

Analysis of Sterilizer Machine Treatment at PT. Karya Tanah Subur (KTS) Using the Overall Equipment Effectiveness (OEE) Method

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ABSTRACT

PT. Karya Tanah Subur (KTS) is a company engaged in the oil palm plantation and processing business located in Padang Sikabu Village, Kaway XVI sub-district, Aceh Barat Regency. The resulting production is crude palm oil CPO (Crude Palm Oil) or crude palm oil Palm Kernel (PK) and shells. In processing crude palm oil, the Boiling Station (sterilizer) is one of the most important machines, because if the sterilizer machine is damaged it will affect the production process of the factory. The purpose of this study was to analyze the performance of the sterilizer using the Overall Equipment Effectiveness (OEE) method by calculating the average Availability, Performance Efficiency, Rate of Quality, and OEE values from the performance of the sterilizer so that maintenance actions can be determined. Based on the analysis results, the average Availability is around 58.44%, Performance Efficiency is 80.77%, Rate of Quality is 100% and the average OEE value on the Sterilizer machine is 46.43%, with these values when compared to the international standards then it will be a fairly high difference.

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I. Introduction

Increasing competition in the industrial world requires companies to further improve the efficiency of their operational processes. A prerequisite for the smooth operation of a company is the operational readiness of production machinery [1]. Maintenance activities play a very important role in ensuring that facilities operate smoothly as desired. In addition, machine maintenance is a system related to maintaining, developing, sustaining, and maximizing the power that exists in a company in order to increase the economic power of the company [2]. Appropriate maintenance is necessary to continue production in order to continue using production machines [3].

PT. Karya Tanah Subur (KTS) is an oil palm plantation and processing company located in Padang Sikabu Village, Kaway XVI Sub-District, Aceh Barat Regency Aceh Province. The products produced are crude palm oil (CPO) or crude palm oil (PK) and pericarp. PT. Karya Tanah Subur it was founded in 1987 and in 1993 he officially started production with a processing capacity of 65 tons/hour. KTS has several stations starting from weigh station, loading dock, stew (sterilizer) and hoist Crane, Thersher, Digester, Press, Depericarper, Station Kernel.

PT. Karya Tanah Subur The sterilization equipment used is a horizontal sterilization equipment, with three tanks of 23m in length and 2.7m in diameter, each of which can accommodate 11 trucks with a load capacity of 3.3 tons. The sterilization process involves cooking at a temperature of approximately 136 °C-142 °C for 60-70 minutes.

The boiling station (Sterilizer) is one of the most important machines in the processing of crude palm oil. This is because if the sterilizer is damaged, it will affect the factory's production process. If the production process stops, it will cause economic loss, the production target will not be met, and it will cause great damage to the company.

Therefore, to maintain quality and improve productivity, sterilizers must be analyzed using the Overall Equipment Effectiveness (OEE) method.



One of the key factors to consider is the issue of sterilizer maintenance. Find factors that degrade machine performance using the Overall Equipment Effectiveness (OEE) method, which measures availability, performance efficiency, and quality ratios by applying corresponding machine performance before executing a maintenance plan is needed [4].

II. Method

In this study, data collection was conducted through direct observation and interviews with machine operators and factory workers to find machine conditions and problems at the sterilization station. In addition, the authors also conduct a literature survey to validate the theory and calculations using the Overall Equipment Effectiveness (OEE) method.

The purpose of this study is to determine what the current state of machine maintenance is, whether it is good or in need of improvement, and to provide alternative solutions that PT can apply. Karya Tanah Subur (KTS), a sterilizer, is the subject of this research and all production to maintain a smooth cooking process for FFB (Fresh Fruit Bunch).

Below are the steps taken by the authors to obtain the study data:

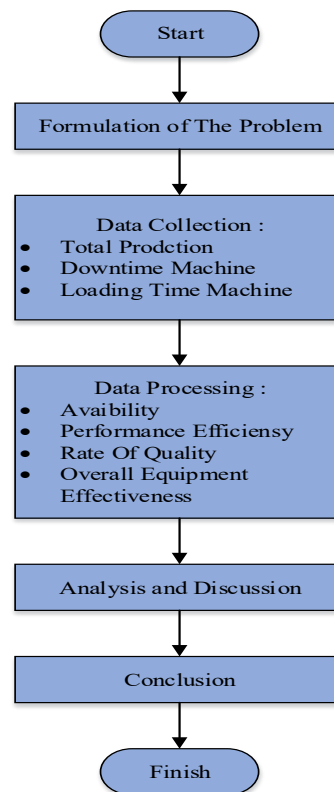


Fig. 1. Stage of Research

A. Definition Of Overall Equipment Effectiveness (OEE) Method

Overall Equipment Effectiveness (OEE) is a calculation used to determine the effectiveness level of a machine or piece of equipment in a factory. OEE is one of the techniques included in TPM (Total Productive Maintenance). OEE is commonly used as an indicator of machine or plant performance [5].

Here are definitions of Overall Equipment Effectiveness (OEE) from various sources.

- According to [6], Overall Equipment Effectiveness (OEE) is a measure of overall plant efficiency determined by considering availability, performance efficiency, and product quality ratios.

- According to [7], Overall Equipment Effectiveness (OEE) is a method of measuring the utilization efficiency of an asset or system by incorporating multiple perspectives into the calculation process [8].
- According to [9], Overall Equipment Effectiveness (OEE) measures machine/plant utilization efficiency by calculating machine availability, performance and product quality.

B. Purpose and Benefits of The Overall Equipment Effectiveness (OEE) Method

The purpose of Overall Equipment Effectiveness (OEE) is to measure the performance of maintenance systems. This method can be used to determine machine/equipment availability, production efficiency, and machine/equipment output quality.

According to [10], using OEE as a performance indicator takes a certain amount of time as follows daily, weekly, monthly or yearly in shifts. OEE measurements are used more effectively in production plants. OEE can be used at several types of levels in an enterprise environment. So it looks like this:

- OEE can be used as a benchmark to measure a company's performance plans.
- The OEE value, which is an approximation of the production flow, can be used to compare performance lines across the organization and ensure flow is not an issue.
- Once the machining processes are run one at a time, OEE can identify underperforming machines and even pinpoint a focus for TPM resources.

C. Calculation Steps Using OEE Method

Overall Equipment Effectiveness (OEE) is a calculation used to determine the level of productivity and effectiveness of equipment. Overall Equipment Effectiveness can be calculated by the formula:

$$OEE (\%) = AV (\%) \times PE (\%) \times Rate \text{ Quality Product } (\%) \quad (1)$$

Based on the award given by the Japan Institute of Plant Maintenance, the ideal conditions for OEE are as follows [7].

- Availability > 90%
- Performance Efficiency > 95%
- Quality Product > 99%

So the ideal OEE is : $0,90 \times 0,95 \times 0,99 = 85\%$

There are three elements of equipment productivity and effectiveness that can be measured, namely: availability, performance efficiency and Rate Of Quality.

• Availability

Availability is the operating efficiency of a machine or plant. Uptime ratio is the ratio of uptime to load time.

The following formula is used:

$$AV = (\text{operation time})/(\text{loading time}) \times 100\% \quad (2)$$

• Performance Efficiency

Performance Efficiency is a ratio that determines the ability of equipment to produce goods. This ratio is the result of the Operating Speed Rate and Nate Operating Rate [11].

Performance Efficiency is formulated as follows:

$$PE = (\text{Total production} \times \text{ideal cycle time})/(\text{operation time}) \quad (3)$$

• Rate Of Quality

According to [7], rate of quality product is the ratio of the number of good products to the total product processed. Rate of Quality Product shows acceptable products per total product produced.

Rate of Quality Product can be calculated by the following formula:

$$QP = (\text{Total production} \times \text{Reject produc})/(\text{total production}) \quad (4)$$

III. Results and Discussion

Process the data collected using steps when determining the outcome of sterilizer maintenance. Uptime is determined by the reduction between data load time and downtime. Below is the data collected for his 15 days in November 2022 at PT Karya Tanah Subur (KTS).

Table 1. Sterilizer Machine Data

Date	Total Production (Ton)	Ideal Cycle Time (Minute)	Loading Time (Minute)	Down Time (Minute)	Operation Time (Minute)
01	1401	60	1440	456	984
02	1345	60	1440	488	952
03	1128	60	1440	654	786
04	695	60	1440	657	783
05	1009	60	1440	554	886
06	613	60	1440	564	876
07	1038	60	1440	667	773
08	936	60	1440	456	984
09	1135	60	1440	676	764
10	1119	60	1440	567	873
11	916	60	1440	768	672
12	1337	60	1440	556	884
14	1175	60	1440	467	973
15	1471	60	1440	789	651

The above data processing will use the Overall Equipment Effectivines (OEE) method and to perform data processing using this method requires several steps starting from:

A. Availability Determination

Availability, is the time ratio of the Operation time and machine loading time.

$$Availability = 984/1440 \times 100\% = 68,33 \%$$

From these calculations, the Availability data recapitulation can be seen in the table below as follows:

Table 2. Availability Sterilizer Ratio

No	Date	Loading time (minute)	Operation time (minute)	Availability (%)
1	1	1440	984	68,33
2	2	1440	952	66,11
3	3	1440	786	54,58
4	4	1440	783	54,37
5	5	1440	886	61,52
6	6	1440	876	60,83
7	7	1440	773	53,68
8	8	1440	984	68,33
9	9	1440	764	53,05
10	10	1440	873	60,62
11	11	1440	672	46,66
12	12	1440	884	61,38
13	14	1440	973	67,56
14	15	1440	651	45,21
15	16	1440	783	54,37
Average				58,44 %

Get the average utilization in PT based on the above calculation. Karya Tanah Subur said he had 58.44% in November. Since normal availability values are at risk above 90%, PT can check the values produced by the sterilizer. Tanah Subur's work is included in the inefficiency category due to extended machine downtime in November.

B. Calculation of Performance Efficiency

Performance Efficiency Is the ratio of the quality of a product that will be multiplied by the ideal cycle time in the available time in the production process (operation time).

$$PE = (1401 \times 60)/984 = 85,42 \%$$

From the calculation above, the overall data recapitulation can be seen in the table below

Table 3. Performance Efficiency Sterilizer Machine Ratio

Date	Total Production(ton)	Ideal cycle time (minute)	Operation time (minute)	Performance efficiency (%)
01	1401	60	984	85,42
02	1345	60	952	84,76
03	1128	60	786	86,13
04	695	60	783	53,25
05	1009	60	886	68,32
06	613	60	876	41,98
07	1038	60	773	80,56
08	936	60	984	57,07
09	1135	60	764	89,13
10	1119	60	873	76,92
11	916	60	672	81,78
12	1337	60	884	90,74
14	1175	60	973	72,45
15	1471	60	651	135,57
16	1403	60	783	107,51
Average				80,77%

Performance Efficiency Calculation Results at PT. Karya Tanah Subur in November obtained an average of 80.77%, because the ideal value that must be obtained is > 95%, the value obtained at PT. Fertile earthworks are included in the Effective Category. This happens because the total production is produced under normal conditions.

C. Calculation Rate Of Quality Product

Rate of quality product is the ratio of a good product (good product) in accordance with the specified quality with the number of products to be processed.

$$\text{Rate of Quality Product} = (1401 \times 0)/1401 = 100 \%$$

D. Calculation of Overall Equipment Effectiveness

After obtaining the Availability, Performant efficiency and Rate of product quality values on the sterilizer machine, an OEE calculation is performed to find out how effectively the sterilizer is used.

$$OEE = AV 68,33\% \times PE 85,42 \% \times QP 100\% = 58,37 \%$$

From the above calculations it can be seen the recapitulation of the Overall Equipment Efficiency calculations in the table below:

Table 4. OEE Value

Date	Availability (%)	Performance Efficiency (%)	Rate Of Quality (%)	OEE (%)
1	68,33	85,42	100	58,36
2	66,11	84,76	100	56,03
3	54,58	86,13	100	46,99
4	54,37	53,25	100	28,95

5	61,52	68,32	100	42,03
6	60,83	41,98	100	25,53
7	53,68	80,56	100	43,24
8	68,33	57,07	100	38,99
9	53,05	89,13	100	47,28
10	60,62	76,92	100	46,61
11	46,66	81,78	100	38,15
12	61,38	90,74	100	55,69
14	67,56	72,45	100	48,94
15	45,21	135,57	100	61,27
16	54,37	107,51	100	58,45
Average				46,43%

From the OEE method calculation above, we can see that the average OEE value is 46.43%, as the OEE value in November is below 60%. This is the value that the sterilizer produces in PT. Karya Tanah Subur is still in invalid standards. Therefore, when comparing the effects of machine work with the international standards of the Japan Institute of Plant Maintenance (JIPM), the difference with this standard is very large, and it can be said that the machines are being maintained and managed. Repairs should be done mechanically as soon as possible.

IV. Conclusion

Based on the analysis performed by the authors in PT. Karya Tanah Subur can be completed as follows:

1. Based on calculations performed in PT. Karya Tanah Subur achieved an average yield of Availability around 58,44%, Performance Efficiency 80,77%, Rate of Quality 100% The average results determined by the authors indicate that the machine's performance in the sterilization station falls into the ineffective category due to excessive machine downtime.
2. Based on the calculation results at PT. KTS obtained an average OEE value on the Sterillizer machine of 46.43%, with this value when compared to international standard values it will be a fairly high difference.

V. Recommendation

From the research that has been applied, the recommendations that can be given by the author for companies are:

1. For companies, it is better to carry out continuous assessments of activities and implement regular machine checks so that the machine can produce maximum performance.
2. The company can carry out preventive maintenance so that the machine can work optimally and get maximum results.

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