Analysis of Factors Causing Downtime on Drum Coolers at PT X

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ABSTRACT

This study aims to explore the various factors causing downtime in the Cooler Drum machine at PT X and identify the main factors contributing to the machine's reliability. The method used was a descriptive quantitative approach, collecting data through field observations, interviews with technicians, and downtime logs. The data were analyzed using Failure Mode and Effect Analysis (FMEA), Fishbone Diagrams, and Pareto Diagrams to identify the root causes of failures. The findings of this study indicate that Plant NPK 2 performed the lowest, with 85.74 hours of downtime, an MTBF of 866.48 hours, and an MTTR of 12.24 hours. Meanwhile, Plant NPK 4 performed the best, with only 4.16 hours of downtime, an MTBF of 2465.39 hours, and an MTTR of 1.39 hours. Based on the Pareto analysis, approximately 75% of the total downtime was caused by four main factors: bearing damage, chain drum impact, rubber inlet leaks, and trunion shaft fractures. The FMEA analysis showed that the fluid coupling and shaft trunion had the highest RPN values (144 and 90), indicating a significant risk of failure. The Fishbone Diagram results indicated that machine factors and maintenance methods were the most important causes, followed by human, material, and environmental factors. Recommended improvements include optimizing preventive and predictive maintenance, improving operator discipline, ensuring the availability of critical spare parts, and controlling the work environment to reduce failure rates and improve operational continuity. This study confirms that implementing an effective maintenance program has a direct impact on reducing downtime and increasing company productivity.

Keywords: preventive maintenance, MTBF, MTTR, FMEA, fishbone diagram, and cooler drum downtime.

1. INTRODUCTION

The fertilizer industry plays a crucial role in supporting national food security, as the availability of high-quality fertilizer directly impacts agricultural productivity. PT X, producing compound fertilizer (NPK) under the Mahkota Fertilizer brand. To maintain product quality and achieve production targets, the continuity and reliability of the production process are crucial.

One of the key units in the NPK production process is the Cooler Drum, which functions to lower the temperature of the fertilizer granules after the drying stage. Proper cooling ensures that the granules do not clump, remain firm, and are easily packaged according to required standards. However, in actual production, the Cooler Drum frequently experiences downtime due to various mechanical and operational issues, disrupting the overall production flow

According to company data, the Cooler Drum units at Plants NPK 2, NPK 3, and NPK 4 experience varying downtime frequencies, ranging from frequent occurrences at NPK 2 to occasional occurrences at NPK 4. Repeated downtime can lead to decreased productivity, increased maintenance costs, and the potential for failure to meet production targets. Therefore, identifying the factors contributing to downtime and determining the most dominant causes is crucial for improving maintenance effectiveness and operational reliability.

This study aims to analyze the factors contributing to downtime in Cooler Drum machines at PT X using several analytical tools, including Failure Mode and Effect Analysis (FMEA), Fishbone Diagrams, and Pareto Charts. The results of this analysis are expected to provide recommendations for optimizing preventive and predictive maintenance strategies to minimize downtime and increase production efficiency.

2. METHOD

This study employs a quantitative descriptive method. This method was chosen because the objective of the study was to describe the actual situation related to downtime on the Cooler Drum machine and identify its causes. Downtime data obtained from the company was then analyzed quantitatively using various methods such as FMEA (Failure Mode and Effect Analysis), Fishbone Diagram, and Pareto diagram to identify the root cause.

3. RESULT AND DISCUSSION

The analysis in this study was conducted using various analytical techniques, including Failure Mode and Effect Analysis (FMEA), Fishbone Diagram, and Pareto Chart. These techniques were applied to identify and assess problems that arise during the production process, especially those that result in downtime on the Cooler Drum machine. By using this approach, the main causes of downtime can be identified, so that appropriate corrective and preventive measures can be formulated to improve machine efficiency and the sustainability of the production process:

3.1. Cooler Drum Machine Downtime Analysis.

This downtime analysis is crucial for understanding the frequency and duration of each type of failure occurring on the Cooler Drum machine. Furthermore, this analysis helps identify the components or factors that contribute most to downtime. With this information, companies can identify the root cause of machine failures and prioritize maintenance repairs.

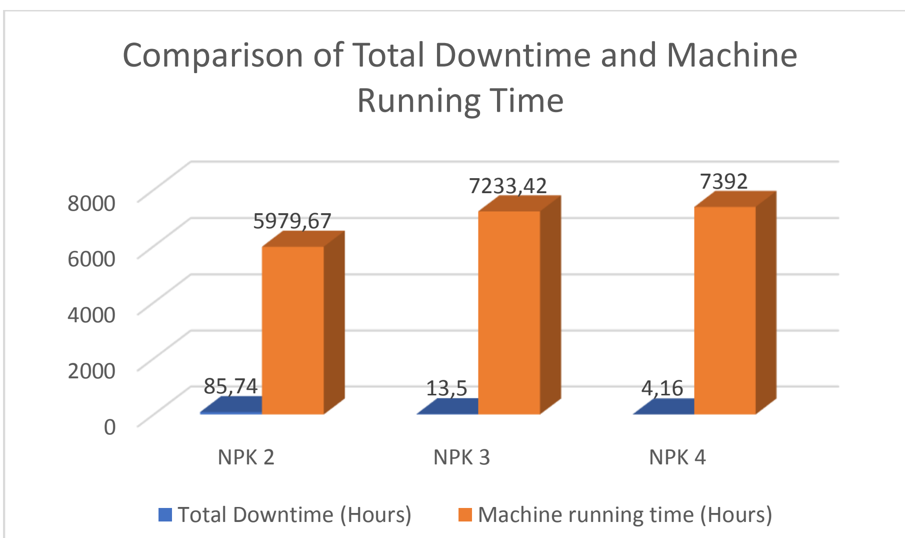


Figure 1 shows the results of a Cooler Drum machine downtime analysis at three production plants: NPK 2, NPK 3, and NPK 4. The maintenance team collected downtime data that revealed differences in the frequency and duration of machine failures at each plant. NPK 2 experienced the highest downtime of 85.74 hours with seven failures, the main causes of which included bearing failure, chain drum breakage, and motor failure. NPK 3, on the other hand, experienced 13.5 hours of downtime with five failures, while NPK 4 performed best with only 4.16 hours of downtime and three minor failures.

This apparent difference indicates that NPK 2 still faces issues related to lower machine reliability, while NPK 3 and NPK 4 demonstrate greater operational stability through more routine preventive maintenance and improved component condition.

3.2. Reliability Analysis.

To evaluate machine performance, several reliability parameters are calculated, such as Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR), availability, and reliability.

Plant	Total Downtime (Hours)	Amount of Damage	Machine running time (Hours)	Operating Hours	MTBF (Hours)	MTTR (Hours)	Failure Rate	Availability (%)	Reability (%)
NPK 2	85,74	7	5979,67	6065,41	866,4871429	12,24857143	1,17E-03	98,61%	90,45%
NPK 3	13,5	5	7233,42	7246,92	1449,384	2,7	6,91E-04	99,81%	99,07%
NPK 4	4,16	3	7392	7396,16	2465,386667	1,386666667	4,06E-04	99,94%	99,83%

Based on the data in Table 1, Plant NPK 4 showed the highest MTBF value, at 2,465.39 hours, and the lowest MTTR, at 1.39 hours. This indicates that the machines at this plant rarely experience breakdowns and require relatively short repair times.

Conversely, Plant NPK 2 showed a lower MTBF value, at 866.48 hours, and a higher MTTR, at 12.24 hours, indicating that the machines at this plant experience breakdowns more frequently and require longer repair times.

These findings demonstrate that maintenance effectiveness has a direct impact on machine reliability and the overall smoothness of the production process.

3.3. FMEA Analysis

This FMEA analysis is used to identify possible failure modes in the Cooler Drum machine and assess their impact on the production process. By calculating a Risk Priority Number (RPN) based on severity, occurrence, and detection factors, this analysis helps identify the highest-risk areas and should be the focus of maintenance improvements.

Component	Failure Mode (causes)	Impact	S	O	D	RPN
Bearing	Damaged bearing	The machine stopped for a long time	9	2	5	90
Chain Drum	Life Time	Broken / loose	8	2	5	80
Shaft / Trunion	Broken trunion shaft	Drum not rotating	8	1	6	48
Rubber Inlet	Rubber inlet torn/leaking	Leakage	9	1	3	27
Motor Listrik	Overload	Cooler Drum Completely Dead	8	1	4	32
Fluid copling	Overload	Structural deformation/damage	9	4	4	144
Plammer	Chain Drum Beat	Engine Stops Completely	9	1	8	72

Based on the information in Table 2, an FMEA was conducted to assess the risk of each type of failure that could occur in the Cooler Drum machine. The three main factors used for the evaluation were Severity (S), Occurrence (O), and Detection (D), which were then multiplied to obtain the Risk Priority Number (RPN).

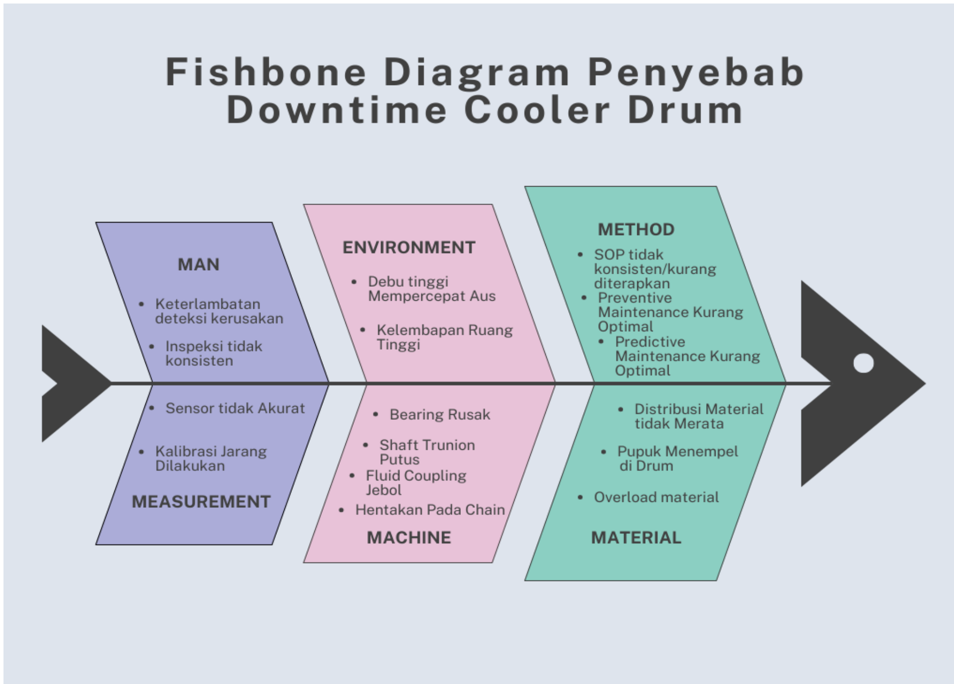
The analysis results showed that the Fluid Coupling component had the highest RPN, at 144, followed by the Shaft Trunion with an RPN of 90, and the Bearing Sprocket with an RPN of 72. High RPN values indicate that these three components have a significant risk of failure and could impact the smooth running of the production process.

Therefore, corrective actions are necessary, such as implementing a condition monitoring system, changing lubricants at specified times, and reviewing the design and materials for components at high risk of failure.

3.4. Fishbone Diagram Analysis

A fishbone diagram is used to identify the root causes of downtime in a cooler drum machine, with particular attention to critical elements that impact machine reliability. In this analysis, the causes are grouped into six categories: Man, Machine, Method, Material, Measurement, and

Environment (5M + 1E), making it easier to identify the main factors and prioritize corrective actions:



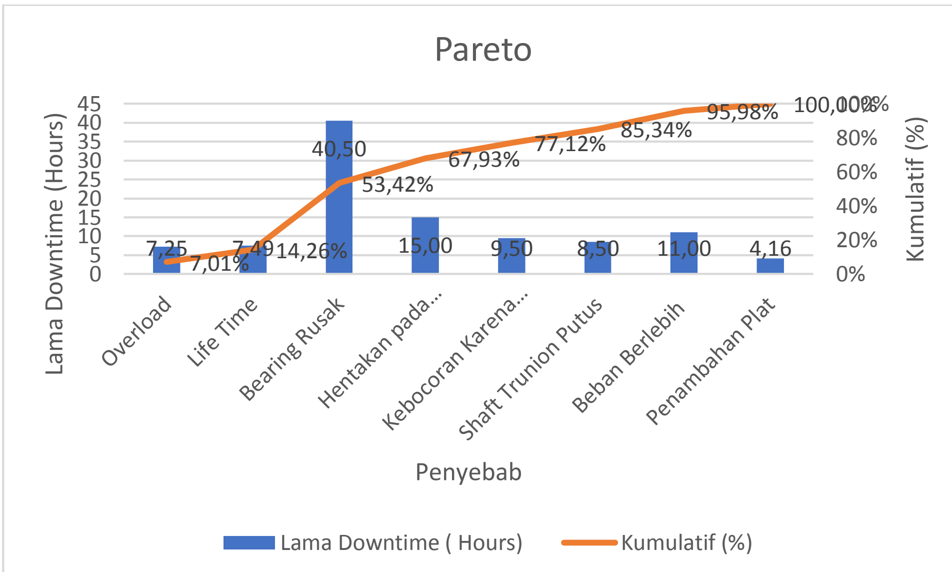
The results of the analysis conducted using a Fishbone Diagram (Figure 2) indicate that the two main categories of causes of Cooler Drum machine downtime are Machine Factors and Method Factors. Machine Factors consist of several factors such as bearing wear, chain drum damage, and shaft misalignment, all of which directly impact Cooler Drum machine performance. On the other hand, Method Factors relate to the suboptimal implementation of preventive maintenance and delays in conducting periodic inspections.

In addition to these two main factors, other factors contribute to downtime: Human Factors, caused by operator negligence and a lack of proper training. Material Factors also play a role due to frequently changing material quality and inadequate lubrication. Furthermore, Measurement Factors are caused by limited monitoring equipment and incomplete maintenance data. Finally, Environmental Factors include issues such as dust, high temperatures, and humidity, which accelerate component wear.

From the analysis findings in Figure 2, it can be concluded that improving maintenance discipline, machine condition monitoring, and work environment control have significant potential to significantly reduce downtime and increase overall machine confidence.

3.5. Pareto Diagram Analysis

This Pareto chart helps us understand the number and proportion of each type of downtime cause that frequently occurs. This analysis allows us to identify the factors that most significantly influence total downtime, making it easier to determine which improvements should be implemented first.



Meanwhile, the Pareto Chart shown in Figure 3 reveals that four main problems account for approximately 75% of the total downtime. These problems include bearing damage, chain drum failure, fluid coupling problems, and rubber inlet leaks. Referring to the 80/20 Pareto principle, it is highly recommended that repair efforts focus on these four main factors, as they have the greatest impact on total downtime.

These results demonstrate that improving the effectiveness of preventive maintenance programs and implementing more regular predictive maintenance on these critical components can significantly reduce the frequency of breakdowns, extend machine life, and improve the operational efficiency of the Cooler Drum unit.

4. CONCLUSION

Based on the analysis conducted, it can be concluded that the downtime of the Cooler Drum machine at PT X is caused by mechanical problems and the lack of effective maintenance methods. Calculations show that NPK Plant 4 has the highest MTBF, which is 2,465.39 hours, and the lowest MTTR, which is 1.39 hours. This indicates that the machines in the plant are very reliable. In contrast, NPK Plant 2 recorded the lowest MTBF and the highest MTTR. Through FMEA analysis, Fluid Coupling, Shaft Trunion, and Bearing Sprocket were identified as the most critical components. In addition, Fishbone Diagram analysis revealed that Machine and Method factors were the main causes of downtime. The Pareto chart shows that approximately 75% of the total downtime is caused by four main problems: bearing failure, chain drum failure, fluid coupling failure, and rubber inlet leakage. Therefore, important steps to reduce downtime and improve overall machine reliability include increasing the effectiveness of preventive and predictive maintenance programs, accuracy in routine inspections, and improving operator skills.

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