used to compare the company's cross-line performance, so it will appear that the flow is not important.
3. Suppose the machining process is carried out individually. In that case, OEE can identify which machines have poor performance, and even indicate that the focus of TPM resources on raising the OEE value requires solid teamwork involving all lines (Stamatis, 2010).

2.1.1 Availability Ratio

The availability of machines/equipment is a comparison between the operating time (operation time) to the preparation time (loading time) of a machine/equipment. Then the availability ratio can be calculated as follows

$$\text{A} = \frac{(\text{Loading Time} - (\text{Failure and Repair} + \text{Setup and Adjustmentt}))}{\text{Loading Time}} \text{x}100\% \quad (1)$$

2.1.2 Performance Efficiency

Is a benchmark of the efficiency of the performance of a machine running the production process. Then the performance efficiency can be calculated as follows:

$$P = \frac{Total\ Production \times Ideal\ Cycle\ Time}{Operation\ Time} x100\% \quad (2)$$

2.1.3 Rate of Quality

Is a good ratio of the number of products to the number of products processed. Then the rate of quality can be calculated as follows:

$$Q = \frac{Total\ Production - Reject\ when\ Setup - Reject\ and\ Rework}{Total\ Production} \quad (3)$$

2.1.4 OEE

In OEE calculation, the relationship between the three elements of productivity, namely availability ratio, performance efficiency and rate of quality can be seen in the formula below:

$$OEE = A\ x\ P\ x\ Q \quad (4)$$

2.2 Six Big Losses

Total Productive Maintenance (TPM) is the principle of management to effectively increase the productivity and efficiency of products produced by the company. Incorrect handling and maintenance of the machine will result in losses, and these losses are called Six Big Losses. According to Nakajima (1998) of the six types of losses are grouped into three main losses, namely:

1. Downtime Losses
   Is wasted time, where the production process is not running which is usually caused by damage to the machine. Downtime losses consist of 2 types of losses, namely:
   (a). Equipment failure losses, this loss is caused by damage to an item that affects the production system.

   $$EFL = \frac{Failure\ and\ Repair}{Loading\ Time} \times 100\% \quad (5)$$

   (b). Set up and adjusment losses, these losses are caused by changes in the operating system.

$$SAL = \frac{Setup\ and\ Adjustment}{Loading\ Time} \times 100\% \quad (6)$$

2. Speed Losses
   Is a condition where the speed of the production process is disrupted, so that production does not reach the expected level. Speed losses consist of two types of losses, namely:
   (a). Idle and minor stoppages losses, these losses are caused by constraints on the machine.

$$\text{IMSL} = \frac{\text{(Production Targets} - \text{Total Production)} \times \text{Ideal Cycle Time}}{\text{Loading Time}} \times 100\% \quad (7)$$

   (b). Reduces speed losses, a reduction in production speed based on design speed.

$$RSL = \frac{\text{(Operation Time} - \text{(Ideal Cycle Time x Total Production))}}{\text{Loading Time}} \times 100\% \quad (8)$$

3. Quality Losses
   Is a situation where the product produced does not comply with specified specifications. Quality losses consist of 2 types, including:
   (a). Deffect Losses, losses caused due to disability during production.

$$DL = \frac{(Reject\ and\ Rework \times Ideal\ Cycle\ Time)}{Loading\ Time} \times 100\% \quad (9)$$

   (b). Yield losses, losses that occur due to wasted raw materials. Although in small amounts, resulting in the machine stops working to take care of raw material waste.

$$RY = \frac{(Ideal\ Cycle\ Time \times reject\ when\ setup)}{Loading\ Time} \times 100\% \quad (10)$$

2.3 Cause and Effect Diagram

Cause and effect diagram is a structured approach that allows more detailed analysis to find the causes of problems, discrepancies, and gaps that occur (Watson, 2004). This diagram can be used in situations where:

1. There is a focus of discussion by using brainstorming to identify why a problem occurs.
2. A more detailed analysis of the problem is needed.
3. There is difficulty in separating causes from effects.

3. RESEARCH METHOD

The stage of the research methodology starts by carrying out a preliminary study. At this stage, observations and field studies are carried out, and then the next step is to formulate a problem framework. In this study, the object of the problem is the effectiveness of using continuous blanking machines at PT. AII. Next, a literature study is conducted to review several scientific journals and review the bibliography to obtain a theoretical framework for carrying out data collection and processing. After doing a literature study, the next stage is data collection, namely the process of observation and primary data retrieval on the performance of continuous blanking machines at PT. AII.

After observing and collecting the required data, the data processing is carried out with the OEE method to show how well PT. AII used a continuous blanking machine during February 2019. After using the data processing using the OEE method, the next step is to calculate and analyze the losses of continuous blanking machine with six big losses method. The final step is to analyze the result of the root of the problem using cause and effect analysis.

4. RESULT AND DISCUSSION

4.1 Overall Equipment Effectiveness (OEE)

In this study, a calculation of the Sakamoto Zoki PAL-500 machine's effectiveness, a continuous blanking machine, is done. To do this calculation requires the components needed in the overall equipment effectiveness method. The components making up the value of machine effectiveness consist of availability ratio, performance efficiency, and rate of product quality. The data was obtained by making direct observations in the production line of PT. AII, especially in the 10th Brikat Zone line. The information was also obtained by expert interviews, namely the head of the production, machining, mechanics, and machine operators.

Example calculation avaibility period-1:

$$A = \frac{\text{120 minutes} - \text{0 minute} - \text{15 minutes}}{\text{120 minutes}} = 88\%$$

Table 1. Activity data and results on continuous blanking machines

Period	Loading Times (minutes)	Setup & Adjustment (minutes)	Failure & Repair (minutes)	Operation Time (minutes)	Total Production (unit)	Ideal Cycle Time (minutes)	Reject when Setup (unit)	Reject and Rework (unit)
1	120	15	0	105	2953	0.033	3	20
2	120	15	0	105	1464	0.033	0	3
4	120	15	0	105	3016	0.033	0	10
5	120	15	5	100	3010	0.033	0	33
6	120	15	0	105	3000	0.033	0	40
7	120	15	0	105	2500	0.033	5	10
8	120	15	0	105	3150	0.033	55	23
9	120	15	0	105	2980	0.033	0	0
11	120	15	0	105	2825	0.033	0	0
12	120	15	0	105	3100	0.033	0	0
13	84	15	0	69	2000	0.033	12	110
14	126	15	7	104	3027	0.033	0	3
15	126	15	5	104	3250	0.033	0	16
16	60	15	0	45	1350	0.033	0	0
18	94	15	0	70	2250	0.033	0	108
19	54	15	0	39	750	0.033	3	27
20	60	15	0	45	1000	0.033	21	15
21	54	15	0	39	750	0.033	1	23
22	60	15	0	45	1250	0.033	0	47
23	121	15	0	106	1590	0.033	0	25
25	102	15	0	87	1328	0.033	0	30
26	102	15	0	87	2000	0.033	2	10
27	95	15	0	80	2250	0.033	0	3
28	165	15	5	145	4500	0.033	28	120

Time available for the operation of machinery or equipment in a study of continuous blanking machines in February 2019 yields an average that is not good at 83.48% (Table 2). The percentage value can be said to be very less because, according to (Wiguna, 2013), the ideal availability ratio value at OEE > 90%. The results of the performance efficiency ratio for measuring the performance of continuous blanking machines in February 2019 can be seen in table 2

Example calculation Performance Efficiency period-1 :

$$P = \frac{2953 \text{ units} \times 0.033 \text{ minutes per unit}}{105 \text{ minutes}} = 93\%$$

Based on the table of product quality table below, it is found that the ability of continuous blanking machines in producing products that are in accordance with the standards in February 2019 produces an average of 99.52%. The percentage value means very good, because according to (Wiguna, 2013), the ideal value of product quality value at OEE> 99%.

Example calculation rate of quality period-1

$$Q = \frac{2953 \text{ units} - 3 \text{ units} - 20 \text{ units}}{2953 \text{ units}} = 99\%$$

After the availability ratio value, performance ratio and quality ratio are obtained, the next step is to calculate the OEE values (Table 2).
Example calculation OEE period-1 :

$$\text{OEE} = 88\% \times 93\% \times 99\% = 81\%$$

the result of OEE Value calculation obtained from multiplying the three components of the OEE method, namely availability ratio, performance efficiency and rate of quality. The Final OEE value on the ability of continuous blanking machines at PT. AII in February 2019 resulted in an average total ratio of 71% (Table 2). This value indicates that it is very unfavorable if the OEE ideal value for the manufacturing industry reaches > 85%. As a result of the lack of OEE values, continuous machine performance during February 2019 can be said to be ineffective in carrying out the production process

Table 2. OEE value for continuous blanking machines

Period	Availability Ratio (%)	Performance Efficiency (%)	Rate of Quality Product (%)	OEE (%)
1	88%	92.81%	99%	81%
2	88%	46.01%	100%	40%
4	88%	94.77%	100%	83%
5	83%	99.33%	99%	82%
6	88%	94.29%	99%	82%
7	88%	78.57%	100%	69%
8	88%	99.00%	100%	86%
9	88%	93.66%	100%	82%
11	88%	88.79%	100%	78%
12	88%	97.43%	100%	85%
13	82%	95.66%	99%	78%
14	83%	96.05%	100%	79%
15	84%	103.13%	100%	85%
16	75%	99.00%	100%	74%
18	84%	93.99%	99%	78%
19	72%	63.46%	99%	46%
20	75%	73.33%	99%	55%
21	72%	63.46%	99%	45%
22	75%	91.67%	98%	68%
23	88%	49.48%	98%	43%
25	85%	50.37%	99%	43%
26	85%	75.86%	100%	65%
27	84%	92.81%	100%	78%
28	88%	102.41%	100%	90%

4.2 Six Big Losses

The calculation of six big losses is carried out to determine the factors that give the biggest contribution and become the main priority of improvement which results in the low effectiveness of using continuous blanking machines against the six factors of six big losses. Of the 6 main losses grouped into 3 namely downtime losses, speed losses and quality losses.

Calculation of the six big losses method on a continuous blanking machine in February 2019:

$$EFL = \frac{12 \text{ minutes}}{2503 \text{ minutes}} \times 100\% = 0.48\%$$

$$SAL = \frac{360 \text{ minutes}}{2503 \text{ minutes}} \times 100\% = 14.38\%$$

$$IMSL = \frac{(102873 - 55292) \times 0.033}{2503} \times 100\%$$

$$IMSL = 62{,}73\%$$

$$RSL = \frac{(2121 - (0.033 \text{ x } 55292))}{2503\%} \times 100\%$$

$$RSL = 11.84\%$$

$$DL = \frac{(679 \times 0.033)}{2503} \times 100\% = 0.89\%$$

$$RY = \frac{(0.033 \times 130)}{2503} \times 100\% = 0.17\%$$

The six factors that have the most significant contribution and become the main priority will be corrected, resulting in low effectiveness of the use of continuous blanking machines is idle and minor stoppage losses with a percentage of 62.73%, the second is set up and adjustment losses of 14.38%. Followed by reducing and speed losses in the amount of 11.84%, while defect losses, equipment failure losses, and yield losses each had a percentage of 0.89%, 0.48%, and 0.17%.

4.3 Analysis of Cause And Effect Diagrams

The following is a causal diagram (fishbone) for factors of idle and minor stoppages losses on continuous blanking machines obtained from interviews with experts, namely the head of the production division (Figure 1).

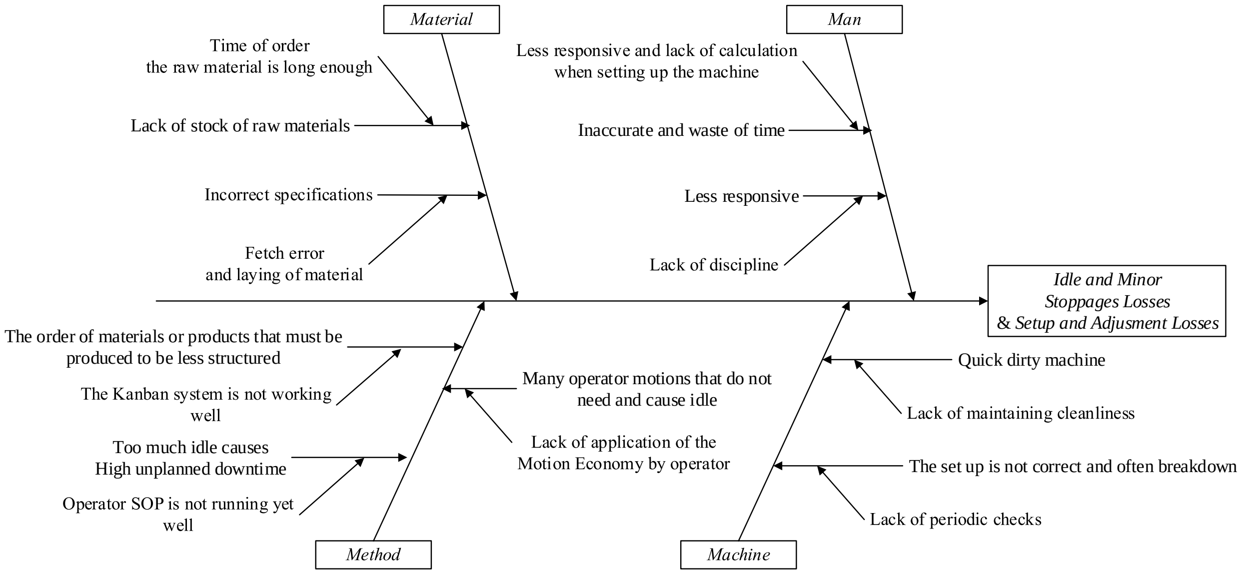

Figure 3. Fishbone Diagram

Based on the analysis of cause and effect diagrams, the things that cause the low productivity of continuous blanking machines are less responsiveness and calculation when setting up the machine. PT. AII should conduct training for all employees and operators. Lack of discipline from the operator so that the idle time is high, PT. AII should provide an understanding of the importance of work ethics and discipline in the work environment (Human Factor).

The cause of the engine factor problems that often occur in this machine is the cessation of the device due to scrap entering into the machine. A lack of maintaining machine cleanliness causes this. PT AII should conduct regular cleaning and urge the operators and cleaners to always maintain cleanliness before and after production. Continuous blanking machine has experienced a number of incorrect machine set up conditions, and this is due to the lack of regular machine checking. The company should not only focus on meeting the number of production targets but do daily machine maintenance schedules.

Some of what happened from the material side are PT. AII often experiences minimal raw materials, and companies should do scheduling calculations to suppliers so that in the production process, the machine does not experience idle. PT. AII does not yet have an SOP regarding the specifications of materials and raw materials used in the production process. As a result, the quality of raw materials used does not meet the standards, and many products experience rejects during the production process. Sometimes, too, the operator positions the material on the machine table so that the product has a reject. PT. AII established SOP regarding material specifications, raw materials, and SOP for the production process so that the products produced high quality.

The factor that causes the OEE value is not achieved from the method factor is the kanban system at PT. AII is not going well. As a result, the material flow on the production floor is not systematically arranged. PT. AII conducted an analysis and evaluation of the problems that caused the kanban system not to work correctly. Then start to rerun the kanban system. Lack of updating of the production process standard, resulting in high idle time and unplanned downtime. Preferably, PT. AII sets SOP regarding production process standards so that production processes are more efficient and can reduce high levels of downtime. Economic analysis of the movement is proven to reduce activities that the operator does not need during the production process. This method can speed up the production process and minimize losses in cost, time, and labor. PT. AII conducts an economic analysis of the movement and urges its workers to carry out the movement/process as the results of the investigation that has been done.

5. CONCLUSION

The values of the components of the OEE are 99% availability ratio, 84% performance efficiency, 83% rate of product quality. While the value obtained on the OEE calculation is 71%, the value is below the world's ideal OEE standard value of> 85%. The values of losses on six big losses are idle and minor stoppage losses with a percentage of 62.73%, setup and adjustment losses of 14.38%, reduce and speed losses of 11.84%. In contrast, defect losses, equipment failure losses, and yield losses have a percentage of 0.89%, 0.48%, and 0.17%. Based on the results of the analysis that has been done, the improvement must be done by PT. AII is PT. AII must conduct training for all employees and operators and PT. AII must provide an understanding of the importance of work ethics and discipline in the work environment. Increasing the equipment factor means that PT AII must carry out regular cleaning and appeal to operators and cleaners to always maintain cleanliness before and after production. The company focuses not only on meeting the number of production targets but also on routine machine maintenance. Material factors improvements that must be made are PT. AII has to do the scheduling calculation to the supplier so that the machine does not experience idle and PT in the production process. AII sets SOPs regarding material specifications and raw materials as well as SOPs for the production process so that the products produced have high quality. From the method factors, improvements that must be made are PT. AII should analyzes and evaluates problems that cause the kanban system not to function properly, then started to rerun the kanban system. PT. AII should set SOPs regarding production process standards so that production processes are more efficient and can reduce high levels of downtime. And last, PT. AII conducts an economic analysis of the movement and urges its workers to carry out the movement/process resulting from the investigation that has been done. This research can be continued with the application of autonomous maintenance to the success of the target of increasing OEE.

REFERENCES

Davis, R K. (1995). *Productivity Improvement Through TPM*. Prentice Hall : London

Garza-Reyes, J. A. (2015). From measuring overall equipment effectiveness (OEE) to overall resource effectiveness (ORE). *Journal of Quality in Maintenance Engineering*, *21*(4), 506-527. https://doi.org/10.1108/JQME-03-2014-0014

Nakajima, S. (1988). I*ntroduction to Total Productive Maintenance*, Productivity Press Inc, p. 21 : Portland

Stamatis, D.H. (2010). *The OEE Primer: Understanding Overall Equipment*. Taylor and Francis Group : New York

Supriyadi, S., Ramayanti, G., & Afriansyah, R. Analisis Total Productive Maintenance Dengan Metode Overall Equipment Effectiveness Dan Fuzzy Failure Mode and Effects Analysis. *Sinergi: Jurnal Teknik Mercu Buana*, *21*(3), 165-172. http://dx.doi.org/10.22441/sinergi.2017.3.002

Tsarouhas, P. (2019). Improving operation of the croissant production line through overall equipment effectiveness (OEE): A case study. *International Journal of Productivity and Performance Management*, *68*(1), 88-108. https://doi.org/10.1108/IJPPM-02-2018-0060

Tsarouhas, P. H. (2013). Evaluation of overall equipment effectiveness in the beverage industry: a case study. *International Journal of Production Research*, *51*(2), 515-523. https://doi.org/10.1080/00207543.2011.653014

Watson, G. (2004). The Legacy Of Ishikawa. Quality Progress 37(4) , 54-47. https://search.proquest.com/openview/aa8d84108ce578a570cffcda68e9c5ef/1?pq-origsite=gscholar&cbl=34671

Wahid, A., & Agung, R. (2016). Perhitungantotal Produktifitas Maintenance (TPM) pada Mesin Bobin dengan Pendekatan Overall Equipment Effectivenes (OEE) di PT. XY. *JKIE*

(Journal Knowledge Industrial Engineering), *3*(3), 40-49. https://jurnal.yudharta.ac.id/v2/index.php/jkie/article/view/873

Wiguna, and Windi. (2013). System Repair Design for Total Productive Maintenance In PT. XYZ, *Skripi*. Jurusan Teknik Industri, Universitas Sumatera Utara. http://repositori.usu.ac.id/handle/123456789/3005