Formosa Journal of Multidisciplinary Research (FJMR)
Vol. 3, No. 9, 2024: 3363-3376

Analysis of Maintenance Management at PT.XYZ Power Plant (With MTTR, MTTF, and Availability Factors) and Development of Performance Improvement Program

Dida Nurdiansyah[1]*, Agustinus Hariadi D.P[2]
Mercubuana University
Corresponding Author: Dida Nurdiansyah nurdiansyahdida0@gmail.com

ARTICLEINFO

Keywords: MTTF, MTTR, Availibility, Pareto Diagram, Preventive Maintenance, Autonomous Maintenance

Received: 16, August
Revised: 30, August
Accepted: 25, September

ABSTRACT

Damage data for machinery at PT. XYZ power plant between October-December 2023 shows that the pump is the component with the highest number of failures, recording 28 incidents (33.7% of the total 83 failures), followed by the condenser with 27 incidents (32.5%). The combined failures of these two components account for 66.3% of the total failures, indicating a need for focused improvements on the pump and condenser. The MTTR analysis for the pump shows a high average repair time: 7.7 hours in October, 7 hours in November, and 7.7 hours in December, with low availability rates (89.64%-89.69%). The MTTF for the pump varies from 65.2 to 75.4 hours, indicating the need for improved preventive maintenance strategies. It is recommended that maintenance be carried out every 2-3 days or at least once a week. The condenser has an MTTR ranging from 6.7 to 7.7 hours and low availability (88.89%-89.95%), with MTTF varying from 66.7 to 92.7 hours. The high MTTR and low availability of these two components highlight the need for improvements in maintenance management to enhance performance.

DOI: https://doi.org/10.55927/fjmr.v3i9.11137
ISSN-E: 2829-8896
https://journal.formosapublisher.org/index.php/fjmr

INTRODUCTION

To improve human well-being, energy is a crucial factor. Electrical energy is one of the necessities that can no longer be separated from human life today. Electrical energy has been widely used for household needs, commercial purposes, government institutions, industries, and more. Therefore, providing reliable, stable, high-quality, and efficient energy is essential to ensure the country's economic growth.

PT. XYZ is a company that operates a steam power plant using coal as the primary fuel. PT. XYZ is one of the companies involved in the effort to provide electrical energy in a safe and efficient manner. Errors and negligence in the maintenance of the system in the power plant can occur, which may lead to damage to the system and equipment, potentially resulting in losses for PT. XYZ.

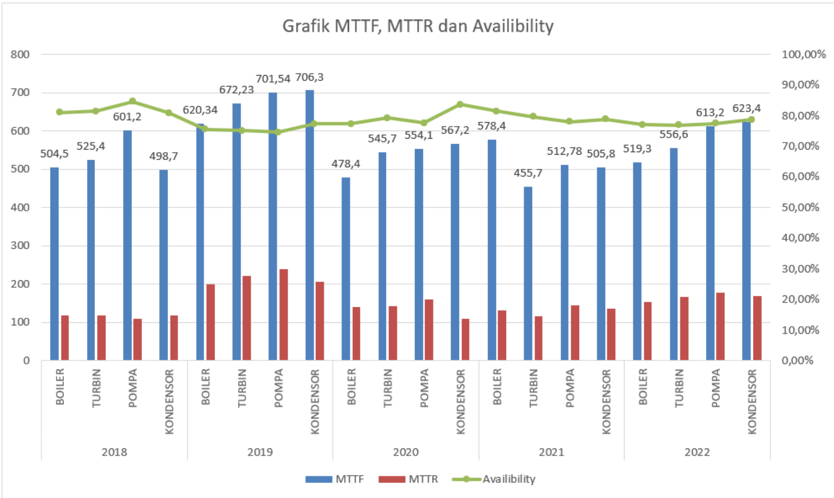

Figure 1. Availability Graph for 2018-2022

Source: Internal Processed Data, 2018-2022

Figure 1 shows that the availability value at PT. XYZ from the period 2018-2022 has consistently been below 90%. This indicates that there are still many machine failures at PT. XYZ and that the maintenance program is not yet optimal.

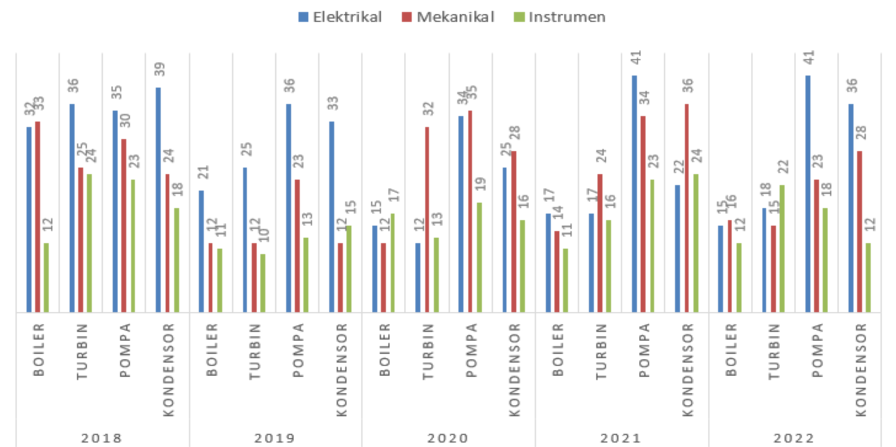

Figure 2. Damage Data by Cluster

Source: Internal Processed Data, 2018-2022

Figure 2 represents the damage data based on failure clusters. During 2018-2022, the clusters with the highest number of failures were primarily the Electrical, Mechanical, and Instrument clusters, which contributed the most to the failure records at PT. XYZ.

LITERATURE REVIEW

Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a productive maintenance system carried out by all employees through small group activities. TPM is also a company-wide equipment maintenance approach.

According to Nakajima (1998), the goal of TPM is to achieve optimal performance by reaching zero loss, which means no defects, breakdowns, or waste in the production process or during changeovers.

According to Corder (1992), maintenance consists of various actions taken by a company to keep goods in working order or to restore them to an acceptable condition. Maintenance actions performed by the maintenance department usually involve tasks that do not add value when repairing machines or performing other repairs.

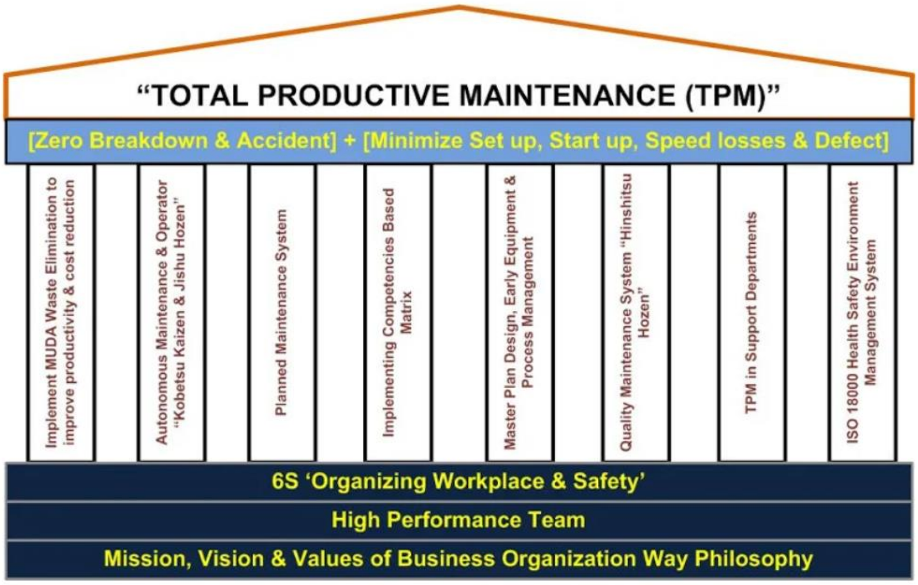

Figure 3. Eight Main Pillars of Total Productive Maintenance
Source: bestmanufacturing.blogspot.com

Definition of Maintenance

According to Matthew (2010), maintenance can be defined as all actions necessary to keep a system and all its components in working condition. All maintenance programs should aim to maintain the system's capability while controlling costs.

In "Operational Management Strategies and Analysis," Deitiana (2011) states that "maintenance involves all activities to ensure that existing systems operate as intended and also to control costs for both prevention and repair if failures occur."

Types of Maintenance:

The types of maintenance include predictive, preventive, corrective, and emergency maintenance.

a) Predictive Maintenance

Predictive maintenance is performed by predicting the condition of electrical equipment, determining whether it is in good condition or not, and estimating when the equipment is likely to fail. By predicting these conditions, early signs of damage can be detected. This is typically done by monitoring the condition online, whether the equipment is operating or not. Specialized equipment and personnel are required for analysis. This type of maintenance is known as Condition-Based Maintenance.

b) Preventive Maintenance

Preventive maintenance activities are aimed at preventing unexpected damage and identifying conditions that could cause production facilities to fail during the production process, thereby preventing a decrease in the function of equipment and facilities. Preventive maintenance is divided into:
Routine Maintenance
Periodic Maintenance

c) Corrective Maintenance

Corrective maintenance involves planned activities such as replacing non-functioning components. Repair maintenance can include unforeseen repairs found during inspections, simultaneous component replacements, and planned overhauls (comprehensive repairs).

d) Emergency/Unplanned Maintenance

Emergency maintenance refers to unplanned maintenance due to the lack of a maintenance plan or schedule for equipment and production facilities. This type of maintenance, also known as breakdown maintenance or emergency maintenance, is defined as maintenance that needs to be carried out to prevent severe consequences such as major equipment damage, loss of production, and safety hazards.

Elements of Performance Maintenance Measurement

In the context of Performance Maintenance, there are several key elements used to measure and evaluate the performance of equipment and systems. Here is a brief explanation of each measurement element:

Mean Time to Failure (MTTF)

MTTF measures the average time required before a component, equipment, or system experiences a failure. It is an important indicator for understanding how reliable a piece of equipment is over a certain period. The higher the MTTF, the more reliable the equipment is.

MTTF is calculated by dividing the total operating time by the number of failures that occur during that period.

$$\text{Mean Time to Failure (MTTF)} = \frac{\text{Total Operation Time}}{\text{Number Of Failures}} \quad \ldots\ldots\ldots1)$$

Mean Time to Repair (MTTR)

MTTR is the average time required to repair a component or system after it has experienced a failure. MTTR is an indicator of efficiency in addressing failures. The lower the MTTR, the faster a system can be restored after a failure, thereby reducing downtime.

MTTR is calculated by dividing the total downtime by the number of failures that occur during that period.

$$\text{Mean Time To Repair (MTTR)} = \frac{\text{Total Repair Time}}{\text{Number Of Failures}} \ldots\ldots..2)$$

Availability

Availability measures how ready a system or equipment is to be used when needed. It is the ratio of the time the system or equipment is operating correctly (uptime) to the total desired time or total time (uptime plus downtime). Availability can be calculated using the following formula:

$$\text{Availability} = \left(\frac{\text{Total Actual Operation Time}}{\text{Total Loading Time}}\right) \text{X}100\% \ldots\ldots3)$$

The Pareto Diagram

Heizer and Render (2014:255) describe the Pareto Diagram (Pareto Analysis) as a method for managing errors, problems, or defects to help focus efforts on problem-solving. This diagram is based on the work of Vilfredo Pareto, a 19th-century economist. Joseph M. Juran popularized Pareto's work by stating that 80% of a company's problems are the result of only 20% of the causes.

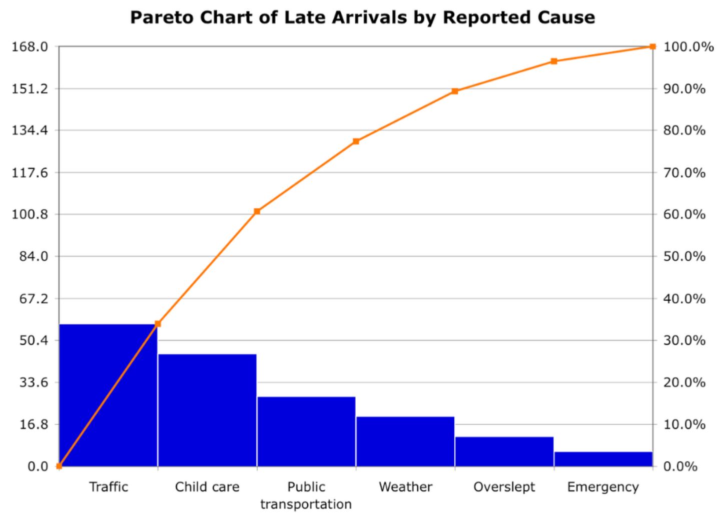

Figure 4. (Example) Pareto Diagram

METHODOLOGY

The methodology used in analyzing the failure and maintenance performance of the pump and condenser at PT. XYZ's power plant involve several key steps and tools in maintenance management and reliability engineering. Here's a breakdown of potential methodologies used:

Data Source: Historical failure records from the plant's maintenance logs, monitoring systems, and incident reports between October and December 2023.

Data Classification: Failures were categorized by component (e.g., pump, condenser) and recorded for frequency, allowing for the identification of critical components with the most significant failure rates.

The methodology used in this analysis likely included failure data collection, MTTR and MTTF calculations, availability analysis, and the application of preventive maintenance strategies. Advanced techniques like Pareto analysis and possibly RCM might have been employed to prioritize critical equipment and optimize maintenance plans for the pump and condenser.

RESEARCH RESULT

The research was conducted at PT. XYZ, a coal-fired steam power plant. The research period was from January 2023 to December 2023. The total population consisted of 83 instances of equipment failure (Boiler, Turbine, Pump, and Condenser), and the sample consisted of 55 instances of failure (Pump and Condenser), analyzed using the Pareto diagram.

Table 1. Pump Failure Data

Number	Date	Operating Time (Hours)	Down Time (Hours)	Total of Failures	Start Repair	Finish Repair	Component of Failures	Type Defect	Description
1	05/10/2023	12	12	1	09.00	21.00	Valve Drain	Process	Material spillage during initial pump start
2	08/10/2023	17	7	1	13.00	20.00	Valve Drain	Process	Material spillage during initial pump start
3	11/10/2023	12	12	1	11.10	23.10	Acid-Base Tank	Process	Dirt from treatment
4	15/10/2023	16	8	1	02.15	10.15	Acid-Base Tank	Process	Steam from treatment process
5	18/10/2023	19	5	1	05.30	10.30	Alum Tank	Process	Alum spillage during alum filling
6	21/10/2023	18	6	1	08.15	14.15	Valve Drain Sample	Process	Material spillage during sample collection
7	25/10/2023	21	3	1	13.10	16.10	Valve Drain Sample	Process	Material spillage during sample collection
8	29/10/2023	17	7	1	04.10	11.10	Mechanical Seal Cooler	Process	Cooling water spillage from crude pump mechseal
9	30/10/2023	19	10	1	02.35	12.35	Packing HE 1st	Process	Alkaline material spillage
10	03/11/2023	19	5	1	09.00	14.00	Waterseal Tank	Process	Water spillage from vacuum luber
11	06/11/2023	18	8	1	01.45	09.45	Vacuum Pump Exhaust	Process	Water spillage from vacuum output during start
12	09/11/2023	17	7	1	06.00	13.00	Valve Drain Sample	Process	Material spillage during sample collection
13	12/11/2023	10	14	1	01.00	15.00	Cover	External	Rainwater spillage
14	15/11/2023	18	6	1	08.30	14.30	Valve Drain Washing 2nd	Process	Water spillage during 2nd washing
15	17/11/2023	21	3	1	09.00	12.00	Valve Drain Washing 3rd	Process	Water spillage during 3rd washing
16	19/11/2023	18	6	1	07.10	13.10	Valve Drain Washing 1st	Process	Water spillage during 1st washing
17	25/11/2023	18	6	1	13.40	19.40	Valve Drain Exhaust 2nd	Process	Condensation water spillage
18	26/11/2023	17	7	1	15.00	22.00	Valve Drain Exhaust 1st	Process	Condensation water spillage
19	28/11/2023	16	8	1	13.15	21.15	Leachate Tank	Process	Material splash from tank
20	01/12/2023	18	8	1	11.00	19.00	Valve Drain	Process	Material splash from drain valve of acid or alkaline filter
21	04/12/2023	17	7	1	16.10	23.10	Filter Press Area Floor	Process	Dirt spillage from acid or alkaline filter during sludging process
22	07/12/2023	0	24	1	01.00	13.00	Output Pipe	Process	Salt material spillage
23	13/12/2023	18	6	1	11.35	17.35	Valve Drain	Process	Salt decanter material spillage
24	19/12/2023	16	8	1	15.30	23.30	Salt Well	Process	Material spillage during salt pouring activity
25	26/12/2023	18	6	1	08.20	14.20	Water Pipe	Process	Water spillage from water line of the water pump
26	29/12/2023	19	5	1	06.30	11.30	Caustic Pipe	Process	Caustic material spillage during pouring
27	30/12/2023	22	2	1	07.40	09.40	Grille	Process	Cooling tower water splash from damaged grating
28	31/12/2023	20	4	1	09.45	13.45	Valve Drain	Process	Material spillage from fiber tank drain valve
TOTAL		471	210	28					

Table 1. data on pump failures at PT. XYZ during the three-month period from October to December 2023 shows a total of 28 cases of failure. The total downtime caused by these failures amounted to 210 hours.

Table 2. Condensers Failure Data

Number	Date	Operating Time (Hours)	Down Time (Hours)	Total of Failures	Start Repair	Finish Repair	Component of Failures	Type Defect	Description
1	01/10/2023	17	7	1	01.35	08.35	Pipe Drain Valve	Maintenance	Oil material spillage during sample collection
2	03/10/2023	20	4	1	13.45	17.45	HSL Static Tank	Process	Presence of foam deposits on the tank surface
3	06/10/2023	18	6	1	09.25	15.25	Oil PHE	Maintenance	Oil and steam water spillage from damaged PHE
4	08/10/2023	17	7	1	08.20	15.20	Sample Collection Valve	Process	Spillage observed during each sample collection
5	09/10/2023	20	4	1	10.10	14.10	Old Reactor Pump	Process	Water spillage from pump gland packing cooler
6	13/10/2023	17	7	1	21.30	04.30	Sample Collection Valve	Process	Neat soap spillage during each sample collection
7	19/10/2023	20	4	1	07.35	11.35	New Reactor Pump	Process	Water spillage from pump mechanical seal cooler
8	24/10/2023	16	8	1	04.35	12.35	HE Flashcooler	Maintenance	PHE leakage causing material to spill out of the PHE
9	28/10/2023	10	14	1	19.30	09.30	P103 Pump	Process	Water spillage from pump mechanical seal cooler
10	29/10/2023	18	6	1	07.35	13.35	Lye Static Tank	Process	Foam deposits inside the tank resulting from hot lye separation in the separator
11	04/11/2023	0	24	1	17.50	17.50	Separator Tank	Maintenance	Clogging inside the separator tank
12	05/11/2023	19	5	1	13.15	18.15	P104 Pump	Process	Water spillage from pump mechanical seal cooler
13	11/11/2023	17	7	1	15.05	22.05	Static Tank	Process	Oil seepage on the W column
14	16/11/2023	18	6	1	12.48	18.48	Static Tank	Maintenance	Spillage from the corroded bottom of the tank
15	21/11/2023	18	6	1	10.32	16.32	Adjusting Valve	Maintenance	Damaged adjuster valve condition, with missing O-rings in the groove
16	26/11/2023	8	16	1	21.24	13.24	Centrifuge Exhaust Chimney	Process	Soap dust mixed with lye escaping from the centrifuge exhaust chimney
17	27/11/2023	16	8	1	10.25	18.25	Lye Line Drain Valve	Process	Oil spillage when the drain valve is opened inside the centrifuge
18	03/12/2023	4	20	1	01.25	21.25	Sample Collection Valve	Process	Spillage observed during each sample collection
19	04/12/2023	18	6	1	17.09	23.09	Centrifuge Body	Maintenance	Oil spillage from the centrifuge body due to a damaged locking bolt
20	05/12/2023	15	9	1	13.15	22.15	Centrifuge O-ring	Maintenance	NS and lye spillage when the centrifuge O-ring is damaged
21	11/12/2023	17	7	1	11.10	18.10	Hose Connection Clamp	Maintenance	NS and lye leakage from the gap in the hose connection claim
22	16/12/2023	19	5	1	08.50	13.50	Sample Collection Valve	Process	Neat soap spillage observed during each sample collection
23	20/12/2023	18	6	1	09.12	15.12	Oil Drain Valve	Process	Oil spillage during the pipeline flushing process
24	22/12/2023	21	3	1	13.32	16.32	Additive Drain Valve	Process	Aditive solution spillage during the pipeline flushing process
25	23/12/2023	21	3	1	10.35	13.35	Furnace	Process	Lye foam deposits overflow from K5 and K6
26	26/12/2023	17	7	1	18.50	01.50	Main Dust Collector 1	External	Dust from the damaged main dust collector 1
27	29/12/2023	16	8	1	14.30	22.30	Main Dust Collector 1	External	Dust escaping from the main filling pipe connection 1 from machines D2 and D3
TOTAL		435	213	27					

In Table 2. data on condenser failures at PT. XYZ during the three-month period from October to December 2023 shows a total of 27 cases of failure. The total downtime caused by these failures amounted to 213 hours.

Table 3. Boiler Failure Data

Number	Date	Operating Time (Hours)	Down Time (Hours)	Total of Failures	Start Repair	Finish Repair	Component of Failures	Type Defect	Description
1	02/10/2023	19	5	1	11.35	16.35	Furnace Heater	Process	Water leakage from tank heater
2	03/10/2023	20	4	1	13.45	17.45	Speed Pump	Process	Cooling water spillage from pump speed
3	06/10/2023	18	6	1	09.25	15.25	Feed Tank	Process	Splash during sample collection
4	08/10/2023	17	7	1	08.20	15.20	Process Pipe	Process	Steam splash from sloop
5	09/10/2023	20	4	1	10.10	14.10	VLS Pump	Process	Cooling water spillage from pump
6	13/10/2023	17	7	1	21.30	04.30	VLS Steam Exhaust Chimney	Process	Water spillage from VLS condensation steam
7	04/11/2023	20	4	1	07.35	11.35	HE Waterseal Vacuum	Process	Condensation water spillage from cooling HE
8	05/11/2023	20	4	1	04.35	08.35	Ploder Conveyor	Process	Chip spillage from conveyor
9	11/11/2023	10	14	1	19.30	09.30	Rotary Storage Silo	Process	Dust from blower exhaust
10	16/11/2023	18	6	1	07.35	13.35	D3 Blower	Process	Condensation water spillage from chiller radiator pipe
11	21/11/2023	0	24	1	17.50	17.50	CT Grating	Process	Water spillage from CT grating
12	26/11/2023	19	5	1	13.15	18.15	Tank Sloop Mainhole	Process	Soap spillage from tank mainhole during pipeline flushing activity
13	27/11/2023	17	7	1	15.05	22.05	Main Dust Collector 1	Process	Dust from dust collector
14	03/12/2023	19	5	1	12.48	17.48	Main Rotary 1	Process	Dust from main blower exhaust 1
15	13/12/2023	18	6	1	10.32	16.32	Dust Collector 2	Process	Dust from dust collector
16	19/12/2023	8	16	1	21.24	13.24	Main Rotary 2	Process	Dust from main blower exhaust 2
17	26/12/2023	16	8	1	10.25	18.25	Main Rotary 3	Process	Dust from main blower exhaust 3
18	29/12/2023	4	20	1	01.25	21.25	Dust Collector 3	Process	Dust from dust collector
TOTAL		280	152	18					

Table 3. data on boiler failures at PT. XYZ during the three-month period from October to December 2023 shows a total of 18 cases of failure. The total downtime caused by these failures amounted to 152 hours.

Table 4. Boiler Failure Data

Number	Date	Operating Time (Hours)	Down Time (Hours)	Total of Failures	Start Repair	Finish Repair	Component of Failures	Type Defect	Description
1	02/10/2023	20	4	1	11.05	15.05	Bearing	Process	Damaged bearing
2	03/10/2023	20	4	1	07.20	11.20	Turbine blade erosion	Process	Turbine blades eroded
3	06/10/2023	18	6	1	09.25	15.25	Shaft damage	Process	Turbine shaft damaged
4	08/10/2023	17	7	1	08.20	15.20	Cracked turbine blades	Process	Cracks in turbine blades
5	09/10/2023	20	4	1	10.10	14.10	Turbine sealing damage	Process	Turbine sealing damaged
6	13/10/2023	17	7	1	21.30	04.30	Corrosion	Process	Turbine corroded
7	04/11/2023	20	4	1	07.35	11.35	Overheating	Process	Overheating occurred
8	05/11/2023	20	4	1	04.35	08.35	Control system failure	Process	Control system failure
9	11/12/2023	17	7	1	12.45	19.45	Misalignment	Process	Misalignment occurred
10	16/12/2023	18	6	1	07.35	13.35	Lubrication system failure	Process	Poor lubrication system
TOTAL		187	53	10					

In Table 4. data on boiler failures at PT. XYZ during the three-month period from October to December 2023 shows a total of 10 cases of failure. The total downtime caused by these failures amounted to 53 hours.

Table 5. Data on Machine Failures for October-December 2023

Number	Machine	October-December 2023	%	% Accumulative
1	Pump	28	33,7%	33,7%
2	Condensor	27	32,5%	66,3%
3	Boiler	18	21,7%	88,0%
4	Turbin	10	12,0%	100,0%

From the data on failures occurring from October to December 2023, a total of 83 failures were recorded, with 28 failures in pumps, 27 in condensers, 18 in boilers, and 10 in turbines.

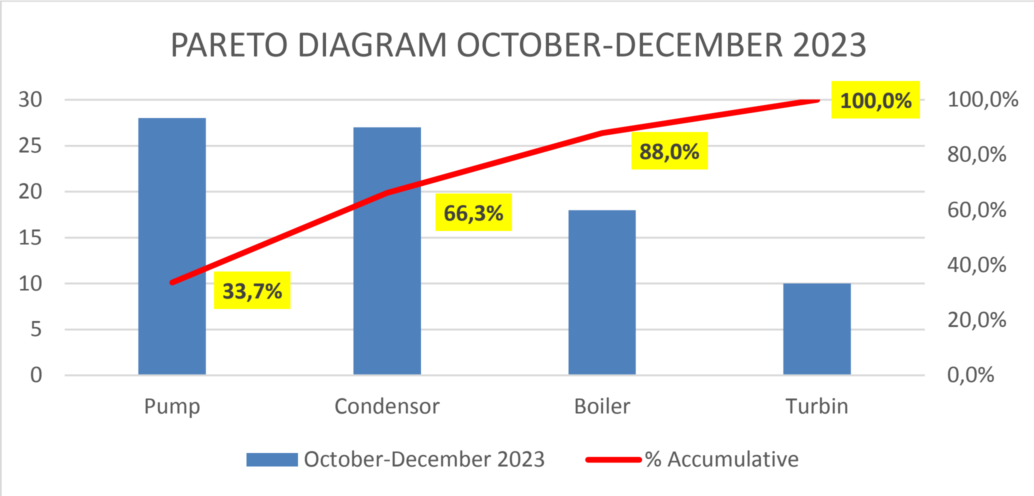

Figure 5. Pareto Diagram of Failure Research for Each Machine

In Figure 5, the Pareto Chart of machine failures for the period October-December 2023 shows that Pumps had 28 failure incidents, accounting for 33.7% of the total failures, making it the machine with the highest failure rate during this period. Condensers ranked second with 27 failure incidents, contributing 32.5% of the total, so together, these two machines account for 66.3% of the total failures. Boilers ranked third with 18 failure incidents, or 21.7% of the total, bringing the cumulative percentage of failures to 88.0% when combined with Pumps and Condensers. Lastly, Turbines had 10 failure incidents, contributing 12.0% of the total, resulting in an overall cumulative total of 100%.

Table 6. Calculation of Pump Preventive Maintenance Schedule

Period	MTTF	*Preventive Maintenance*
October 2023	75,4 Hours	75,4 Hours/24 Hours = 3,14 Days
November 2023	65,2 Hours	65,2 Hours/24 Hours = 2,71 Days
December 2023	75,1 Hours	75,1 Hours/24 Hours = 3,12 Days

From Table 6. Calculation of Pump Preventive Maintenance Schedule, the results indicate that the pumps should be maintained every 2-3 days or at least once a week to ensure optimal performance of the pump.

Tabel 7. MTTR and *Availibility* Pump

Period	MTTR	*Availibility*
October 2023	7,7 Hours	89,69%
November 2023	7,0 Hours	89,26%
December 2023	7,7 Hours	89,64%

In December 2023, the MTTR (Mean Time To Repair) was 7.7 hours, with an Availability of 89.64%. Additionally, Table 4.7 MTTR and Availability of Pumps shows that the MTTR values are still higher than expected: 7.7 hours in October 2023, 7 hours in November 2023, and 7.7 hours in December 2023. Furthermore, the Availability rates are also identified as still low, at 89.69% in October 2023, 89.26% in November 2023, and 89.64% in December 2023.

Table 8. Calculation of Condensor Preventive Maintenance Schedule

Periode	MTTF	*Preventive Maintenance*
October 2023	66,7 Hours	66,7 Hours /24 Hours = 2,78 Hari
November 2023	92,7 Hours	92,7 Hours /24 Hours = 3,86 Hari
December 2023	67 Hours	67 Hours /24 Hours = 2,79 Hari

From Table 8 Calculation of Condenser Preventive Maintenance Schedule, the results indicate that the condensers should be maintained every 2-3 days or at least once a week to ensure optimal performance.

Tabel 9. MTTR dan *Availibility* Kondensor

Periode	MTTR	*Availibility*
October 2023	6,7 Hours	89,95%
November 2023	7 Hours	88,89%
December 2023	7,7 Hours	88,95%

In Table 9. MTTR and Availability of Condensers, it was found that the MTTR (Mean Time To Repair) values are still higher than expected, with 6.7 hours in October 2023, 7 hours in November 2023, and 7.7 hours in December 2023. Additionally, the Availability rates are identified as still low, at 89.95% in October 2023, 88.89% in November 2023, and 88.95% in December 2023.

Based on the analysis of MTTF, MTTR, and Availability for pumps and condensers, to ensure the availability of pumps and condensers at PT. XYZ, the following is the scheduled maintenance plan for Pumps and Condensers at PT. XYZ.

Table 10. Updated Maintenance Schedule Plan for Pumps and Condensor

Number	Job Activity	Week 1							Week 2							Week 3							Week 4									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Pump																															
2	Condensers																															

DISCUSSION

From the total of 83 failures and malfunctions, the Pareto Chart of machine failures for the period October-December 2023 shows that Pumps had 28 failure incidents, accounting for 33.7% of the total failures, making it the machine with the highest failure rate during this period. Condensers ranked second with 27 failure incidents, contributing 32.5% of the total, so together, these two machines account for 66.3% of the total failures.

For Pumps from October to December 2023, the MTTF (Mean Time To Failure) values are 75.4 hours in October, 65.2 hours in November, and 75.1 hours in December. Since PT. XYZ operates 24 hours a day, the preventive maintenance schedule for Pumps is every 2-3 days or at least once a week to maintain optimal performance.

In terms of MTTR (Mean Time To Repair) and Availability for Pumps, it was found that the MTTR values are still higher than expected: 7.7 hours in October 2023, 7 hours in November 2023, and 7.7 hours in December 2023. Additionally, the Availability rates are identified as still low, at 89.69% in October 2023, 89.26% in November 2023, and 89.64% in December 2023.

For Condensers from October to December 2023, the MTTF values are 66.7 hours in October, 92.7 hours in November, and 67 hours in December. The preventive maintenance schedule for Condensers is also every 2-3 days or at least once a week to maintain optimal performance.

Regarding MTTR and Availability for Condensers, it was found that the MTTR values are still higher than expected: 6.7 hours in October 2023, 7 hours in November 2023, and 7.7 hours in December 2023. Additionally, the Availability rates are identified as still low, at 89.95% in October 2023, 88.89% in November 2023, and 88.95% in December 2023.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Current machine maintenance activities at PT. XYZ involve breakdown maintenance, which includes replacing machine components only after the machine has failed. This results in low machine availability and disrupts the production process.
2. It was found that the application of equipment maintenance has not been effective, as seen during the 3-month period (October 2023, November 2023, and December 2023). Several factors contribute to the suboptimal machine maintenance activities at PT. XYZ, including a lack of understanding of machine maintenance, minimal awareness of maintenance, and the absence of regular maintenance practices.
3. An effective maintenance planning method to optimize Steam Power Plant (PLTU) machines at PT. XYZ is an integrated, data-driven approach that includes preventive maintenance and autonomous maintenance. Preventive maintenance for pumps and condensers should be performed weekly, alongside autonomous maintenance.

Recommendations

A comparative study on the implementation of autonomous maintenance could serve as an intriguing research foundation to compare the effectiveness of this approach across different industrial contexts. The study could focus on comparing companies that implement autonomous maintenance with those using traditional methods or various maintenance strategies. Key components that affect the success of implementation include corporate culture, management commitment, operator involvement, and the technological infrastructure used.

The study could also investigate how these differences impact operational efficiency, maintenance costs, and equipment performance. Such a comparative study could provide valuable insights to the industry as they select the maintenance strategy best suited to their needs and conditions.

ADVANCED RESEARCH

Conduct long-term research to evaluate the impact of autonomous maintenance and other maintenance strategies over an extended period. This can provide insights into the long-term success and sustainability of various maintenance strategies.

Investigate the qualitative aspects of autonomous maintenance implementation, such as corporate culture and management commitment, through more detailed case studies. This can help to better understand how these factors influence the success of the implementation.

ACKNOWLEDGMENT

I would like to extend my heartfelt thanks to my family, parents, and classmates from the MM UMB Regular 1 program at Menteng Campus for their unwavering support throughout this research. Your encouragement, patience, and belief in my work have been invaluable. I am deeply grateful for the sacrifices you have made and the motivation you have provided. Your support has been crucial in overcoming challenges and achieving this milestone. Thank you for being a constant source of strength and inspiration. Your contributions have played a significant role in the success of this research.

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