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Cone Crusher Machine Maintenance Analysis Using Overall Equipment Effectiveness (OEE) and Six Big Losses Method to Improve Machine Effectiveness at PT Selo Agung

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Abstract. PT Selo Agung is a company engaged in andesite stone mining located in Plered, Purwakarta Regency, West Java. Its cone crusher machine plays a vital role in crushing andesite stone into construction material, but its performance is frequently hindered by component failures and suboptimal maintenance activities, resulting in high downtime and disrupted production. This study aims to analyze the effectiveness of the cone crusher machine using the Overall Equipment Effectiveness (OEE) method, identify the factors causing the decline in production effectiveness through Six Big Losses calculation, and propose improvements to enhance machine effectiveness. Historical data from February 2025 to January 2026 were processed by calculating Availability, Performance Efficiency, and Quality Ratio, followed by Six Big Losses analysis, a fishbone diagram, and improvement proposals using the 5W+1H method. The results show that the average OEE value of the cone crusher machine was only 56.10%, far below the JIPM world-class standard of 85%, falling into the Unacceptable category. Availability at 67.86% was the largest contributor to the gap, followed by Performance Efficiency at 85.14% and Quality Ratio at 97.08%. Equipment Failure (Breakdown) Losses was identified as the most dominant loss, contributing 53.08% of total losses, mainly caused by the absence of scheduled preventive maintenance. The proposed improvements include implementing scheduled preventive maintenance with periodic replacement of the mantle and concave, developing a written maintenance SOP, operator training, and stabilizing material supply along with regular Closed Side Setting (CSS) calibration. Consistent long-term implementation (12-18 months) of these proposals is projected to raise the OEE value from 56.10% to 83.05%, approaching the world-class standard.

Keywords: *Cone Crusher, Maintenance, Overall Equipment Effectiveness (OEE), Preventive, Maintenance, Six Big Losses.*

A. INTRODUCTION

The rapid pace of industrial and technological development in the era of globalization has intensified competition among companies. In this context, companies are required to improve their efficiency and productivity to remain competitive, one of which is achieved through sound production planning and optimal management of machines and equipment. Machinery breakdowns can disrupt or even halt production entirely, so a well-managed maintenance system is essential to keep equipment in optimal condition (Wibisono, 2021).

Machine effectiveness can be measured using the Overall Equipment Effectiveness (OEE) method, which comprises three main components: availability, performance, and quality. Effectiveness is further influenced by six major types of losses known as Six Big Losses, namely equipment failure (breakdown) losses, setup and adjustment losses, idling and minor stoppages, reduced speed losses, defect losses, and yield/scrap losses (Wibisono, 2021). These losses are the principal causes of declining efficiency and productivity in production processes, and identifying them provides the basis for determining appropriate corrective actions (Wibisono, 2021).

PT Selo Agung, part of the Selo Group, is located in Plered, Purwakarta Regency, West Java, and is engaged in andesite stone mining that supplies raw material for construction aggregates. One of its main production units is the cone crusher machine, which crushes andesite stone into smaller, uniform sizes by pressing the material between the mantle and concave surfaces. The performance of this machine directly affects production capacity and product quality.

In practice, the cone crusher machine frequently experiences disturbances or damage during operation, primarily on its main components such as the mantle, concave, and drive system, largely due to suboptimal maintenance activities. Downtime data recorded from February 2025 to January 2026 show considerable month-to-month fluctuation, ranging from 32 hours in August 2025 to a peak of 98 hours in July 2025, indicating a significant operational disturbance during that period. Such fluctuations highlight the need for a systematic effectiveness analysis to determine the underlying causes of the recurring downtime.

Previous studies have applied the OEE and Six Big Losses methods to various types of production and heavy equipment, including excavators (Daman & Nusraningrum, 2020), welding machines, coal crusher machines (Iskandar & Fitriani, 2023), and cement industry machinery, generally confirming that breakdown-related losses tend to dominate machine ineffectiveness (Santoso & Wahyuni, 2021; Heizer & Render, 2015). However, studies that specifically combine OEE and Six Big Losses analysis for a cone crusher machine in an andesite mining operation, followed by root-cause identification through a fishbone diagram and a structured 5W+1H improvement plan, remain limited. This gap forms the basis and novelty of the present study, which is expected to contribute a practical, replicable improvement framework for similar mineral-processing operations.

This study aims to analyze the effectiveness of the cone crusher machine at PT Selo Agung using the OEE method, identify the factors causing the decline in production effectiveness, particularly in the Availability, Performance, and Quality aspects, and provide improvement recommendations that can be applied to enhance the effectiveness and efficiency of the cone crusher production process. Article history and formatting notes: all articles must comply with the HEURISTIC journal formatting standard, and the plagiarism similarity index detected by Turnitin must be below 20%.

B. METHOD

This research uses a quantitative descriptive approach with a case-study design, based on historical operational data of the cone crusher machine at PT Selo Agung. The study was conducted at PT Selo Agung, located at Gunung Gadung, Kampung Cikadu, Pamoyanan Village, Plered District, Purwakarta Regency, West Java Province, from November 2025 to April 2026. Primary data were obtained through direct observation at the research site, interviews with the cone crusher machine operators, and documentation of company records related to machine downtime, setup time, and production output. Secondary data were obtained through a literature review of books, journal articles, and other relevant sources concerning maintenance systems, OEE, and Six Big Losses.

The collected data-comprising loading time, downtime, setup time, operation time, actual production, and reject product for the period February 2025 to January 2026-were processed using the following formulas:
Availability = (Operation Time/Loading Time) x 100%
Performance Efficiency = (Actual Production x Ideal Cycle Time/Operation Time) x 100%
Quality Ratio = (Actual Production - Reject Product)/Actual Production x 100%
OEE = Availability x Performance Efficiency x Quality Ratio

Six Big Losses were subsequently calculated for the categories relevant to the available data, namely Equipment Failure (Breakdown) Losses, Setup and Adjustment Losses, Idling and Minor Stoppage Losses, Reduced Speed Losses, and Defect Losses, using the standard OEE loss formulas referenced from prior OEE literature (Wibisono, 2021; Purba et al., 2024).

Yield/scrap losses were not calculated separately because the available reject data already fully represent quality-related losses through the Defect Losses component.

The resulting OEE values were compared against the world-class OEE standard set by the Japan Institute of Plant Maintenance (JIPM), i.e., Availability >= 90%, Performance Efficiency >= 95%, Quality Ratio >= 99.9%, and overall OEE >= 85% (Wibisono, 2021. The Six Big Losses results were ranked by their percentage contribution to total losses to identify the most dominant loss. A fishbone (cause-and-effect) diagram was then used to identify the root causes of the dominant loss across five factor categories: man, method, machine, material, and environment. Finally, an improvement plan was formulated using the 5W+1H method (what, why, where, when, who, how) to translate the identified root causes into concrete, actionable recommendations.

C. RESULT AND DISCUSSION

Data processing for the twelve-month period (February 2025-January 2026) produced the OEE component values, the Six Big Losses recapitulation, the root-cause identification, and the OEE improvement projection presented below.

The average Availability of the cone crusher machine was 67.86%, with the lowest monthly value of 46.70% in July 2025-coinciding with the highest recorded downtime of 98 hours-and the highest value of 82.42% in August 2025. The average Performance Efficiency was 85.14%, and the average Quality Ratio was 97.08%. Combining the three components yields an average OEE of 56.10%, with monthly values fluctuating between 37.77% (July 2025) and 68.77% (August 2025). Table 1 summarizes these results against the JIPM world-class standard.

Table 1. Recapitulation of Average OEE Component Values Compared to the JIPM World-Class Standard

OEE Component	Actual Value (%)	JIPM Standard (%)	Gap (%)
Availability	67.86	90.00	22.14
Performance Efficiency	85.14	95.00	9.86
Quality Ratio	97.08	99.90	2.82
Overall Equipment Effectiveness (OEE)	56.10	85.00	28.90

Table 1 shows that Availability has the largest gap (22.14%) toward the JIPM standard, followed by Performance Efficiency (9.86%) and Quality Ratio (2.82%). With an average OEE of 56.10%, which is below the 65% threshold, the cone crusher machine's effectiveness falls into the Unacceptable category, indicating an urgent need for comprehensive improvement.

The Six Big Losses recapitulation in Table 2 confirms that Equipment Failure (Breakdown) Losses is the most dominant loss, averaging 32.14% and contributing 53.08% of total losses, followed by Idling and Minor Stoppage Losses (11.86%; 19.59%), Reduced Speed Losses (10.18%; 16.81%), Setup and Adjustment Losses (4.69%; 7.75%), and Defect Losses (1.68%; 2.77%).

Table 2. Recapitulation of Six Big Losses Values (February 2025-January 2026)

No	Type of Loss	Average Value (%)	Related OEE Component	Contribution to Total Losses (%)
1	Equipment Failure (Breakdown) Losses	32.14	Availability	53.08
2	Idling and Minor Stoppage Losses	11.86	Performance Efficiency	19.59
3	Reduced Speed Losses	10.18	Performance Efficiency	16.81

4	Setup and Adjustment Losses	4.69	Availability	7.75
5	Defect Losses	1.68	Quality Ratio	2.77
Total		**60.55**	**-**	**100.00**

Root-cause identification of Equipment Failure Losses through a fishbone diagram (Figure 1) covered five factor categories. Under man, causes included delayed damage reporting by operators, operator fatigue from long shifts, and limited technical competence of the maintenance team. Under method, the main cause was the absence of a written, scheduled preventive maintenance SOP, with maintenance still being predominantly corrective rather than preventive. Under machine, wear on the mantle and concave due to prolonged use without periodic replacement or overhaul was identified. Under material, oversized andesite feed from the jaw crusher stage-caused by insufficient sorting-increased the machine's workload. Under environment, dusty, high-temperature working conditions and minimal automatic lubrication accelerated mechanical component wear.

Based on these root causes, improvement proposals were formulated using the 5W+1H method, prioritizing the reduction of Equipment Failure Losses as the most dominant loss, followed by measures to reduce Idling and Minor Stoppage Losses and Reduced Speed Losses. The proposals consist of: (1) implementing a scheduled preventive maintenance program with periodic replacement of the mantle and concave every 4-5 months, developing a written maintenance SOP, daily and weekly inspection checklists, a component maintenance log, and brief operator training on early detection of damage symptoms; and (2) stabilizing the andesite material supply from the jaw crusher stage through a production-integrated supply schedule and minimum buffer stock control, together with regular Closed Side Setting (CSS) calibration to maintain a consistent crushing gap and operating speed.

The projected impact of these improvements was estimated under two scenarios. In the short-term scenario (0-6 months), assuming a 50% gap closure for Availability and 30% for Performance Efficiency, the OEE value is projected to rise from 56.10% to 67.51% (an increase of 11.41%). In the long-term scenario (12-18 months), assuming full and consistent implementation so that Availability reaches the JIPM standard of 90.00% and Performance Efficiency reaches 95.00%, while Quality Ratio remains at 97.08%, the projected OEE rises to 83.05% (an increase of 26.95%), moving the effectiveness category from Unacceptable to Good and approaching the world-class threshold of 85%.

The finding that Availability is the largest contributor to the low OEE value, driven primarily by Equipment Failure (Breakdown) Losses, is consistent with several previous studies on crusher and heavy mining equipment. (Iskandar & Fitriani, 2023) similarly found that breakdown-related downtime was the dominant loss in a coal crusher machine, while (Santoso & Wahyuni, 2021) identified component wear and delayed maintenance response as key contributors to crusher damage in mining operations. (Sugianto et al. 2023) likewise reported that Availability was the weakest OEE component for an andesite crusher, corroborating the pattern observed in this study.

Daman & Nusraningrum (2020) in their study of an excavator unit, found that performance-related losses were more dominant than availability losses, suggesting that the pattern of Six Big Losses is highly dependent on the type of equipment, its operating environment, and the maturity of the maintenance system already in place. This comparison reinforces the importance of conducting equipment-specific OEE analysis rather than relying solely on generalized industry benchmarks.

The root-cause analysis confirms that the absence of a scheduled, written preventive maintenance system-rather than a single isolated technical failure-is the underlying driver of the high breakdown losses, a conclusion aligned with the broader Total Productive Maintenance (TPM) literature emphasizing the shift from reactive corrective maintenance to planned preventive maintenance as the primary lever for improving machine reliability (Wibisono, 2021; Muchiri & Pintelon, 2008). The proposed 5W+1H improvement plan operationalizes this shift into concrete actions: scheduled component replacement, documented SOPs, operator training, and supply-chain stabilization, each targeting a specific loss category identified in Table 2.

The projected long-term OEE of 83.05% demonstrates that, while still marginally below the 85% world-class threshold, consistent implementation of preventive maintenance combined wiAnalysis (FMEA) or a Reliability Centered Maintenance (RCM) approach, and to conduct periodic post-implementation monitoring to verify whether the projected OEE improvements are achieved in practice.

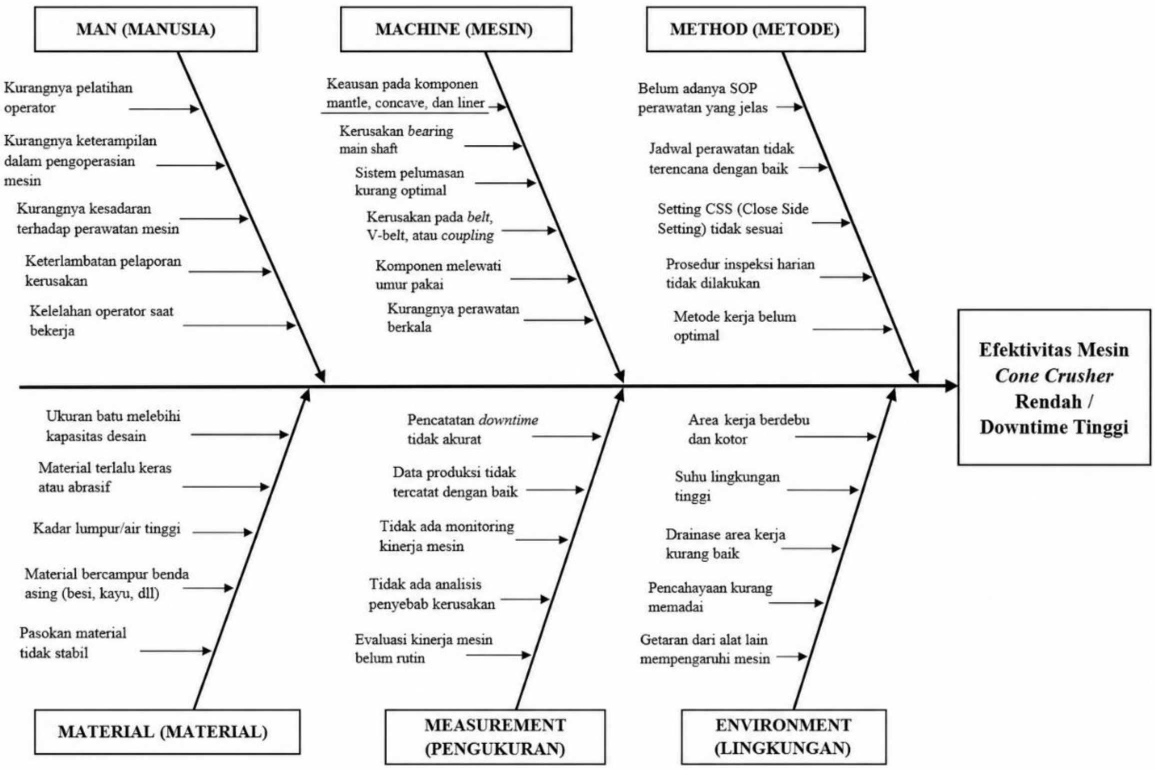

Figure 1. Fishbone Diagram of Root Causes of Equipment Failure (Breakdown) Losses

D. CONCLUSION

The effectiveness of the cone crusher machine at PT Selo Agung during the period February 2025 to January 2026 was found to be low, with an average Overall Equipment Effectiveness (OEE) of only 56.10%, far below the 85% world-class standard set by the Japan Institute of Plant Maintenance (JIPM), placing it in the Unacceptable category. This value was formed by an Availability of 67.86%, a Performance Efficiency of 85.14%, and a Quality Ratio of 97.08%, with monthly OEE fluctuating between 37.77% and 68.77%, indicating that machine effectiveness was not only low but also unstable.

The dominant factor behind this low effectiveness was the high level of unplanned downtime, reflected in Equipment Failure (Breakdown) Losses of 32.14%, or 53.08% of total losses, followed by Idling and Minor Stoppage Losses (11.86%; 19.59%), Reduced Speed Losses (10.18%; 16.81%), Setup and Adjustment Losses (4.69%; 7.75%), and Defect Losses (1.68%; 2.77%). Fishbone analysis identified the absence of scheduled preventive maintenance as the root cause, compounded by delayed damage reporting, oversized feed material from the jaw crusher stage, and a dusty, high-temperature working environment.

Improvement proposals formulated through the 5W+1H method include implementing scheduled preventive maintenance with periodic mantle and concave replacement every 4-5 months, developing a written maintenance SOP, training operators in early damage detection, stabilizing the andesite material supply, and performing regular Closed Side Setting (CSS) calibration. If implemented consistently over the long term (12-18 months), these measures are projected to raise the OEE value from 56.10% to 83.05%, an increase of 26.95%, moving the machine's effectiveness category from Unacceptable to Good and bringing it close to the world-class standard.

E. CONCLUSION

The OEE analysis of the cone crusher machine at PT Selo Agung from February 2025 to January 2026 reveals an unacceptable average OEE of 56.10%, which falls significantly below the 85% JIPM world-class standard. This poor performance is primarily driven by a low Availability rate of 67.86%, while the Six Big Losses analysis identifies Equipment Failure (Breakdown) Losses as the most dominant factor (53.08%) resulting from the absence of scheduled preventive maintenance. To mitigate these inefficiencies, a 5W+1H improvement strategy is proposed, encompassing scheduled preventive maintenance with periodic mantle and concave replacements, written SOP development, operator training, material supply stabilization, and regular Closed Side Setting (CSS) calibration. Consistent implementation of these measures over a 12-to-18-month period is projected to successfully elevate the OEE value to 83.05%, bringing the machine's operational effectiveness close to global standards.

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