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Analysis of Screw Press Machine Performance Using the Overall Equipment Effectiveness Method at PT. Agro Synergy Nusantara

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ABSTRACT

PT Agro Sinergi Nusantara PKS Aceh Seujahtera is a company engaged in the plantation and processing of oil palm fruit, where the production is in the form of crude palm oil (CPO), palm kernel and fiber. This factory has 2 horizontal type sterilizers with a capacity of 40 tons each. One machine that has a vital role in the production process is the screw press. Based on the results of observations and interviews with the company, it was found that the screw press machine was often damaged in the production process, as a result the production process was stopped and production results were not optimal, besides that the company would also experience losses. The purpose of this research is to measure the performance of the Screw Press Machine at PT Agro Sinergi Nusantara by calculating OEE through 3 main factors, namely Availability Ratio, Performance Effeciency Ratio, and Quality Ratio and determining corrective actions that can improve the performance of the Screw Press machine. The results of the performance analysis on the screw press machine obtained an Availability Ratio value of 84.52%, Performance Effeciency Ratio of 86.68%, Quality Ratio of 100%, and OEE of 73.37%. Based on a comparison with the Word Class Ideal Standard, only the Quality Ratio value meets the standard while the Availability Ratio, Performance Effeciency Ratio, and OEE have not met, meaning that the overall performance of the Screw Press Machine has decreased and has not met the Word Class Ideal Standard and it is necessary to improve the performance of the machine. Recommendations for improvements that can be made to improve the performance of the screw press machine again are to carry out routine maintenance on machine components so that damage can be prevented before severe damage occurs and cause longer downtime, conduct training for workers so that they can develop themselves and know more about the machine and the responsibilities that must be carried out, reinforce the implementation of routine and scheduled maintenance (preventive maintenance), and increase supervision during the FFB sorting process.

I. Introduction

In the growing industrial era, production efficiency is one of the key factors affecting the success of the company. The production process plays a central role in producing quality and competitive products. machines become one of the vital elements that encourage smooth production, with the machine the production process will run quickly [1]. However, continuous use of the machine can result in a decrease in the effectiveness of the machine's performance and of course it will affect the output produced by the machine [2].

PT Agro Sinergi Nusantara is a company engaged in the plantation and processing of oil palm fruit, where the production is in the form of crude palm oil (CPO), palm kernel and fiber. This palm oil mill is located in Pasie Timon Village, Teunom District, Aceh Jaya Regency and began operating in June 2017 with an installed processing capacity of 30 tons of FFB / hour. One of the machines that have a vital role in the production process is the screw press. PT Agro Sinergi Nusantara has 3 operating screw press machines, this machine functions as the main component for extracting CPO from Fresh Fruit Bunches (FFB) [3].

Based on the results of observations and interviews with the company, it is found that screw press machines often experience damage in the production process, as a result the production process is stopped and production results are not optimal, besides that the company will also experience losses. The damage is usually caused by several factors such as, machine components that have expired, incorrect installation of machine components, and excessive input (not according to SOP). To deal with these problems, the company must carry out good maintenance actions. Maintenance is an activity that aims to ensure the functional continuity of a production system so that it can be used in the expected conditions [4]. According to [5], ood maintenance is maintenance that is able to carry out repairs or maintenance to the root of the problems that occur in a machine so that there is no waste of costs which ultimately only go to waste.

To support this, a tool or method is needed that can clearly reveal the problems that occur, one of which is the Overall Equipment Effectiveness (OEE) method. OEE is a method that functions to see the overall condition of the line and the effectiveness of a machine which includes three factors, namely Availability Ratio, Performance Efficiency Ratio, and Quality Ratio, from these 3 factors will be analyzed to get the root of the problem and action to fix it [6]. The purpose of this research is to measure the performance of the Screw Press Machine at PT Agro Sinergi Nusantara by calculating OEE through 3 main factors namely Availability Ratio, Performance Efficiency Ratio, and Quality Ratio and determining corrective actions that can improve the performance of the Screw Press machine.

II. Theoritical Foundations

A. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a method in machine maintenance that aims to measure the performance or performance of machines in producing products [7]. In the calculation, a value will be obtained which will then be analyzed by observing the 3 main factors (Availability Ratio, Performance Efficiency Ratio, and Quality Ratio) to find the root cause of the problem and determine corrective action [8].

B. Fishbone Diagram

Fishbone Diagram is a problem-solving method with the principle of thinking through many possible causes of a problem to be solved [9]. Causal factors usually consist of people, machines, methods, environment, and materials.

III. Methods

A. Place and Time of Research

This research was conducted at the PT Agro Sinergi Nusantara Palm Oil Mill located in Pasie Timon Village, Teunom District, Aceh Jaya Regency. The object under study is the Screw Press Machine. This research was conducted from January to May 2023.

B. Data Source

The data used in this study is the production process data of the Screw Press machine in May 2023. The following is a recapitulation of the data that has been collected by researchers.

Table 1. Screw Press Machine Production Process Data

Date	Machine Working Time (Minutes)	Total Production (Ton/day)	*Reject Product* (Ton/Hari)	Downtime Machine (Minute)
03-Mei-23	540	283,2	0	60
04-Mei-23	540	290,4	0	30
05-Mei-23	540	288,3	0	60
08-Mei-23	540	267,9	0	80

Date	Machine Working Time (Minutes)	Total Production (Ton/day)	*Reject Product* (Ton/Hari)	Downtime Machine (Minute)
09-Mei-23	540	260,2	0	80
10-Mei-23	540	255,2	0	80
11-Mei-23	540	274	0	60
12-Mei-23	540	260,3	0	75
15-Mei-23	540	269,4	0	90
16-Mei-23	540	270,4	0	80
17-Mei-23	540	265,7	0	70
18-Mei-23	540	280,2	0	80
19-Mei-23	540	274	0	60
22-Mei-23	540	257,5	0	90
23-Mei-23	540	289	0	60
24-Mei-23	540	279,2	0	65
25-Mei-23	540	267,8	0	90
26-Mei-23	540	260,5	0	60
29-Mei-23	540	256,3	0	90
30-Mei-23	540	240,7	0	90
31-Mei-23	540	280,3	0	60

C. Flow of Research

Below is a flowchart of this research:

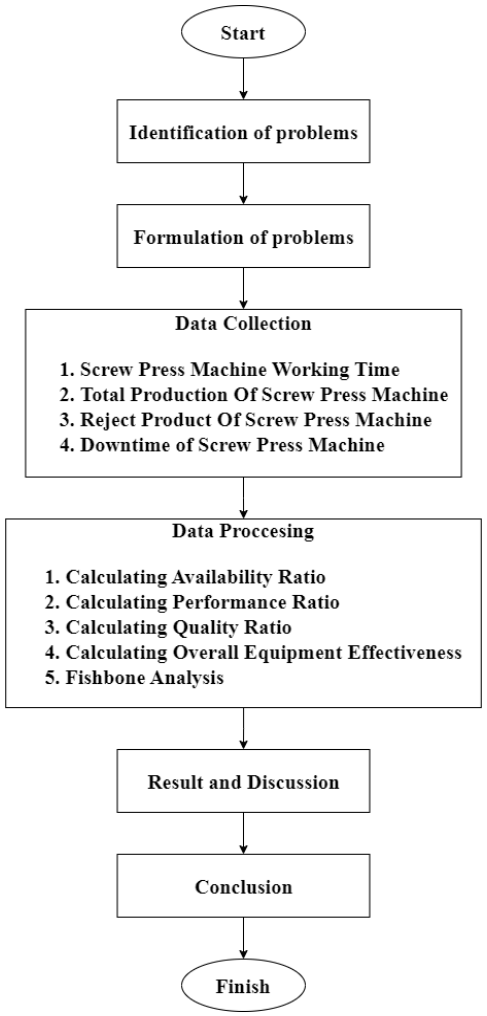

Fig. 1. Flow of Research

D. Data Collection Methods

The data collection methods used in this research are observation and interview methods. Observation is a method that makes observations in data collection directly at the research site [10]. Observations were made on the Screw Press machine at PT Agro Sinergi Nusantara.

Interview is a data collection technique through conversations conducted with a specific purpose, from two or more parties [11]. The interview was conducted with the Screw Press Machine Operator of PT Agro Sinergi Nusantara.

E. Data Analysis Methods

1. Metode Overall Equipment Effectiveness (OEE)

The following are the steps in calculating the OEE Value [12]:

- Calculating The Availability Ratio Value

  Availability Ratio value is a value that describes the utilization of time available for machine or equipment operations.

  $$AR = (Operation\ Time / Loading\ Time) \times 100\% \quad (1)$$

  Loading Time = Machine Working Time – Downtime Machine

  Operation Time = Loading Time – Downtime Machine

- Calculating The Performance Efficiency Ratio Value

  The Performance Efficiency Ratio value is a value that describes the ability of the machine to produce products.

  $$PER = ((Total\ Production \times Ideal\ Cycle\ Time) / Operation\ Time) \times 100\% \quad (2)$$

  Cycle Time = Loading Time /Total Production

  Working Percentage = (Operation Time / Machine Working Time) x 100%

  Ideal Cyle Time = Cycle Time x Working Percentage

- Calculating The Quality Ratio Value

  The Quality Ratio value is a value that describes the machine's ability to produce products that are in accordance with the standards.

  $$QR = ((Total\ Production – Reject\ Produk) / Total\ Production) \times 100\% \quad (3)$$

- Calculating The Overall Equipment Effectiveness (OEE)

  The OEE value can be obtained by multiplying the three ratios, namely:

  $$OEE = AR \times PER \times QR \quad (4)$$

  After obtaining the results, an analysis of the value obtained is carried out. The machine is said to be in good performance if it meets the Word Class Ideal OEE standards as follows:

Table 2. Standard Word Class Ideal OEE

Description	Value (%)
Availability Ratio	90
Performance Efficiency Ratio	95
Quality Ratio	99
OEE	85

Source : [12]

2. Fishbone Diagram

The steps taken in the preparation of the Fishbone Diagram, namely [13]:

- Create a Fishbone Diagram framework
- Determine the problem to be identified
- Determine the causes of the problem
- Find the causes in each category/group of causes with discussion techniques (brainstorming)
- Once the problem and its causes are known, the Fishbone Diagram can be drawn

IV. Result and Discussion

A. Calculation Results of Overall Equipment Effectiveness (OEE) Method

1. Calculating the Availability Ratio Value

This calculation aims to see the performance level of the Screw Press machine on the availability ratio. The following is an example of an availability ratio calculation:

Loading Time = 540 minute – 60 minute = 480 minutes

Operation Time = 480 minute – 60 minute = 420 minutes

AR = (420 minute / 480 minute) x 100% = 87,50%

Based on the above calculations, the availability ratio value is 87.50%. For further results presented in Table 3 below.

Table 3. Availability Ratio of Screw Press Machine

Loading Time	*Operation Time*	*Availability Rate*
480	420	87,50%
510	480	94,12%
480	420	87,50%
460	380	82,61%
460	380	82,61%
460	380	82,61%
480	420	87,50%
465	390	83,87%
450	360	80,00%
460	380	82,61%
470	400	85,11%
460	380	82,61%
480	420	87,50%
450	360	80,00%
480	420	87,50%
475	410	86,32%
450	360	80,00%
480	420	87,50%
450	360	80,00%
450	360	80,00%
480	420	87,50%
Average		**84,52%**

Based on the above calculations, the availability ratio value obtained an average value of 84.52%, this value is still below the Word Class Ideal Standard of 90%, so it is concluded that the machine has not met the Word Class Ideal standard on the availability ratio.

2. Calculating the *Performance Efficiency Ratio Value*

This calculation aims to see the performance level of the Screw Press machine on the performance efficiency ratio. The following is an example of calculating the performance efficiency ratio:

Cycle Time = 480 minute /283,2 ton = 1,69 minute/ton
Work Percentage = (420 minute / 540 minute) x 100% = 78%
Ideal Cyle Time = 1,69 x 78% = 1,32
PER = ((283,2 ton x 1,32 minute) /420 minute) x 100% = 88,89%

Based on the above calculations, the result of the performance efficiency ratio value is 88.89%. Further results are presented in Table 4 below.

Table 4. Performance Efficiency Ratio of Screw Press Machine

Cycle Time	Work Percentage	*Ideal Cyle Time*	*Performance*
1,69	78%	1,32	88,89%
1,76	89%	1,56	94,44%
1,66	78%	1,29	88,89%
1,72	70%	1,21	85,19%
1,77	70%	1,24	85,19%
1,80	70%	1,27	85,19%
1,75	78%	1,36	88,89%
1,79	72%	1,29	86,11%
1,67	67%	1,11	83,33%
1,70	70%	1,20	85,19%
1,77	74%	1,31	87,04%
1,64	70%	1,16	85,19%
1,75	78%	1,36	88,89%
1,75	67%	1,17	83,33%
1,66	78%	1,29	88,89%
1,70	76%	1,29	87,96%
1,68	67%	1,12	83,33%
1,84	78%	1,43	88,89%
1,76	67%	1,17	83,33%
1,87	67%	1,25	83,33%
1,71	78%	1,33	88,89%
	Average		**86,68%**

Based on the above calculations, the performance efficiency ratio value obtained an average value of 86.68%, this value is still below the Ideal Word Class Standard of 95%, so it is concluded that the machine has not met the Ideal Word Class standard on the performance efficiency ratio value.

3. Calculating The *Quality Ratio Value*

This calculation aims to see the performance level of the Screw Press machine on the Quality Ratio. The following is an example of Quality Ratio calculation:

QR = ((283,2 ton – 0) / 283,2 ton) x 100% = 100%

Based on the above calculations, the Quality Ratio value is 100%. Further results are presented in Table 5 below.

Table 5. Quality Ratio Mesin Screw Press

Total Production	***Reject* Product**	***Quality Ratio***
283,2	0	100%
290,4	0	100%
288,3	0	100%
267,9	0	100%
260,2	0	100%
255,2	0	100%
274	0	100%
260,3	0	100%
269,4	0	100%
270,4	0	100%
265,7	0	100%
280,2	0	100%
274	0	100%
257,5	0	100%
289	0	100%

Total Production	***Reject* Product**	***Quality Ratio***
279,2	0	100%
267,8	0	100%
260,5	0	100%
256,3	0	100%
240,7	0	100%
280,3	0	100%
Rata-rata		**100%**

Based on the calculations above, the Quality Ratio value has an average of 100%, so that the machine reaches the ideal world class standard in Quality Ratio, which is greater than 99%.

4. Calculatinf The Overall Equipment Effectiveness (OEE) Value

This calculation aims to see the performance level of the Screw Press machine at the OEE value. The following is an example of OEE calculation:

OEE = 87,50% x 88,89% x 100% = 77,78%

Based on the calculations above, the OEE value is 77.78%. Further results are presented in Table 6 below.

Table 6. OEE of Screw Press Machine

Availability Ratio	***Performance Ratio***	***Quality Ratio***	***OEE***
87,50%	88,89%	100%	77,78%
94,12%	94,44%	100%	88,89%
87,50%	88,89%	100%	77,78%
82,61%	85,19%	100%	70,37%
82,61%	85,19%	100%	70,37%
82,61%	85,19%	100%	70,37%
87,50%	88,89%	100%	77,78%
83,87%	86,11%	100%	72,22%
80,00%	83,33%	100%	66,67%
82,61%	85,19%	100%	70,37%
85,11%	87,04%	100%	74,07%
82,61%	85,19%	100%	70,37%
87,50%	88,89%	100%	77,78%
80,00%	83,33%	100%	66,67%
87,50%	88,89%	100%	77,78%
86,32%	87,96%	100%	75,93%
80,00%	83,33%	100%	66,67%
87,50%	88,89%	100%	77,78%
80,00%	83,33%	100%	66,67%
80,00%	83,33%	100%	66,67%
87,50%	88,89%	100%	77,78%
Rata-rata			**73,37%**

Based on the OEE calculation above, the average value obtained is 73.37%, this value is still below the Ideal Word Class standard, namely 85%, so it is concluded that the machine does not meet the Ideal Word Class standard in OEE values. The following Table 7 is a comparison of the availability ratio, performance efficiency ratio, Quality Ratio, and OEE values obtained with the standard Word Class Ideal values.

Table 7. Comparison of OEE Values from Calculation Results with Ideal Word Class Standards

OEE Factor	**Standard *Word Class Ideal* (%)**	***Performance of Screw Press Machine Value* (%)**
Availability Ratio	90	84,52
Performance Efficiency Ratio	95	86,68
Quality Ratio	99	100
OEE	85	73,37

Based on Table 7 above, the availability ratio value for the screw press machine is found to be 5.49% lower than the standard Word Class Ideal value. In the Performance Efficiency Ratio value of the screw press machine, a quite large difference was found, namely 8.32% lower than

the standard Word Class Ideal value. For the Quality Ratio value of the screw press machine, a value of 100% is obtained, so that this value meets the Word Class Ideal standard value. In the OEE value of the screw press machine, a quite large difference was found, namely 11.63% lower than the standard value for Word Class Ideal.

The following is a graph of the results of calculating the OEE value on a screw press machine:

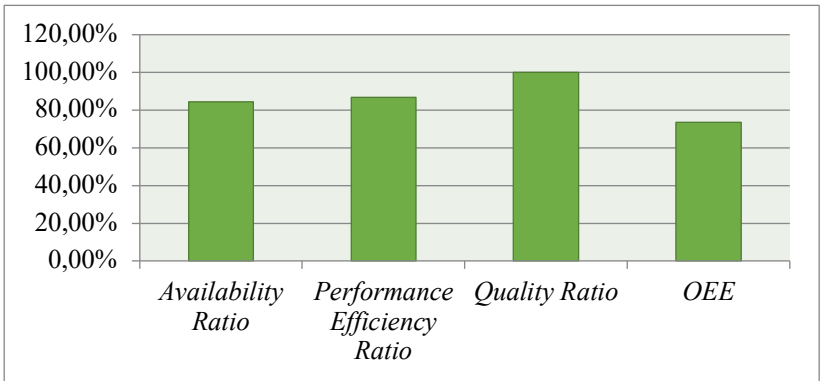

Fig. 2. Graph of OEE Value Calculation Results

Based on Figure 2, the Quality Ratio value is the highest and has met the ideal word class standard. This is because there were no rejected products in production during May 2023, while the availability ratio, performance efficiency ratio and OEE were still below the ideal word class standard. This is because in that month there was a lot of machine downtime which affected machine performance in production.

B. Cause and Effect Analysis

Based on the OEE method calculation results, the results were 73.37%, so it can be concluded that the screw press machine does not meet the ideal word class standard, namely 85%. Therefore, identification needs to be carried out to find out the cause of the screw press machine not meeting the OEE ideal word class standards. Cause analysis was carried out using a fishbone diagram. The following are the results of the analysis of the causal factors that influence the performance of the Screw Press Machine at PT. Agro Synergy Nusantara. using a Fishbone Diagram.

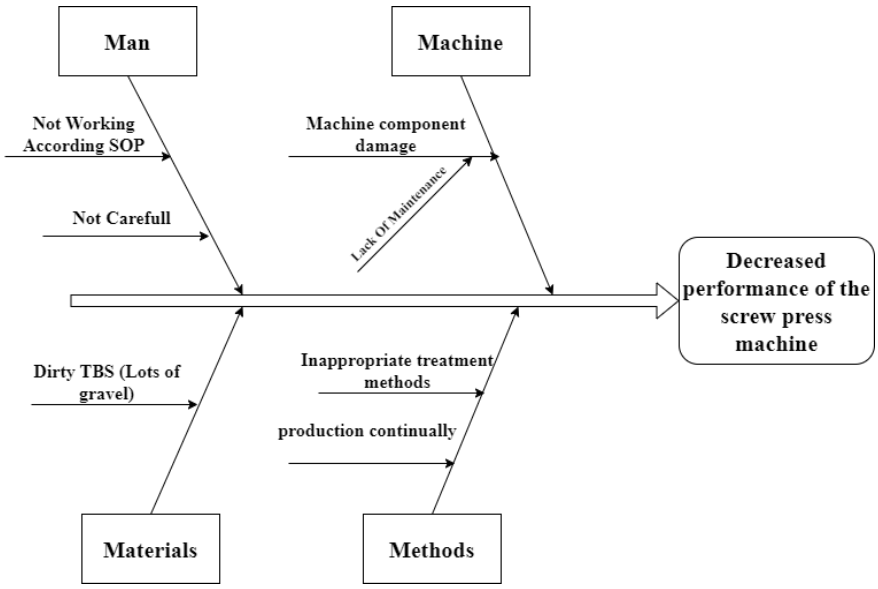

Fig. 3. Fishbone Diagram Analysis of Decrease in Screw Press Machine Performance

Based on Figure 3, there are 4 main factors that cause a decrease in the performance of the Screw Press Machine, namely Machines, People, Methods and Materials:

1) Machine Factors, a decrease in machine performance is caused by damage to machine components, causing the machine not to operate at its best performance and also causing longer downtime when repairs are carried out. Damage to these components is caused by lack of maintenance on the machine. The improvement recommendation that can be given is to carry out routine maintenance on machine components so that damage can be prevented before serious damage occurs and causes losses to the company.
2) Human factors, workers are less careful and do not work according to SOP in carrying out production activities so that production targets are not achieved. This can be caused by a lack of deeper knowledge of the machine. Recommendations for improvement that can be given are to provide training for workers so that they can develop themselves and understand more about the machines and the responsibilities that must be carried out.
3) Method factors, the cause is due to inappropriate maintenance methods and continuous production without paying attention to machine components, which can cause machine damage and increase downtime. Recommendations for improvement that can be given are to emphasize the implementation of routine and scheduled maintenance (preventive maintenance). Forming a special team to carry out routine inspections and identify machine damage so that maintenance will be carried out on target and downtime can be minimized.
4) Material factors, FFB that is dirty or contaminated with gravel can hinder the machine in carrying out the production process, what is more fatal is that it can cause damage to machine components because it is eroded by the gravel. Recommendations for improvement that can be given are to increase supervision during the FFB sorting process.

V. Conclusion

The conclusions obtained from the discussion above are:

1. Measuring the performance of the Screw Press Machine, the average Availability Ratio was 84.52%, the Performance Efficiency Ratio was 86.68%, the Quality Ratio was 100%, and the OEE was 73.37%. Based on the comparison with the Ideal Word Class Standard, only the Quality Ratio value meets the standard, while the Availability Ratio, Performance Efficiency Ratio and OEE do not meet it, meaning that the overall performance of the Screw Press Machine has decreased and does not meet the Ideal Word Class Standard and performance needs to be improved the machine.

2. Decreased performance of the Screw Press Machine is caused by machine, human, method and material factors. Recommendations for improvements that can be made are carrying out routine maintenance on machine components so that damage can be prevented before serious damage occurs and causing longer downtime, holding training for workers so that they can develop themselves and know more about the machine and its responsibilities. that must be carried out, emphasize the implementation of routine and scheduled maintenance (preventive maintenance), and increase supervision during the FFB sorting process.

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