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Calculation of Centrifugal Pump Effectiveness Using The Overall Equipment Effectiveness (OEE) Method at PT. Permata Hijau Group

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Abstract - Centrifugal pumps often experience downtime due to damage, which disrupts the production process. By applying the Overall Equipment Effectiveness (OEE) method, it is expected that the factors causing decreased pump efficiency can be identified, and strategies and corrective actions can be formulated to improve the operational efficiency of centrifugal pumps at PT. Permata Hijau Group from May 2024 to April 2025. The research results showed that the OEE values each month were above the JIPM standard of 85%, with the highest value in February 2025 at 88.15% and the lowest in July 2024, September 2024, January 2025, and March 2025 at 85.34%. The biggest losses came from reduced speed losses at 8.32% and idling and minor stoppages losses at 6.96%. Based on a fishbone analysis, the main cause of high breakdown time in the Hydrogenation division of PT. Permata Hijau Group is the lack of scheduled preventive maintenance, indicating a need for the company to reorganize its maintenance schedule.

Keywords: Overall Equipment Effectiveness (OEE), Centrifugal Pump, Six Big Losses, reduced speed, efficiency

1. INTRODUCTION

PT. Permata Hijau Group is a company engaged in the processing of Crude Palm Oil (CPO), which is processed using machinery. One of its main production machines is the centrifugal pump, which is the heart of the company's cooking oil production. However, in practice, the company often faces issues such as unplanned downtime, suboptimal work capacity, and frequent maintenance needs, all of which lead to decreased productivity and increased operational costs. Centrifugal pumps often experience downtime due to damage such as excessive vibration, damaged bearings, and others, resulting in halted production. The company incurs losses due to these disruptions in production.

1.1. Problem Formulation

Based on the background above, the research problem can be formulated as follows:

1. What is the current work effectiveness value of the centrifugal pump as measured using the Overall Equipment Effectiveness (OEE) method?
2. What are the factors causing the low OEE value of the centrifugal pump at the research site?
3. What corrective steps can be taken to increase the OEE value and operational efficiency of the centrifugal pump?

1.2. Research Objectives

This research aims to:

1. Identify and calculate the Overall Equipment Effectiveness (OEE) value of the centrifugal pump based on three main indicators: availability, performance, and quality.
2. Identify the factors that lead to decreased centrifugal pump efficiency through analysis of OEE components.
3. Formulate strategies and corrective actions that can improve the performance and operational effectiveness of the centrifugal pump.

1.3. Research Benefits

The benefits of this research for the company include:

1. Providing a quantitative overview of the centrifugal pump's performance through the OEE value.
2. Assisting in identifying root causes of efficiency decline, such as high downtime or suboptimal performance.
3. Serving as a basis for decision-making regarding repair or replacement of the pump unit.

1.4. Problem Limitations and Assumptions

1.4.1 Problem Limitations

To avoid unwanted factors influencing this research, the following limitations are established:

1. The research is limited to the production process flow in the Hydrogenation department.
2. The study focuses only on horizontal end-suction centrifugal pumps that operate continuously within the production system.

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3. Efficiency analysis is based on the Overall Equipment Effectiveness (OEE) method using the criteria of Availability, Performance, and Quality.
4. The data used includes operational, downtime, and maintenance data from May 2024 to April 2025.

1.4.2. Assumptions

1. Other variables such as production and maintenance costs, and productivity are not discussed in this research.
2. There are no changes in the production process.
3. The OEE evaluation standard used is relevant.
4. Assigned manpower is trained and qualified.
5. The operational environment is stable.
6. The available operational data is accurate and valid.

2. THEORETICAL FRAMEWORK

2.1 Centrifugal Pump

A centrifugal pump is a dynamic pressure pump that uses the concept of velocity pressure to increase fluid working pressure, where the shaft serves as the mounting point for the *impeller* equipped with vanes. The *impeller* is typically rotated by a motor and enclosed within a pump casing (Amoi Simo;on, 2022).

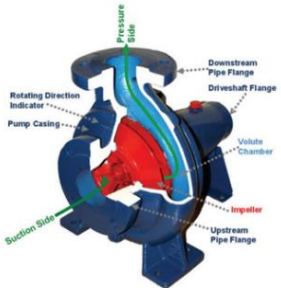

Figure 1. Centrifugal Pump

2.2 Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a basic performance measurement method. OEE is the level of overall equipment effectiveness obtained by considering the availability rate, performance rate, and quality rate (Amalia et al., 2021).

There are three main factors in calculating OEE, with the following formulas:

2.2.1 Availability

Availability is the ratio of operation time to loading time. To calculate machine availability, the following values are needed:

1. Operation time
2. Loading time
3. Downtime

The formula for calculating **availability** is as follows:

$$Avaiblity = \frac{Operation\ Time}{Loading\ Time}\ x\ 100\%$$

2.2.2 Performance Efficiency

Performance Efficiency is the result of multiplying the number of products produced by the ideal cycle time, then dividing by the available operation time. Three important factors are needed to calculate Performance Efficiency:

1. Ideal cycle time
2. Processed amount
3. Operation time

Performance Efficiency is calculated as follows:

$$Performance\ E = \frac{Processed\ amount\ x\ Idle\ cycle\ time}{Operation\ Time}\ x\ 100\%$$

2.2.3 Rate of Quality Products

The rate of quality products is the ratio of good products to the total number of processed products. It is calculated using two factors:

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1. Processed amount
2. Defect amount

Rate of Quality Products is calculated as follows:

$$Rate\ of\ Quality\ Product = \frac{Processed\ amount\ x\ Defect\ amount}{Processed\ amount}\ x\ 100\%$$

3. RESEARCH METHOD

3.1. Type of Research

This research is descriptive in nature, which aims to systematically, factually, and accurately describe the facts and characteristics of a specific object or population.

3.2. Research Location and Time

The research was conducted at PT. Permata Hijau Group, a company engaged in palm oil processing. The company is located at Jalan Pelabuhan Baru No. 124, Bagan Deli, Medan Kota Belawan, Medan City, North Sumatra 20414. The study was carried out from January 2025 until completion.

3.3. Research Object

The research object observed is the performance of centrifugal pumps in the Refinery department of PT. Permata Hijau Palm Group. The issue faced by the company is frequent downtime caused by machine breakdowns, which delays the production process.

4. DATA COLLECTION AND PROCESSING

4.1 Data Collection

a. Downtime Duration

Downtime refers to the length of time during which the centrifugal pump experiences failures or interruptions that cause operational losses in the machine process.

Table 1. Centrifugal Pump Downtime Data

Bulan	***Total Break Time*** **(Jam)**	***Total Set up*** **(Jam)**	***Downtime*** **(Jam)**
May-24	22	15	37
Jun-24	30	10	40
Jul-24	22	16	38
Aug-24	23	18	41
Sep-24	25	10	35
Oct-24	40	11	51
Nov-24	25	16	41
Dec-24	24	15	39
Jan-25	26	17	43
Feb-25	19	15	34
Mar-25	26	12	38
Apr-25	25	15	30

Source: PT. Permata Hijau Group

b. Planned Maintenance

Planned Maintenance refers to scheduled time within the production plan, including scheduled maintenance and other management activities such as meetings. When there are indications of damage to machine components or when a component has reached the end of its service life, replacement or maintenance is scheduled accordingly.

c. Production Time Data

Production time data for the Centrifugal Pump at PT. Permata Hijau Group for the period of May 2024 – April 2025 includes:

a. Total available time
b. Total product processed
c. Total defect product

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4.2 Data Processing

a. Calculation of Availability Ratio

Availability is the ratio of operation time to loading time. The formula for calculating availability is as follows:
Loading Time = Total Available Time – Planned Downtime
Operation Time = Loading Time – Downtime
For example, the availability value for the centrifugal pump in May 2024 is calculated as follows:

Loading Time = 744 - 24 = 720 hours
Operation Time = 720 – 37 = 683 hours

So, the availability of the centrifugal pump for May 2024 is:

$$Avaiblity = \frac{683\ jam}{720\ jam}\ x\ 100\% = 94{,}86\%$$

With the same calculation method, the availability values from May 2024 to April 2025 are shown in: The highest availability value was in April 2025 at 95.82%, with an average availability over the year of 94.54%.

b. Calculation of Performance Efficiency

Performance Efficiency is the ratio of the total quantity of products produced multiplied by the ideal cycle time, divided by the actual operation time.

$$Performance\ E = \frac{Processed\ amount\ x\ Idle\ cycle\ time}{Operation\ Time}\ x\ 100\%$$

For May 2024, the values are:

- Processed amount = 15,815 tons
- Ideal cycle time = 0.04 hours/ton

So, Performance Efficiency Centrifugal pump =

$$Performance\ E = \frac{15815\ Ton\ x\ 0.04\ jam/ton}{683\ jam}\ x\ 100\% = 92.62\%$$

With the same calculation method, the performance efficiency values from May 2024 to April 2025 are shown in Tabel Below

Tabel 2 .Performance Efficiency Pompa Sentrifugal pada periode Mei 2024 - April 2025

Bulan	*Idle Cycle Time* (Jam/ton)	*Total Product Processed* (Ton)	*Operation Time* (Jam)	*Performance Efficiency* (%)
May-24	0,04	15815	683	92,62%
Jun-24	0,04	15308	677	90,45%
Jul-24	0,04	15820	703	90,01%
Aug-24	0,04	15312	655	93,51%
Sep-24	0,04	15818	706	89,62%
Oct-24	0,04	15309	666	91,95%
Nov-24	0,04	15815	679	93,17%
Dec-24	0,04	15308	678	90,31%
Jan-25	0,04	15820	698	90,66%
Feb-25	0,04	14289	614	93,09%
Mar-25	0,04	15817	703	90,00%
Apr-25	*0,04*	*15310*	*687*	*89,14%*

Source: PT. Permata Hijau Group

The highest performance efficiency was in August 2025 at 93.51%, with a yearly average of 91.21%.

c. Calculation of Rate of Quality Product

Rate of Quality Product is calculated using production data:

$$Performance\ E = \frac{15815\ Ton\ x\ 0.04\ Jam/ton}{683\ Jam}\ x\ 100\%$$

- Processed amount = 15,815 tons
- Defect amount = 5 tons

$$Rate\ of\ Quality\ Product = \frac{15815\ ton - 5\ ton}{15815\ ton}\ x\ 100\% = 99{,}97\%$$

With the same method, the Rate of Quality Product for the period May 2024 – April 2025 is shown in tabel below:

Tabel 3.Rate of Quality Product Pompa Sentrifugal pada Periode Mei 2024-April 2025

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Bulan	Total Defect Amount (Ton)	Total Product Processed (Ton)	Rate of Quality Product (%)
May-24	5	15815	99,97%
Jun-24	8	15308	99,95%
Jul-24	10	15820	99,94%
Aug-24	12	15312	99,92%
Sep-24	8	15818	99,95%
Oct-24	9	15309	99,94%
Nov-24	5	15815	99,97%
Dec-24	8	15308	99,95%
Jan-25	10	15820	99,94%
Feb-25	9	14289	99,94%
Mar-25	7	15817	99,96%
Apr-25	10	15310	99,93%

Source: PT. Permata Hijau Group

From the table, the highest rate of quality product for the centrifugal pump was achieved in May and November 2024, at 99.97%, with an average rate of quality product of 99.95%.

d. Calculation of Overall Equipment Effectiveness (OEE)

OEE is calculated by multiplying the Availability, Performance Efficiency, and Rate of Quality Product values:
OEE (%) = Availability (%) × Performance Efficiency (%) × Quality Rate (%).
The Overall Equipment Effectiveness (OEE) value of the Centrifugal Pump in May 2024 is as follows:
Availability = 94.86%
Performance Efficiency = 92.62%
Rate of Quality Product = 99.97%
OEE = 94.39% × 96.15% × 99.80% = 87.83%.

Using the same calculation method to determine the Overall Equipment Effectiveness for the period of May 2024 – April 2025 are shown in tabel below.

Tabel 4. Overall Equipment Effectiveness Pompa Sentrifugal pada periode Mei 2024-April 2025

Bulan	*Availability (%)*	*Performance Efficiency (%)*	*Rate of Quality Product (%)*	OEE (%)
May-24	94,86%	92,62%	99,97%	87,83%
Jun-24	94,42%	90,45%	99,95%	85,36%
Jul-24	94,87%	90,01%	99,94%	85,34%
Aug-24	94,11%	93,51%	99,92%	87,93%
Sep-24	95,28%	89,62%	99,95%	85,34%
Oct-24	92,89%	91,95%	99,94%	85,36%
Nov-24	94,31%	93,17%	99,97%	87,83%
Dec-24	94,56%	90,31%	99,95%	85,36%
Jan-25	94,20%	90,66%	99,94%	85,34%
Feb-25	94,75%	93,09%	99,94%	88,15%
Mar-25	94,87%	90,00%	99,96%	85,34%
Apr-25	95,82%	89,14%	99,93%	85,36%

Source: PT. Permata Hijau Group

From the table above, we can observe the monthly comparison of the Centrifugal Pump's Overall Equipment Effectiveness (OEE) values. It is evident that the highest OEE values were recorded in May and December 2024 at 87.83%, while the lowest was recorded in January 2025 at 85.34%.

e. Calculation of Six Big Losses

Calculation of Six Big Losses which includes the following major types of losses:

- Downtime Losses (Equipment Failure and Setup and Adjustment)
- Speed Losses (Idling and Minor Stoppages Loss and Reduced Speed)
- Defect Losses (Rework Loss and Yield/Scrap Loss)

Downtime Losses

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$$Breakdown\ Losess = \frac{Breakdown\ time}{Loading\ time}\ x\ 100\%$$

Using the above formula, the calculation of Equipment Failure/Breakdown Losses for the Centrifugal Pump in May is as follows:

$$Breakdown\ Losess = \frac{37\ jam}{720\ jam}\ x\ 100\% = 5{,}14\%$$

Using the same calculation method to determine Equipment Failure/Breakdown Losses for the period of May 2024 – April 2025 "can be seen in tabel below:

Tabel 5.Breakdown Losses Pompa Sentrifugal periode Mei 2024-April 2025

Bulan	***Downtime* (Jam)**	***Loading Time* (Jam)**	***Breakdown Losses* (%)**
May-24	37	720	5,14%
Jun-24	40	717	5,58%
Jul-24	38	741	5,13%
Aug-24	41	696	5,89%
Sep-24	35	741	4,72%
Oct-24	51	717	7,11%
Nov-24	41	720	5,69%
Dec-24	39	717	5,44%
Jan-25	43	741	5,80%
Feb-25	34	648	5,25%
Mar-25	38	741	5,13%
Apr-25	30	717	4,18%

Source: Pengolahan Data

From the table below, it can be observed that the highest percentage of breakdown losses occurred in October 2024 at 7.11%, while the lowest was in April 2025 at 4.18%.
Setup Adjustment Loss

The formula to calculate the percentage of Setup and Adjustment Losses is as follows:

$$Setup\ \&\ Adjustment\ Losess = \frac{Setup\ \&\ Adjustment\ time}{Loading\ time}\ x\ 100\%$$

By using the formula above, the Setup and Adjustment Losses for the Centrifugal Pump in May 2024 can be calculated as follows:

Setup & Adjustment Time = 15 hours
Loading Time = 720 hours

$$Set\ up\ \&\ Adjustment\ Losess = \frac{15\ jam}{720\ jam}\ x\ 100\% = 2{,}08\%$$

Using the same calculation method, the Equipment Failure/Setup and Adjustment Losses for the period of May 2024 – April 2025 can be seen in the table below.

Tabel 6. Set up and Adjustment Losses Pompa Sentrifugal pada Periode Mei 2024 - April 2025

Bulan	***Total Set up* (Jam)**	***Loading Time* (Jam)**	***Set up & Adjusment time* (%)**
May-24	15	720	2,08%
Jun-24	10	717	1,39%
Jul-24	16	741	2,16%
Aug-24	18	696	2,59%

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Sep-24	10	741	1,35%
Oct-24	11	717	1,53%
Nov-24	16	720	2,22%
Dec-24	15	717	2,09%
Jan-25	17	741	2,29%
Feb-25	15	648	2,31%
Mar-25	12	741	1,62%
Apr-25	15	717	2,09%

Source: Pengolahan Data

Speed Losses

To determine the magnitude of effectiveness loss due to idling & minor stoppages, the following formula is used:

$$Idling\ \&\ Minor\ Stoppages\ Losess = \frac{Nonproductive\ time}{Loading\ time}\ x\ 100\%$$

Using the formula above, the Idling and Minor Stoppages Losses for the Centrifugal Pump in May 2024 can be calculated as follows:

Nonproductive Time = Breakdown + Setup + Planned Downtime

Nonproductive Time = 22 + 15 + 24 = 61 hours

Loading Time = 720 hours

$$Idling\ \&\ Minor\ Stoppages\ Losess = \frac{61\ jam}{720\ jam}\ x\ 100\% = 8{,}47\%$$

Using the same method, the Idling & Minor Stoppages Losses for the period of May 2024 – April 2025 can be seen in tabel below

Tabel 7. Idling & Minor Stoppages Losses Pompa Sentrifugal pada periode Mei 2024-April 2025

Bulan	***Total Break Time* (Jam)**	***Total Set up* (Jam)**	***Total Waktu Planned Maintenance* (Jam)**	***Nonproductive Time* (Jam)**	***Loading Time* (Jam)**	***Idling & minor stoppages (%)***
May-24	22	15	24	61	720	8,47%
Jun-24	30	10	3	43	717	6,00%
Jul-24	22	16	3	41	741	5,53%
Aug-24	23	18	24	65	696	9,34%
Sep-24	25	10	3	38	741	5,13%
Oct-24	40	11	3	54	717	7,53%
Nov-24	25	16	24	65	720	9,03%
Dec-24	24	15	3	42	717	5,86%
Jan-25	26	17	3	46	741	6,21%
Feb-25	19	15	24	58	648	8,95%
Mar-25	26	12	3	41	741	5,53%
Apr-25	25	15	3	43	717	6,00%

Source: Pengolahan Data

From the table, it can be seen that the highest percentage of idling & minor stoppages losses occurred in August 2024 at 9.34%, while the lowest occurred in July 2024 and March 2025 at 5.53%.

Reduce speed Loss

To determine the percentage of Reduced Speed Losses, the following formula is used:

$$Reduced\ Speed = \frac{Operation\ time - (Ideal\ cycle\ x\ Processed\ amount)}{Loading\ time}\ x\ 100\%$$

Using the formula above, the Reduced Speed Losses for the Centrifugal Pump in May 2024 can be calculated as follows:

Ideal Cycle Time = 0.04 hours/ton

Processed Amount = 15,815 tons

Operating Time = 683 hours

Loading Time = 720 hours

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$$Reduced\ Speed\ = \frac{683\ Jam - \left(0{,}04\frac{Jam}{Ton} x\ 15815\ Ton\right)}{720\ Jam}\ x\ 100\% = 7{,}0\%$$

Using the same calculation method, the Reduced Speed Losses for the period of May 2024 – April 2025 can be seen in tabel below:

Tabel 8. Reduced Speed Losses Pompa Sentrifugal pada periode Mei 2024-April 2025

Bulan	***Operation Time* (Jam)**	***Loading Time* (Jam)**	***Idle Cycle Time* (Jam/ton)**	***Total Product Processed* (Ton)**	***Reduced Speed Losses* (%)**
May-24	683	720	0.04	15815	7,00%
Jun-24	677	717	0.04	15308	9,02%
Jul-24	703	741	0.04	15820	9,47%
Aug-24	655	696	0.04	15312	6,11%
Sep-24	706	741	0.04	15818	9,89%
Oct-24	666	717	0.04	15309	7,48%
Nov-24	679	720	0.04	15815	6,44%
Dec-24	678	717	0.04	15308	9,16%
Jan-25	698	741	0.04	15820	8,80%
Feb-25	614	648	0.04	14289	6,55%
Mar-25	703	741	0.04	15817	9,49%
Apr-25	687	717	0.04	15310	10,40%

Source: Pengolahan Data

From the table, it can be seen that the highest percentage of reduced speed losses occurred in April 2025 at 10.40%, while the lowest occurred in August 2024 at 6.11%.

Defect Losse

To determine the percentage of the rework losses factor that affects the effectiveness of machine utilization, the value of Rework Losses is calculated using the following

$$Rework\ Losess\ = \frac{Ideal\ cycle\ x\ Rework}{Loading\ time}\ x\ 100\%$$

Thus, the Rework Losses for the Centrifugal Pump in May 2024 can be calculated as follows:
Ideal Cycle Time = 0.04 hours/ton

Loading Time = 720 hours

$$Rework\ Losess\ = \frac{0{,}04\frac{Jam}{Ton}\ x\ 5\ Ton}{720\ Jam}\ x\ 100\% = 0{,}03\%$$

Using the same calculation method, the Rework Losses for the period of May 2024 – April 2025 can be seenin tabel below:

Tabel 9. *Rework Losses* Pompa Sentrifugal Periode Mei 2024-April 2025

Bulan	***Total Defect Amount* (Ton)**	***Loading Time* (Jam)**	***Idle Cycle Time* (Jam/ton)**	***Rework Losses* (%)**
May-24	5	720	0,04	0,03%
Jun-24	8	717	0,04	0,04%
Jul-24	10	741	0,04	0,05%
Aug-24	12	696	0,04	0,07%
Sep-24	8	741	0,04	0,04%

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Oct-24	9	717	0,04	0,05%
Nov-24	5	720	0,04	0,03%
Dec-24	8	717	0,04	0,04%
Jan-25	10	741	0,04	0,05%
Feb-25	9	648	0,04	0,06%
Mar-25	7	741	0,04	0,04%
Apr-25	10	717	0,04	0,06%

From the table, it can be observed that the highest percentage of rework losses occurred in August 2024 at 0.07%, while the lowest percentages were recorded in May and November 2024 at 0.03%.

To determine the percentage of the yield/scrap losses factor that affects machine utilization effectiveness, the following formula is used:

$$YS = \frac{Ideal\ cycle\ x\ Reject}{Loading\ time}\ x\ 100\%$$

Thus, the yield/scrap losses of the Centrifugal Pump for May 2024 can be calculated as follows:
Ideal Cycle Time = 0.04 hours/ton
Loading Time = 720 hours
Reject = 0 tons
Yield/Scrap Losses:

Reject = 0 tons
Loss = (Reject × Ideal Cycle Time) / Loading Time × 100% = 0%

$$YS = \frac{0{,}04\ \frac{Jam}{Ton}\ x\ 0\ Ton}{720\ Jam}\ x\ 100\%$$

Using the same calculation method, the Yield/Scrap Losses for the period of May 2024 – April 2025 were 0%.

5. ANALYSIS AND EVALUATION

a. Analysis of Overall Equipment Effectiveness (OEE) Calculations
The OEE measurement of the centrifugal pump is based on three factors: availability, performance efficiency, and rate of quality product during operation. The magnitude of each factor's contribution to the final OEE value is displayed in:

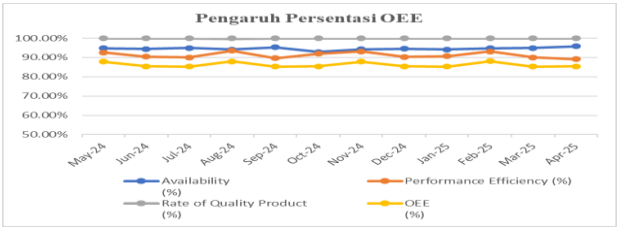

Figure 1. Influence of Availability Percentage, Performance

Efficiency, and Rate of Quality Product on the OEE Value of the Centrifugal Pump
Source: Data Processing

b. Analysis of the Six Big Losses Calculation
Through the analysis of the Six Big Losses calculation, we can better understand the factors affecting the effectiveness of the centrifugal pump. Therefore, a time loss calculation is carried out for each factor within the Six Big Losses, as shown in the calculation results in the following table:

Table10. Six Big Losses Factors Percentage for the Centrifugal Pump (Period: May 2024 April 2025)

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No	Six Big Losses	Total Time (Jam)	Persentasi (%)	Persentasi Kumulatif (%)
1	Breakdown Losses (%)	461	5,42%	65,07%
2	Set up & Adjusment time (%)	199	2,34%	23,74%
3	Idling & minor stoppages Losses (%)	592	6,96%	83,58%
4	Reduced Speed Losses (%)	707	8,32%	99,82%
5	Rework Losses (%)	4	0,05%	0,56%
6	Yield/ Scrap Losses (%)	0	0,00%	0,00%

Source: Data Processing

c. Fishbone Diagram Analysis

Fishbone Diagram

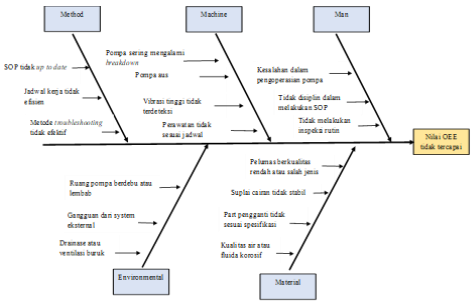

Figure 2. Cause and Effect Diagram

Based on the fishbone diagram analysis, the main factors that significantly affect the low OEE value of the centrifugal pump can be identified, as well as the evaluations that need to be made to minimize the OEE value below the JIPM standard.

d. Evaluation

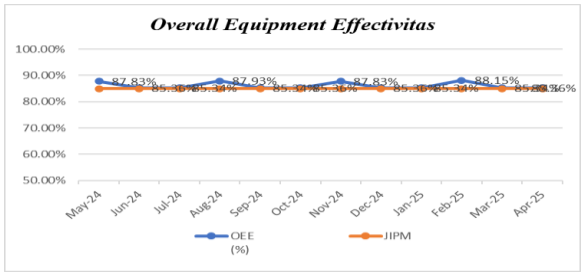

Figure 3 : OEE Percentage Value of the Centrifugal Pump (Period: May 2024 – April 2025)

From the graph above, we can observe that the standard OEE value set by JIPM (Japan Institute of Plant Maintenance) is 85%. Comparing this global OEE standard with the OEE value of the Centrifugal Pump at PT. Permata Hijau Group, the values in September 2024, November 2024, January 2025, and March 2025 are relatively below the JIPM standard, with the lowest value recorded in March at 75.49%. The only month with an OEE value exceeding the JIPM standard was August 2024, with a value of 92.68%.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Based on the analysis results and evaluation of the Overall Equipment Effectiveness (OEE) measurement of the Centrifugal Pump at PT. Permata Hijau Group, the following conclusions can be drawn:

1. Based on the OEE measurement results using the Overall Equipment Effectiveness (OEE) method, the OEE value of the centrifugal pump over a one-year period (May 2024 – April 2025) was above the JIPM standard of 85%, with the highest value recorded in February 2025 at 88.15% and the lowest values recorded in July 2024, September 2024, January 2025, and March 2025 at 85.34%.
2. From the calculation of the six big losses factors influencing the low OEE value of the centrifugal pump, the highest to lowest percentages are:

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- Reduced Speed Losses: 8.32%
- Idling and Minor Stoppages: 6.96%
- Breakdown Losses: 5.42%
- Setup and Adjustment Losses: 2.34%
- Rework Time Losses: 0.05%

3. From the fishbone diagram, it can be concluded that the lack of scheduled preventive maintenance is a major contributing factor to the high breakdown time in the hydrogenation division of PT. Permata Hijau Group.

6.2 Recommendation

The following recommendations are provided from this research as considerations for the company to improve equipment effectiveness, particularly for the centrifugal pump:

1. The maintenance team, production team, and warehouse team should collaborate in decision-making to provide a minimum stock of spare parts. This would help reduce setup time during spare part searches and minimize unplanned maintenance occurrences.
2. There is a need to schedule preventive maintenance on a daily, weekly, or monthly basis. This helps reduce equipment breakdown time.

Implementation of lean awareness is essential among the production and maintenance teams to create a work culture that is attentive and loyal to the job and the company

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