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Analysis Of Overall Equipment Effectiveness On The Heading Machine To Minimize Six Big Losses Using The Total Productive Maintenance Method: A Case Study Of PT XYZ

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Abstract

Machine efficiency and productivity are key factors in the manufacturing industry to ensure product quality and smooth production processes. PT XYZ, as a company engaged in manufacturing, faces challenges in optimizing the performance of its Heading machine used during the production process. One of the identified problems is the high downtime, which averages 5,509.7 minutes per month during the research period. This study applies the Overall Equipment Effectiveness (OEE) and Six Big Losses methods to analyze machine effectiveness and designs improvement recommendations through the Total Productive Maintenance (TPM) approach. Data collected over a six-month period, from January to June 2024, shows that the Heading machine has an availability rate of 86.63%, a performance rate of 87.93%, and a quality rate of 99.55%, resulting in a total OEE value of 75.5%. The Six Big Losses analysis indicates that the main factor affecting machine effectiveness is reduced speed losses. Therefore, this study recommends the implementation of TPM to improve the effectiveness of the Heading machine performance at PT XYZ.

Keywords: Overall Equipment Effectiveness, Six Big Losses, Total Productive Maintenance, Reduced Speed Losses, Downtime.

INTRODUCTION

In the current era of globalization, every company is required to continuously advance and develop. The effect of globalization is the increasing competitiveness in global trade, which drives industries, particularly manufacturing, to improve their competitiveness to enter the global market. Machine efficiency and productivity are key factors in manufacturing industries to ensure product quality and the smoothness of the production process. PT XYZ, as a manufacturing company, faces challenges in optimizing the performance of the Heading machine used in the production process. Common issues that arise include machine downtime, which, as shown in the company's downtime data table, averages 5,509.7 minutes per month during the research period. This can lead to a reduction in operational speed, as well as product defects that may affect the overall equipment effectiveness (Satpatmantya et al., 2023). If not properly handled, this condition could result in inefficiencies in production and increased operational costs. Inefficiency in the use of the Heading machine could have a significant impact on production output and the company's profitability (Puspita and Widjajati, 2021). High downtime will reduce production capacity, while a decrease in operational speed could cause delays in meeting production targets. Furthermore, the increased number of defective products will add workload to the inspection and rework processes, ultimately increasing production costs. If this problem is not addressed immediately, the company's competitiveness in the manufacturing industry could decline (Dewi and Sudharto, 2024).

This study was conducted to evaluate the effectiveness of the Heading machine at PT XYZ through the analysis of Overall Equipment Effectiveness (OEE). Machine effectiveness is a crucial aspect in maintaining the smoothness and efficiency of the production process. A machine that does not operate optimally can lead to a waste of time, energy, and costs, which ultimately lowers productivity and the company's competitiveness. Based on the calculation results, the average OEE value of the Heading machine is 75.5%, which is still below the ideal standard set by the Japan Institute of Plant Maintenance (JIPM), which is 85%. This value indicates that the production system is still in the moderate category and not yet optimal. Therefore, it is necessary to identify the factors that contribute to the low machine effectiveness so that targeted improvements can be made. The main goal of this

research is to identify critical areas that need to be improved to enhance operational efficiency and the company's competitiveness in the manufacturing industry.

METHODS

The following section is a description of the literature on TPM, OEE, and Six Big Losses.**Total Productive Maintenance (TPM)** is a maintenance program concept that involves all workers through small group activities. It encompasses several aspects, such as total commitment to the program from top management, providing workers with ample time to carry out corrective actions, and scheduling downtime (idle time) for maintenance as part of the daily production process, making it an inseparable part of the production process itself.

According to Dewi and Sudharto (2024), Total Productive Maintenance (TPM) is not solely focused on optimizing the productivity of equipment or materials supporting work activities, but also on improving the productivity of workers or operators who will ultimately take control of the equipment and materials. Total Productive Maintenance aims to enhance the overall efficiency and effectiveness of manufacturing companies.

Overall Equipment Effectiveness (OEE) is a tool used to measure productivity and is the best method for monitoring and improving manufacturing process efficiency. OEE calculates the ratio of actual equipment output to the maximum possible output under optimal performance conditions. It is determined based on three factors: Availability, Performance, and Quality. The goal of OEE is to measure the performance of a maintenance system, helping to assess machine availability, production efficiency, and the quality of machine output.

The Availability Ratio measures how effectively equipment or machines are used during the available time, calculated as the ratio of operation time to loading time. The Performance Ratio gauges the speed at which machines operate compared to their maximum capacity, indicating the efficiency of production speed. Lastly, the Quality Ratio measures the quality of products produced, comparing the number of defect-free products to total output. A high Quality Ratio indicates that the production process is generating more high-quality products, while a low ratio signifies that product quality needs improvement.

The OEE assessment standard formulated by the Japan Institute of Plant Maintenance (JIPM) is as follows:

Table 1. OEE assessment standard

Nilai OEE	Kategori
40%-59%	Rendah
60%-84%	Sedang
85%-99%	Kelas Dunia
100%	Sempurna

Six Big Losses,Six Big Losses in a production system can hinder efficiency and productivity. These losses are categorized into three main types: Downtime Losses, Speed Losses, and Quality Losses. Downtime losses include Breakdown Losses (when machines fail unexpectedly, causing unplanned stoppages) and Setup and Adjustment Losses (wasted time during machine setup or adjustments before production). Speed losses occur when the machine operates at a lower speed than its maximum capacity, such as Reduce Speed Losses, where machines run slower than expected, and Idling and Minor Stoppage Losses, caused by brief delays or minor issues that stop production.

Quality Losses arise when the produced products do not meet quality standards, leading to defective goods. This includes Reduced Yield Losses, where a significant portion of the produced items does not meet quantity or quality standards, and Process Defect Losses, where defective products must be discarded or reworked. To minimize these losses, it is crucial to maintain equipment properly, ensure proper setup times, and implement consistent quality checks throughout the production process. Proper operator training and material handling are essential to reducing downtime and improving production efficiency.

RESULT AND DISCUSSION

Overall Equipment Effectiveness (OEE),The effectiveness of the Heading machine at PT XYZ was evaluated using the Overall Equipment Effectiveness (OEE) method, which consists of three main components: availability rate, performance rate, and quality rate. The OEE calculation was based on operational data collected from January to June 2024, including machine operating time, downtime, production output, and defective products.

Table 2. OEE Value Calculation

Bulan	Availability Rate (%)	Performance Rate (%)	Quality Rate (%)	OEE (%)	Standart OEE (%)	Keterangan
Januari	83.41	89.00	99.54	74%	85	Belum Memenuhi Standart
Februari	86.03	87.06	99.41	74%	85	Belum Memenuhi Standart
Maret	85.10	87.27	99.37	74%	85	Belum Memenuhi Standart
April	86.53	89.48	99.50	77%	85	Belum Memenuhi Standart
Mei	85.69	91.28	99.57	78%	85	Belum Memenuhi Standart
Juni	86.63	87.93	99.55	76%	85	Belum Memenuhi Standart
Rata Rata				0.755		

The results show that the availability rate of the Heading machine reached 86.63%. This value indicates that the machine availability was relatively good; however, there were still significant losses in productive time due to machine downtime. This condition suggests that the current maintenance system has not yet been fully optimized to minimize non-value-added downtime.

The performance rate obtained was 87.93%, indicating that the machine did not consistently operate at its ideal speed. This result reflects inefficiencies during machine operation, particularly related to speed reductions while the machine was running. Consequently, the actual output produced was lower than the theoretical maximum output.

Meanwhile, the quality rate of the Heading machine reached 99.55%, indicating a very low level of defective products. The high quality rate demonstrates that the quality control system has been effectively implemented and is not a major contributor to the low overall machine effectiveness. Based on the three components, the overall OEE value of the Heading machine was 75.5%, which is still below the world-class standard of 85%. This result indicates that the machine effectiveness falls into the moderate category, highlighting the need for improvement, particularly in the availability and performance aspects, to enhance overall machine effectiveness.

Six Big Losse. To identify the main factors contributing to the low OEE value, an analysis using the Six Big Losses method was conducted. This analysis aims to determine the dominant types of losses that affect the effectiveness of the Heading machine during the research period.

Table 3. Six Big Losses Value Calculation

Bulan	SIX BIG LOSSES					
	AVAILABILITY		PERFORMANCE		DEFECT LOSSES	
	Downtime Losses		Speed Losses		Defect Losses	
	Equipment Failure Losses (%)	Setup & Adjustment Losses (%)	Idling & Minor Stoppage Losses (%)	Reduce Speed Losses (%)	Reduce Yield (%)	Product Defect Losses (%)
Januari	0.18%	0.0954%	0.1062%	9.085%	0.1121%	0.0041%
Februari	0.14%	0.0936%	0.1025%	9.108%	0.0266%	0.0051%
Maret	0.15%	0.1014%	0.1276%	9.104%	0.0234%	0.0055%
April	0.14%	0.0911%	0.1154%	9.085%	0.0359%	0.0045%
Mei	0.15%	0.0968%	0.1206%	9.065%	0.0704%	0.0039%
Juni	0.14%	0.0883%	0.1448%	9.100%	0.0594%	0.0040%
Rata-Rata	0.15%	0.09%	0.12%	9.09%	0.05%	0.005%

The results indicate that reduced speed losses were the most significant contributor to the decrease in machine effectiveness. The high proportion of reduced speed losses shows that the machine frequently operated below its ideal speed, resulting in lower production output than expected. In addition to reduced speed losses, other losses such as breakdown losses and setup and adjustment losses also contributed to the reduction of effective operating time. Breakdown losses represent unplanned machine stoppages, while setup and adjustment losses are associated with the time required to prepare and adjust the machine before and during production.

Conversely, quality-related losses, including reduced yield losses and product defect losses, had relatively small contributions. This finding is consistent with the high quality rate, indicating that quality issues were not the primary cause of the reduced effectiveness of the Heading machine. Overall, the Six Big Losses analysis confirms that the main issues affecting machine effectiveness are related to machine speed and operating time. Therefore,

improvement efforts should focus on reducing reduced speed losses to enhance performance and increase the overall OEE value.

Fishbone Diagram Analysis

To further identify the root causes of reduced speed losses, a cause-and-effect analysis using a fishbone diagram was conducted. This analysis was used to systematically identify the factors influencing machine performance based on major cause categories.

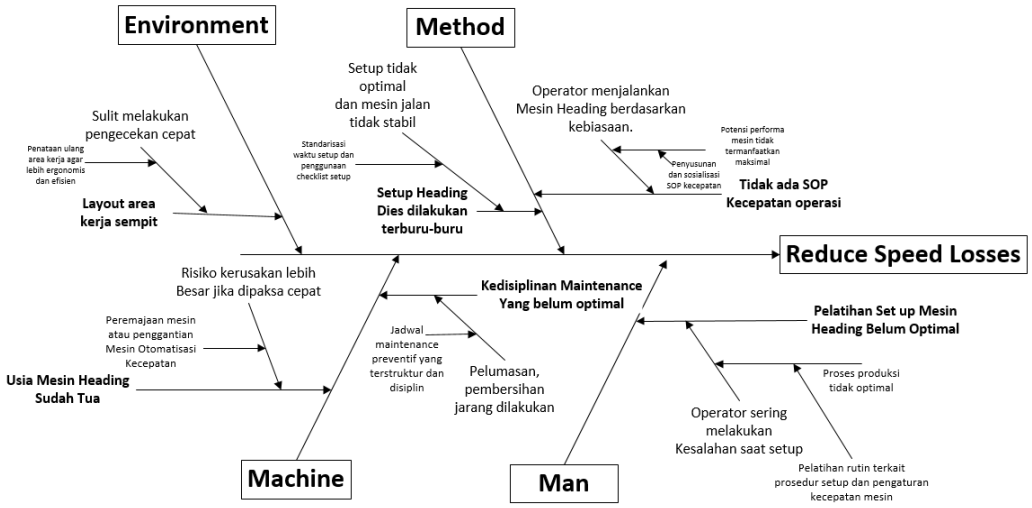

Figure 1 Fishbone Diagram

The fishbone diagram analysis shows that man factors play a significant role in reducing machine speed. Inconsistent operator discipline in maintaining optimal operating speed and limited understanding of ideal machine conditions caused the machine to operate below its maximum performance. From the machine aspect, the main causes include suboptimal machine conditions and delays in handling minor disturbances. The lack of scheduled preventive maintenance resulted in the machine continuing to operate even when its performance had already declined. Regarding the method factor, the absence of clear standard operating procedures related to machine speed settings and minor problem handling contributed to increased ineffective operating time. This condition directly led to higher reduced speed losses. From the environment perspective, workplace conditions and the layout of supporting equipment also affected the operator's response time to machine disturbances. Poorly organized work areas can slow down corrective actions and reduce production speed.

Overall, the fishbone diagram analysis reinforces the findings from the OEE and Six Big Losses analyses, indicating that the reduced effectiveness of the Heading machine at PT XYZ is caused by a combination of human, machine, method, and environmental factors. Therefore, improving machine effectiveness requires a comprehensive approach through the implementation of Total Productive Maintenance (TPM) to reduce reduced speed losses and sustainably increase the OEE value.

CONCLUSION

This study evaluated the effectiveness of the Heading machine at PT XYZ using the Overall Equipment Effectiveness (OEE) approach, supported by Six Big Losses and fishbone diagram analyses. The results indicate that the overall OEE value of the Heading machine was 75.5%, which is below the world-class benchmark of 85%. This finding shows that the machine effectiveness remains at a moderate level and still has considerable potential for improvement. Among the three OEE components, the quality rate achieved a very high value, indicating that product quality was not a major issue during the production process. However, the availability and performance rates were relatively lower, mainly due to machine downtime and reduced operating speed. These factors significantly limited the machine's ability to achieve optimal production output.

The Six Big Losses analysis revealed that reduced speed losses were the dominant contributor to the loss of machine effectiveness, followed by breakdown losses and setup and adjustment losses. In contrast, quality-related losses had minimal impact, which is consistent with the high quality rate observed in the OEE analysis. Furthermore, the fishbone diagram analysis identified that the root causes of reduced speed losses were associated with a combination of human, machine, method, and environmental factors. Issues such as inconsistent operator practices, suboptimal machine conditions, lack of standardized operating procedures, and inadequate workplace organization were found to influence machine performance.

Based on these findings, it can be concluded that improving the effectiveness of the Heading machine at PT XYZ requires a comprehensive improvement strategy, particularly focusing on reducing reduced speed losses. The implementation of Total Productive Maintenance (TPM), along with operator training, preventive maintenance scheduling, and standardization of operating procedures, is expected to enhance machine performance and increase the overall OEE value sustainably.

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