

Literature Review: Overall Equipment Effectiveness in Electric Power Generation Systems in Indonesia

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ABSTRACT

This study investigates the effectiveness of Total Productive Maintenance (TPM) implementation in Indonesian power generation companies using Overall Equipment Effectiveness (OEE) as an evaluative tool. The research focuses on power plants that have adopted TPM in maintenance operations. OEE values were calculated using standard formulas for Availability, Performance, and Quality, and analyzed based on the impact of the six big losses. Results show that only 25% of power plants achieved world-class OEE standards, while 67% remain in the normal category. Performance efficiency emerged as the dominant factor affecting OEE (60%), followed by quality (30%) and availability (10%). These findings indicate that TPM has not been optimally implemented, especially in minimizing performance-related losses.

INTRODUCTION

Maintenance management is a critical component of a company's operations. Its primary objectives include: (1) extending the lifespan of production facilities; (2) optimizing the availability of production equipment; (3) ensuring the operational readiness of all company assets, especially during emergencies; (4) safeguarding operator health and safety, as well as equipment integrity; (5) enabling production machines to fulfill their intended functions effectively; (6) reducing excessive usage and inventory storage while preserving capital investment over a specified period according to company policy; (7) conducting maintenance activities efficiently to minimize costs; and (8) fostering strong collaboration between maintenance and other core company functions to achieve organizational goals.

To ensure these objectives are met, companies must periodically evaluate the performance of their maintenance management systems across all production units. This evaluation is essential to assess effectiveness and initiate corrective actions when necessary. Accurate and reliable tools are required to perform such assessments. Among the most widely used methods are Reliability Centered Maintenance (RCM) and Overall Equipment Effectiveness (OEE).

The RCM method is a systematic approach to determine the most appropriate maintenance actions needed to ensure physical assets continue to perform their intended functions. RCM is based on the principle that every asset has a specific role, and maintenance should be tailored to preserve that role. Its key objectives include: (1) designing systems with high maintainability; (2) gathering feedback to improve inadequate initial designs; (3) restoring equipment reliability and safety after degradation from prolonged use; and (4) achieving all these goals at the lowest possible cost (Muhammad et al., 2013).

Recent advancements in maintenance practices have transformed traditional maintenance strategies within the industrial sector. One such approach gaining traction is Total Productive Maintenance (TPM), which introduces an innovative, team-based strategy involving both maintenance personnel and machine operators. TPM aims to eliminate equipment breakdowns and defects through a collaborative effort. It is a comprehensive methodology that emphasizes quality and productivity improvement by engaging employees at all levels, treating them as integral parts of the maintenance investment. Full support from both top management and employees is critical to the success of TPM implementation.

Within the TPM framework, the Overall Equipment Effectiveness (OEE) method has emerged as a powerful tool for evaluating maintenance performance. OEE provides a single metric that reflects the overall condition and productivity of equipment, making it one of the most widely used indicators in manufacturing. It quantifies the percentage of time that equipment is producing quality products, thus serving as a barometer for capital asset utilization. Additionally, OEE helps identify and categorize equipment-related losses, offering actionable insights for continuous improvement. By clarifying loss sources, OEE aligns improvement efforts with organizational performance goals and significantly enhances productivity (Agustiady & Cudney, 2016).

Based on the above considerations, this study aims to review the application of the Overall Equipment Effectiveness (OEE) method in evaluating the maintenance performance of electric power generation system equipment in Indonesia.

This study was conducted due to the limited availability of studies that comprehensively assess the effectiveness of TPM implementation and map standard equipment effectiveness in power plants in Indonesia. In addition, the novelty of this study lies in its examination of the factors contributing to the decline in Overall Equipment Effectiveness (OEE) values.

LITERATURE REVIEW

Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a key component of quality management systems aimed at increasing productivity by investing in proactive and preventive maintenance to minimize production losses. If your work is quantitative, please provide previous research that agrees or rejects your proposed hypothesis.

The Six Big Losses

In maintenance management, six major categories of losses are commonly associated with production equipment performance. These include (Agustiady & Cudney, 2016):

- (1) Breakdowns – unplanned stoppages that exceed acceptable time limits due to equipment failure.
- (2) Setup and Adjustments – downtime related to equipment changeovers, initial setups, or fine-tuning.
- (3) Idling – periods of inactivity caused by loading/unloading processes or external factors beyond the operator's control.
- (4) Minor Stoppages – brief interruptions (typically under five minutes) caused by small equipment malfunctions or material jams.
- (5) Quality Defects – losses due to producing defective products that do not meet quality standards.
- (6) Rework – time and effort required to reprocess or repair defective items.

These six losses significantly impact production performance. Specifically, breakdowns and setup/adjustments reduce equipment availability and the operational readiness of the production system. Idling and minor stoppages affect the performance efficiency of equipment and reduce the operating rate. Meanwhile, quality defects and rework lead to a decline in the quality rate, ultimately lowering the overall product quality. Implementing TPM is considered an effective approach to systematically address and minimize these losses.

TPM Implementation Steps

The implementation of Total Productive Maintenance (TPM) in maintenance management involves a structured 12-step process designed to

ensure that all departments and personnel carry out their specific roles effectively.

The steps for implementing TPM can be outlined as follows(Baety et al., 2019):

- (1) Disseminate top management's decision and commitment to the TPM program.
- (2) Conduct education and training sessions on TPM principles and practices.
- (3) Design the TPM organizational structure.
- (4) Establish TPM policies and set measurable objectives.
- (5) Develop a master plan for TPM implementation and development.
- (6) Launch and execute the TPM program.
- (7) Improve the effectiveness of machines and equipment.
- (8) Develop an Autonomous Maintenance program.
- (9) Establish a Preventive Maintenance program.
- (10) Provide ongoing training to enhance the skills of operators and technicians.
- (11) Develop an initial Maintenance Management program.
- (12) Fully integrate TPM across all operational areas.

Implementing TPM through a disciplined and well-structured process significantly enhances the effectiveness of maintenance management and contributes to overall organizational performance.

TPM Pillars

The principles of Total Productive Maintenance (TPM) are commonly represented as a house supported by nine foundational pillars. These pillars form the core components that sustain and reinforce TPM practices throughout the organization. Each pillar addresses a critical aspect of equipment management and continuous improvement(Agustiady & Cudney, 2016; Baety et al., 2019).

- (1) 5S,
The implementation of comprehensive and systematic workplace organization and maintenance practices. Derived from Japanese terms—Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain)—5S serves as the foundational step for establishing a clean, safe, and efficient work environment.
- (2) Education and Training,
Focuses on providing essential knowledge, appropriate teaching methods, and mechanisms to ensure that this knowledge is effectively understood and applied. This pillar aims to confirm and continuously improve operator competence and technical skills.
- (3) Focused (Targeted) Improvement
Involves the systematic identification and elimination of equipment or process issues that are unexpected or have been difficult to address in the past. This pillar promotes cross-functional teamwork to improve equipment reliability and reduce chronic losses.
- (4) Planned Maintenance

Involves structured maintenance planning to identify root causes of equipment failures and implement preventive measures. The goal is to transition from reactive to proactive maintenance strategies, thereby improving equipment availability and reliability.

- (5) **Autonomous Maintenance**
Encourages operators to take ownership of their equipment by performing routine inspections, cleaning, lubrication, and early detection of abnormalities. This pillar builds operator responsibility and helps prevent equipment deterioration.
- (6) **Quality Maintenance**
Aims to enhance product quality by continuously monitoring and improving production processes. Teams investigate root causes of quality defects and make necessary process modifications to ensure stable and defect-free output.
- (7) **Safety, Health, and Environment (SHE)**
Emphasizes the importance of a safe and healthy working environment. This includes regular training in risk assessment, safety procedures, and environmental practices to prevent accidents and ensure regulatory compliance.
- (8) **Administrative and Office TPM**
Extends TPM principles to administrative functions. This pillar addresses inefficiencies such as incorrect or missing spare parts, poor-quality materials, miscommunication, and other issues that indirectly impact production efficiency.
- (9) **Maintenance Prevention**
Focuses on designing equipment and systems with built-in maintainability and reliability. This proactive approach involves collecting feedback from maintenance activities and using it to inform design improvements, ensuring that future equipment is easier to maintain and less prone to failure.

Overall Equipment Effectiveness (OEE)

OEE is a widely used metric for evaluating equipment performance and accurately assessing its operational effectiveness. The primary purpose of OEE is to analyze various input data and provide detailed insights into the manufacturing process. This information is then used to assess the current state of operations and serve as a foundation for identifying the root causes of production-related issues (Supriyadi et al., 2017).

Beyond root cause identification, OEE also provides valuable data on the impact of equipment-related losses. By categorizing these losses clearly, OEE enables management teams to prioritize and target appropriate improvement activities. As such, OEE has a significant influence on overall productivity by helping to systematically reduce inefficiencies (Agustiady & Cudney, 2016).

OEE is considered one of the most suitable tools for evaluating the effectiveness of TPM (Total Productive Maintenance) implementation, as it directly supports the goal of maintaining equipment in optimal condition by

addressing the Six Big Losses. The OEE metric is derived from the product of three key performance factors: Availability, Performance, and Quality (Agustiady & Cudney, 2016; Supriyadi et al., 2017).

Availability

Availability is a comparison of the utilization of available time for a machine or equipment operation activities. Availability is formulated by the following equation.

$$Availability = \frac{Operation\ time}{Loading\ time} = \frac{Loading\ time - Downtime}{Loading\ time} \quad (1)$$

Loading time, refers to the total available time per day or month, also known as the planned operating time.

Downtime, is the period during which the equipment is not operational, often due to breakdowns or scheduled maintenance.

Operating time, represents the actual duration the equipment is running and performing its intended function.

Performance

Performance is a ratio that reflects the capability of equipment to produce output at its maximum potential under given conditions. It is calculated using the following formula:

$$Performance = \frac{Processed\ amount \times Ideal\ cycle\ time}{Operation\ time} \quad (2)$$

Ideal cycles time (ideal cycles time)

Processed amount (number of products processed)

Operation time (machine operating time)

Quality ratio

Quality ratio is a ratio that describes the ability of the equipment to produce goods according to established standards.

$$Quality\ ratio = \frac{Processed\ amount - Defect\ amount}{Processed\ amount} \quad (3)$$

Processed amount (number of products processed)

Defect amount (number of products that do not meet standards/defects)

OEE is formulated based on the three ratios above, so that it can be formulated as follows.

$$OEE = Availability \times Performance \times Quality \quad (4)$$

The target OEE level in TPM is rarely set at 100%, as achieving this would imply no allowance for planned maintenance and could potentially result in overproduction. A commonly accepted benchmark for world-class OEE performance is approximately 85%. However, depending on the specific processes and operational goals of a company, a target OEE level of around 50% may still be considered acceptable under certain conditions (Agustiady & Cudney, 2016).

METHODOLOGY

In this study, a literature review was conducted on the Overall Equipment Effectiveness (OEE) values of electrical power generation system equipment in Indonesia. The objective was to examine the repair and maintenance (M&R) methods applied and assess their impact on both OEE values and the Six Big Losses associated with power generation equipment.

Figure 1 presents the schematic of the research, illustrating the application of M&R methods and the effectiveness standards achieved by the studied objects. These effectiveness standards are evaluated based on the following criteria (Agustiady & Cudney, 2016).

OEE = 100% has perfect production criteria: good quality production, fast and without any downtime.

OEE = 85% of the world-class standard criteria to be long term goals.

OEE = 60% of the general criteria for the condition of manufacturing companies in the world. And there is considerable for improvement.

OEE = 40% is a very low value. Needs improvement by tracking and addressing the source of the cause

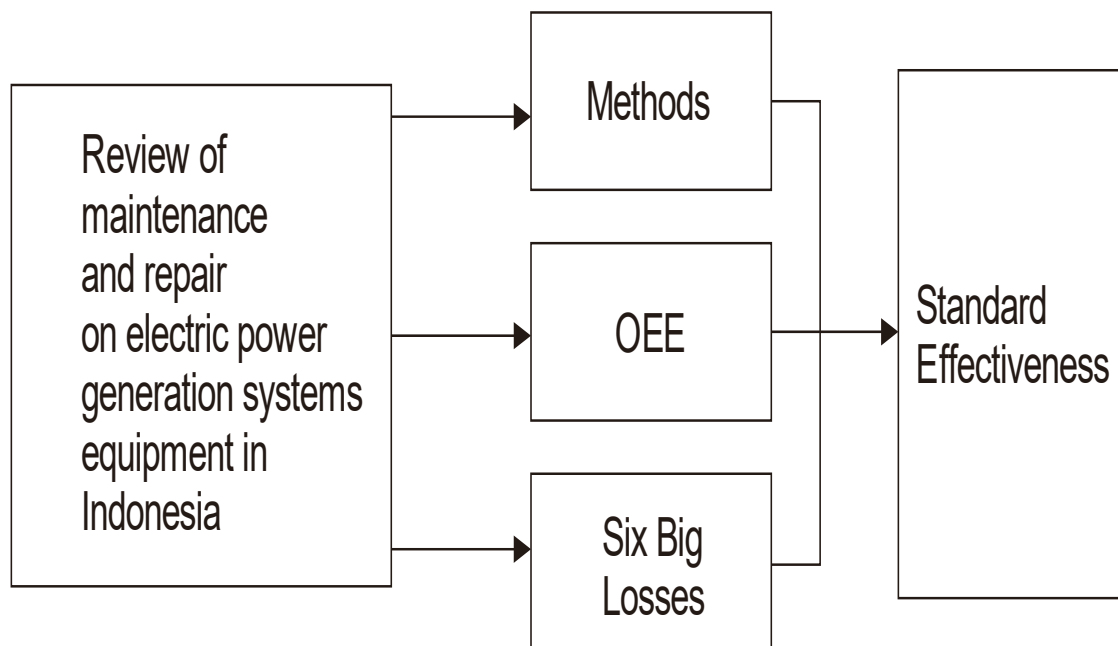


Figure 1. Research Schematic

This study aims to assess the effectiveness of maintenance at twelve power plants in Indonesia by comparing their Overall Equipment Effectiveness (OEE) values against established standards. The study also seeks to identify the key contributing factors affecting the decline of OEE, with a particular focus on determining the most significant causes of performance decline.

This study was conducted at several power plants that have implemented the TPM method in the maintenance and repair of power generation equipment. The impact of the six big losses influences the values of Availability, Performance, and Quality ratios, which are used to calculate Overall Equipment Effectiveness (OEE), as shown in Formulas (1), (2), (3), and (4). This study also identifies the contributing factors and their respective percentages in relation to the decline in OEE values.

Equipment effectiveness standards are defined based on OEE values, with classification criteria determined by OEE percentage thresholds, as shown in Table 1.

Table 1. Standard effectiveness

OEE	Standar effectiveness
100%	Perfect
85% to less than 100%	World Class
60% to less than 85%	Normal
40% to less than 60%	Very Low

RESEARCH RESULT AND DISCUSSION

The implementation of Total Productive Maintenance (TPM) has been adopted by many companies in Indonesia; however, this study specifically focuses on the application of TPM in the field of electric power generation equipment. A total of twelve power plant units were reviewed, based on findings from several previous studies.

1. PT PJB – PLTU Paiton Unit IX
2. Diesel Power Plant (PLTD) in Central Salawati District
3. PT Dizamatra Powerindo (Sibayak Geothermal Power Plant)
4. PT PLN (Persero) – Haruku Rayon
5. PT PLN (Persero) – ULPLTD Bagan Besar (PLTD Bengkalis)
6. PLTG Tanjung Datuk – Pekanbaru
7. PLTGU – PT Krakatau Daya Listrik
8. PT Star Energy Geothermal Wayang Windu Ltd
9. Waste Heat Recovery Power Generation (WHRPG) in a cement plant
10. PLTG Tanjung Datuk (second unit reviewed)
11. PT Indonesia Power – Suralaya Generation Unit
12. PT Mitra Energi Batamating.

Measurement and Analysis of Overall Equipment Effectiveness in Indonesia's Power Generation Sector

OEE evaluation related to the implementation of TPM at PT Pembangkitan Jawa Bali, PLTU Paiton Unit IX, was conducted by Riza Virdian et al. (2014), focusing on the coal feeder machine as the object of evaluation. The coal feeder was chosen because it is a frequent source of issues at PLTU Paiton Unit IX. This machine regulates the flow of coal into the pulverizer. The purpose of the study was to provide an overview and identify the challenges and benefits of the maintenance system in order to offer recommendations or evaluations regarding the maintenance and repair mechanisms of machinery and equipment through the implementation of TPM. Data was collected over one year (January–December 2014), with the lowest OEE recorded at 77.07%, the highest at 84.38%, and an annual average of 80.2%. The six big losses identified were: reduced speed loss (48.41%), breakdown loss (17.63%), idling and minor stoppages (15.01%), setup and adjustment loss (9.07%), rework loss (5.11%), and scrap/yield loss (4.73%). (Riza et al., 2014)

Amri & Malakabu, (2017) conducted OEE research at the PLTD Unit in the Salawati Tengah District, focusing on diesel generator engines and low-voltage distribution networks. The research was motivated by ineffective maintenance systems and high operational costs, especially fuel expenses. Routine and periodic maintenance systems were found to be ineffective, as maintenance actions were only taken after complaints from consumers. This reactive approach hindered the anticipation and prevention of disruptions. The objective was to measure the effectiveness of the maintenance system using the OEE method and to estimate PLN's operational costs, particularly fuel consumption for 24-hour operation. Data collection took place over one year (January–December 2014), using both primary and secondary data. The average OEE value was 92.4%, with availability at 97.2%, performance efficiency at 95%, and quality rate at 100%.

Sutrisno, (2015) analyzed the OEE of turbine engines and generator unit 1 at the Sibayak geothermal power plant (PLTP), focusing on the main building equipment. The study was driven by significant downtime in electricity production at PT Dizamatra Powerindo. This downtime affected productivity and output levels. The goal was to determine the OEE of the Unit I engine as a reference for improvement strategies. Data collection spanned six months (November 2013–April 2014), resulting in OEE values ranging from 31.31% to 60.19%, with an average of 49.54%. The largest contributors to losses were reduced speed loss (72.93%) and breakdown loss (17.82%).

Tupan et al., (2018) assessed OEE and six big losses at PT PLN (Persero) Rayon Haruku by analyzing operational data after installing a maintenance reminder device. The study aimed to address the low power reserve margin between installed capacity and peak demand, which posed a risk to supply continuity. Maintenance activities at the site were poorly monitored, often delayed or neglected, as evidenced by the frequency of disruptions. The study aimed to measure OEE and six big losses after the installation of the maintenance reminder system. Data was collected over one year (January–December 2016), including production (kWh), working hours, and machine delay data. The OEE

ranged from 91.49% to 96.50%, with an annual average of 94.3%. The six big losses were: equipment failure (2.39%), setup and adjustment (22.63%), idling and minor stoppages (15.28%), reduced speed loss (22.15%), defect loss (2.67%), and scrap/yield loss (4.12%).

Hafiz & Martianis, (2019) examined OEE at the Bengkalis PLTD, focusing on Caterpillar Type 3512B engines, which are the primary power suppliers. The plant operates 19 main engines: 15 Caterpillars, 2 Yamnar, and 2 KHD engines, supplemented by rental units. The research emphasized the importance of effective maintenance management to ensure uninterrupted power distribution on Bengkalis Island. The objective was to evaluate the OEE of 15 Caterpillar units as an indicator of maintenance efficiency. Data was collected over four months (December 2018–March 2019). The OEE ranged from 0% to 75%, with an average of 52%.

Nurjaman et al., (2018) studied OEE at the PLTG Tanjung Datuk in Pekanbaru, focusing on gas turbine generators. The research responded to increasing electricity demand and the need for reliable generation. The objective was to evaluate generator performance using OEE, MTF, and MTTR. Data collection lasted one month (April 2017), yielding OEE values from 61.99% to 66.99%, with an average of 63.98%. This result indicated performance below world-class standards. Six big losses were recorded as follows: reduced speed loss (56.64%), yield/scrap loss (82.88%), idling and minor stoppages (100%), setup and adjustment (100%), equipment failure (100%), and defect/rework losses (100%).

Kurniawan et al., (2020) evaluated the OEE of the main seawater pump at PLTGU PT Krakatau Power Electric. The goal was to identify potential improvements in the seawater pumping system to increase reliability. Weekly data collection was conducted every Wednesday from March to April 2020. The OEE was found to be 75.15%, with availability at 90.25%, performance efficiency at 79.80%, and a quality rate of 100%. The six big losses included: idle and minor stoppages (54.85%), reduced speed loss (17.1%), and minimal setup/adjustment losses (0.08%).

Muhsin & Pratama, (2018) analyzed the effectiveness of the cooling tower at PT Star Energy Geothermal Wayang Windu Ltd. using the OEE approach. Data was collected over a full 24-hour period. The study recorded an availability rate of 90.13%, performance rate of 88.50%, quality rate above 92.75%, and OEE exceeding 86%.

Nugrahadi & Adi, (2021) conducted an OEE assessment at a Waste Heat Recovery Power Generation (WHRPG) facility in a cement factory, comparing performance before and after TPM implementation. The aim was to evaluate improvement following TPM adoption. The OEE after implementation was 78.96%, with availability at 92.18%, performance at 95.23%, and quality at 89.95%.

Razak Tuara et al., (2018) analyzed a gas turbine engine at PLTG Tanjung Datuk, Riau, using OEE as a TPM tool to enhance machine effectiveness. The six big losses were: reduced speed loss (69.26%), yield/scrap loss (19.01%), idling and minor stoppages (11.72%), while setup, equipment failure, and rework losses were 0%. The OEE value was 66.89%

Sahrupi & Juriantoro, (2018) evaluated the OEE of Transfer Conveyor 17A, which distributes coal from the unloading area to the power plant bunker at PT Indonesia Power, Suralaya. The aim was to propose improvements based on the lowest among the three OEE components. The calculated OEE was 82.98%, with availability at 86.76%, performance at 98.09%, and quality at 97.50%

Suhendriko & Sirait, (2020) aimed to improve the effectiveness of gas turbine generators at PT Mitra Batam Energy using the OEE approach. The six big losses were: equipment failure (17.09%), setup and adjustment (0.48%), idling and minor stoppages (18.13%), reduced speed (48.60%), rework (0.00%), and scrap losses (15.08%). The overall OEE was 83.49%, with low performance efficiency identified as the major limiting factor

The results of the OEE review on TPM implementation in various power plants are summarized in Table 2

Table 2. OEE Summary for Selected Power Plants

No	Power Generation	Meth od	Availibi lity	Performa nce Efficiency	Rate of quali ty	OEE Avera ge (%)	Standard Efektive ness
1	PLTU Paiton Unit IX,	TPM				80,2	Normal
2	PLTD Salawati Tengah,	TPM	97,2	95	100	92,4	World Class
3	PLTP Sibayak	TPM	82,11- 95,53	57,23- 65,02	95,16- 99,30	49,54	Low
4	PLN Rayon Haruku	TPM	99,44- 100	97,64- 98,66	93,83- 96,50	94,3	World Class
5	PLTD Bengkalis,	TPM				52	Normal
6	PLTG Tangjung Datuk	TPM	91,54	83,88	83,33	63,98	Normal
7	PLTGU PT. Krakatau Daya Listrik	TPM	90,25	79,8	100	75,15	Normal
8	PT Star Energy Geothermal	TPM	90,13	88,5	92,75	>86	World Class

Wayang Windu Ltd							
9	Waste Heat Recovery Power Generation (WHRPG) pabrik semen	TPM	92,18	95,23	89,95	78,96	Normal
10	PLTG Tangjung Datuk	TPM	90,22	82,74	89,66	66,89	Normal
11	PT Indonesia Power Unit Pembangkitan Suralaya.	TPM	86,76	98,09	97,5	82,98	Normal
12	PT. Mitra Energi Batam	TPM	97,11	88,67	97,08	83,49	Normal

Among the twelve power plants reviewed, only three have an OEE value above 85%, indicating effectiveness at a world-class standard. Meanwhile, eight power plants fall within the reasonable or acceptable effectiveness category, and one plant still records a low OEE value, indicating poor effectiveness. As illustrated in Figure 2, only 25% of the power generation systems are classified as world-class, while 67% fall into the normal or fair category.

Table 4. Percentage of Standard Effectiveness

No.	Power Generation	Standard Efektiveness	%
1	PLTD Salawati Tengah,	World Class	25%
2	PLN Rayon Haruku	World Class	
3	PT Star Energy Geothermal Wayang Windu Ltd	World Class	
4	PLTU Paiton Unit IX,	Normal	67%
5	PLTD Bengkalis,	Normal	
6	PLTG Tangjung Datuk	Normal	
7	PLTGU PT. Krakatau Daya Listrik	Normal	

8	Waste Heat Recovery Power Generation (WHRPG) pabrik semen	Normal	
9	PLTG Tangjung Datuk	Normal	
10	PT Indonesia Power Unit Pembangkitan Suralaya.	Normal	
11	PT. Mitra Energi Batam	Normal	
12	PLTP Sibayak	Low	8%
		Total	100%

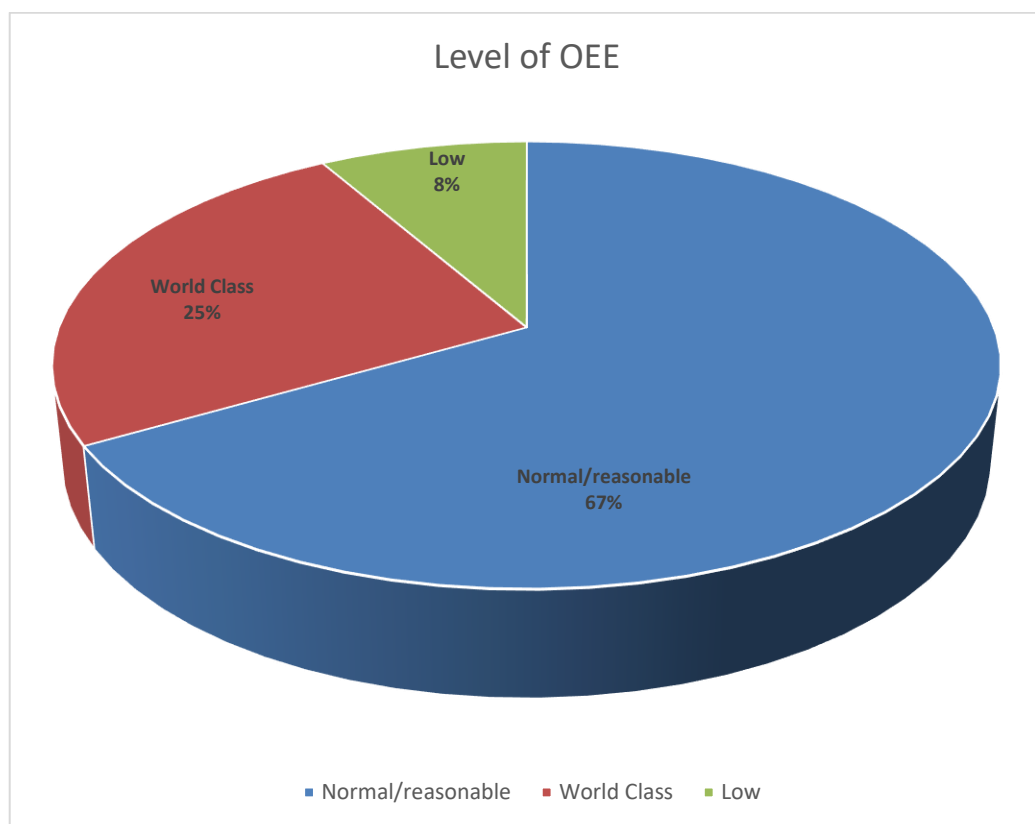


Figure 2. Level of OEE

Three key factors that influence the OEE value are availability, performance efficiency, and quality rate. Based on the results from twelve power plants, it is possible to identify which variables have the greatest impact on OEE performance. To determine the factors contributing to low OEE values, the percentages of availability, performance efficiency, and quality rate were analyzed.

Table 5. Factors affecting the decline of OEE

No.	Power Generation	Availibility	Performance Efficiency	Rate of quality
1	PLTU Paiton Unit IX,	Undefine	Undefine	Undefine
2	PLTD Salawati Tengah,	97,2	95	✓ 100
3	PLTP Sibayak	82,11- 95,53	57,23- 65,02	✓ 95,16- 99,30
4	PLN Rayon Haruku	99,44-100	97,64- 98,66	93,83- 96,50 ✓
5	PLTD Bengkalis,	Undefine	Undefine	Undefine
6	PLTG Tangjung Datuk	91,54	83,88	83,33 ✓
7	PLTGU PT. Krakatau Daya Listrik	90,25	79,8	✓ 100
8	PT Star Energy Geothermal Wayang Windu Ltd	90,13	88,5	✓ 92,75
9	Waste Heat Recovery Power Generation (WHRPG) pabrik semen	92,18	95,23	89,95 ✓
10	PLTG Tangjung Datuk	90,22	82,74	✓ 89,66
11	PT Indonesia Power Unit Pembangkitan Suralaya.	86,76	✓ 98,09	97,5
12	PT. Mitra Energi Batam	97,11	88,67	✓ 97,08
		1	6	3
Factors affecting the decline of OEE		10%	60%	30%

The results of the analysis are presented in Table 4. It shows that the main factor contributing the decline of OEE is performance efficiency (60%), followed by quality ratios (30%) and availability (10%).

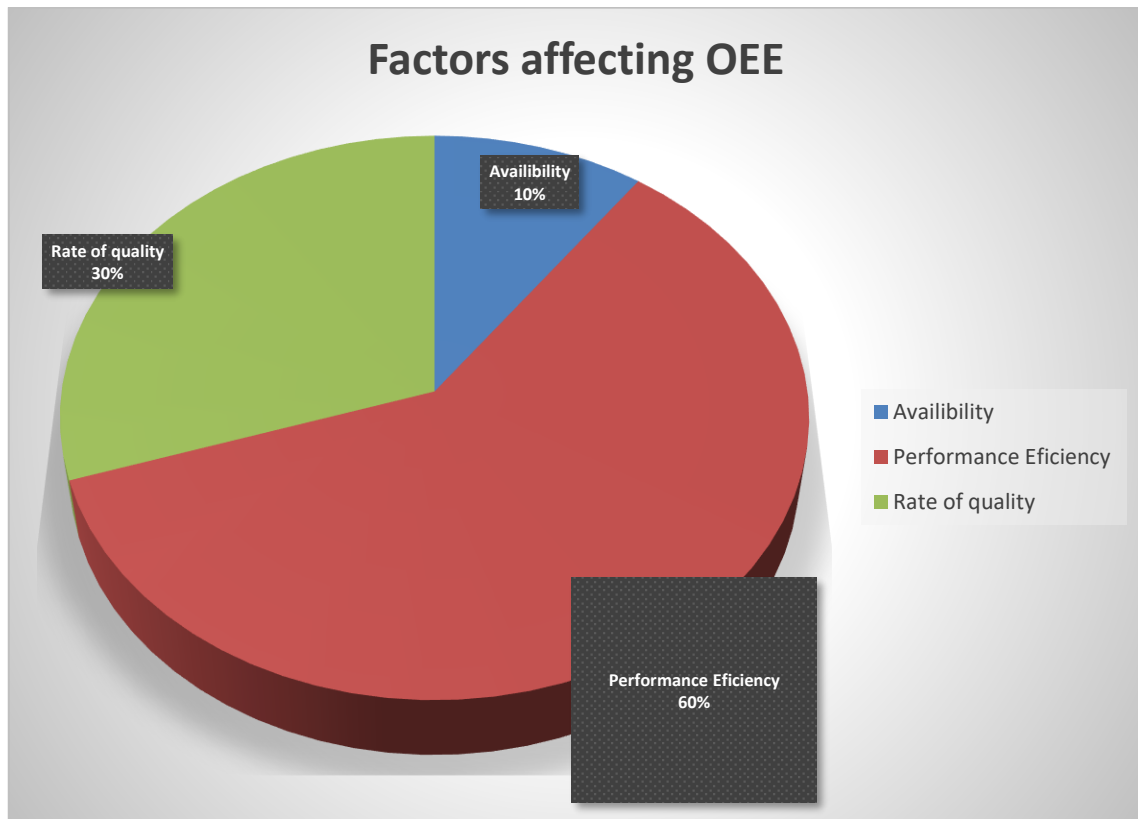


Figure 3. Factors affecting OEE

Based on the OEE values observed in this study, the implementation of Total Productive Maintenance (TPM) should be a primary focus of maintenance management in power plants – especially those supplying electricity to PT PLN (Persero), which has a vision of delivering world-class service.

Several studies did not provide a detailed calculation of the reduction in the six big losses, despite the fact that reducing these losses is one of the key benefits of TPM implementation. A decrease in the six big losses serves as an important indicator of successful TPM implementation. The OEE value, along with the six big losses, can be used as a reference to identify components that require improvement, ultimately enhancing the effectiveness of maintenance management.

The use of task reminder tools for workers or operators within maintenance systems can also help improve the effectiveness of maintenance activities. TPM is one of the strategic approaches that can be adopted to increase overall operational efficiency within a company.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the analysis, it can be concluded that only 25% of the power plants in Indonesia have achieved an OEE value at the world-class level, while the majority (67%) are within the normal or acceptable range. The most significant factor affecting the OEE value is performance efficiency, accounting for 60%, followed by quality rate at 30%, and availability at 10%.

These findings indicate that the six big losses have not been effectively minimized, particularly those related to performance efficiency, such as reduced speed loss and idling/minor stoppages. OEE proves to be a reliable tool for evaluating the implementation of Total Productive Maintenance (TPM) in maintenance management. The wide variation in OEE values across power plants suggests that maintenance practices need to be improved to achieve higher effectiveness.

TPM has the potential to reduce the six big losses and serves as a foundation for identifying and addressing areas requiring performance improvement. It is a highly appropriate method for enhancing maintenance management in power plants, with its success relying heavily on the full participation of all employees within the organization.

Recommendations: That power plants adopt more precise performance monitoring systems to identify and address reduced speed losses and frequent minor stoppages. Empowering operators to carry out basic maintenance tasks can minimize downtime and enhance equipment performance. Should benchmark with higher-performing plants to learn and adopt effective maintenance practices and TPM initiatives.

ADVANCED RESEARCH

Studies on OEE in power generation companies in Indonesia remain scarce, primarily due to the limited access granted by companies for conducting OEE evaluations. However, this research can be further developed by creating a predictive model for equipment failures in power plants, using historical OEE data and trends in the six big losses through machine learning algorithms. Another potential development is the design of an OEE-based decision support system that assists power plant management in prioritizing maintenance actions through real-time analysis of availability, performance, and quality.

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