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Article

Slab Cutter Machine Maintenance to Improve the Efficiency of Rubber Products at PT Bridgestone

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A B S T R A C T

Industrial asset maintenance management is a determining factor in ensuring operational continuity and output quality in the rubber processing manufacturing sector. This report examines the effectiveness of Slab Cutter machine maintenance at PT Bridgestone Sumatra Rubber Estate (BSRE) based on observations conducted during an Industrial Internship (Practical Work Program). The background of this study is grounded in the critical role of the Slab Cutter machine as an initial processing unit that reduces the dimensions of raw rubber slabs into uniform pieces in order to optimize subsequent milling and drying processes. Disruptions to this machine often result in significant downtime and irregular rubber particle sizes, which ultimately reduce energy efficiency and daily productivity. The main objective of this observation is to evaluate the preventive maintenance procedures implemented, identify the root causes of mechanical failures, and analyze their impact on the consistency of crumb rubber quality. Through the application of a qualitative field observation method, it was found that synchronization between routine cleaning, bearing lubrication, and blade sharpening was able to reduce operational failures by more than 75%. The conclusion of this study emphasizes that a reliability-based preventive maintenance strategy not only extends the service life of the machine but is also a fundamental prerequisite for achieving sustainable production efficiency targets within the Bridgestone industrial environment. This report recommends the adoption of a data-based monitoring system to detect early component wear in order to minimize emergency repair costs.

1. Introduction

The natural rubber industry in Indonesia is a strategic sector that makes a significant contribution to the national economy and the global supply chain, particularly to the global automotive industry. PT Bridgestone Sumatra Rubber Estate (BSRE), located in Dolok Merangir, North Sumatra, was established in 1916 (originally as Goodyear) and was officially acquired by Bridgestone Corporation in 2005.PT Bridgestone Sumatra Rubber Estate Profile, 2024).1As part of a global leader in tire and rubber product manufacturing, BSRE plays a vital role in supplying high-quality natural rubber materials through land management of approximately 17,900 hectares (Budi, 2019).2The location of this plantation is very strategic because it has fertile soil conditions and an ideal climate for cultivating rubber trees (Hevea brasiliensis), which allows Bridgestone to maintain an efficient and sustainable supply chain for its production needs in more than 150 countries (Bridgestone News, 2022)3The company's vision to "Serve the Community with Superior Quality" is reflected in their commitment to innovation in rubber processing technology and social responsibility towards the surrounding community in Simalungun (Bridgestone News, 2010)4

In the daily operations of a crumb rubber processing plant, the Slab Cutter machine occupies a central position as the main gateway for material flow. This machine has a mechanical function to cut large rubber lumps or slabs into smaller, more uniform pieces, thus facilitating the crushing process in a hammer mill or grinding in a creeper machine (Rubber Slab Cutter Machine). The main challenge in operating this machine is the physical characteristics of natural rubber which is very resilient and elastic, which demands large cutting forces and high blade material resistance. Without adequate maintenance, key components such as blades, V-belt transmission systems, and electric motors will experience excessive mechanical stress, leading to a drastic decrease in performance. Technical problems such as dull blades not only hamper cutting speed, but also cause the motor's workload to increase exponentially, which often leads to motor damage or very wasteful energy consumption.(Razul Harfi, Fadil Gunawan, Veriah Hadi, & Edy Supriyadi, 2022)

Problem identification in this observation focuses on the phenomenon of unplanned machine downtime due to critical component failures, often caused by the accumulation of dust and rubber residue. Irregular maintenance schedules often force machines to run to failure, resulting in the shutdown of entire production lines during peak operating hours. Furthermore, fluctuations in the size of rubber pieces produced by worn blades create problems in the drying stage, where non-uniform pieces require different drying times, thus reducing the physical quality of the resulting crumb rubber. These problems indicate a gap between the machine's design capacity and field maintenance practices that needs to be addressed immediately through a more proactive and structured maintenance management approach (Machine Maintenance Planning with the Markov Chain Method to Reduce Maintenance Costs).

The purpose of this Field Work Practice observation report is to map in detail the Slab Cutter machine maintenance procedures that apply at PT Bridgestone and analyze their effectiveness in supporting production efficiency targets. The author seeks to evaluate how each maintenance action, from daily inspections to periodic component replacements, contributes to reducing machine failure rates and optimizing resource use. In addition, this report aims to provide technical recommendations based on observation data regarding ideal maintenance intervals to minimize long-term repair costs. Through an in-depth understanding of the machine's working mechanisms and failure patterns, it is hoped that this report can serve as a reference for improving the asset management system in the rubber processing plant area.

The theoretical support in this report refers to the principles of preventive maintenance and reliability-centered maintenance. References regarding the design of natural rubber cutting machines using the VDI 2221 method can be accessed through accredited journal portals such as JTTM which emphasizes the importance of blade materials such as 440C Stainless Steel to maintain cleanliness and durability. Similar literature shows that the use of the Markov Chain or Age Replacement method in maintenance planning can significantly reduce repair costs by up to 20% and increase the overall operational efficiency of the factory. In addition, research on the effectiveness of machine maintenance at PTPN XII confirms that daily cleaning of the mill rolls and water outlets is crucial to prevent rubber sticking and maintain output quality

(Machine Maintenance Planning with the Markov Chain Method to Reduce Maintenance Costs)

Fieldwork Internships (PKL) are an integral component of the engineering curriculum, serving as a bridge between academic theory in the classroom and the operational realities of the industrial world. Through PKL, students are given the opportunity to apply concepts from information systems, mechanical engineering, and industrial management in a dynamic and competitive work environment. This program not only hones technical skills such as machine troubleshooting and production data analysis, but also builds non-technical competencies such as adaptability, teamwork, and professional communication. At multinational companies like PT Bridgestone, PKL provides valuable insights into occupational safety (OHS) standards, global industry ethics, and the importance of responding quickly to operational disruptions to maintain reliable energy and material supplies.(Wibowo Ari, 2021)

The contribution of internships to the field of industrial engineering is significant, particularly in providing new perspectives or independent audits of the efficiency of ongoing production processes. Internship students are often able to identify waste points or potential system failures that internal staff might overlook due to daily routines. A high-quality internship report can provide input to company management in developing more effective maintenance strategies or adopting new, more efficient technologies. Furthermore, the resulting technical documentation enriches the practical literature in educational institutions, ensuring that curricula remain relevant to Industry 4.0 technology trends, such as the use of AI for machine failure diagnosis.(Wibowo Ari, 2021)

The importance of asset maintenance at PT Bridgestone is also closely linked to the company's global sustainability strategy. By maintaining optimal Slab Cutter machines, the company can reduce electricity consumption and minimize the carbon footprint generated from the manufacturing process. This aligns with Bridgestone's long-term environmental vision of achieving carbon neutrality and using 100% sustainable materials by 2050. Proper maintenance also means minimizing waste from defective or off-specification products, thereby increasing the overall yield of natural rubber production. Therefore, machine maintenance is not simply a mechanical matter, but part of an environmental management philosophy that is responsible for the plantation ecosystem and local communities (Bridgestone News, 2022).

Finally, PT Bridgestone's dedication to human resource development through the PKL program demonstrates the company's commitment to the advancement of education in Indonesia. By providing access for students to learn about rubber processing in its five divisions—Naga Raja, Dolok Merangir, Dolok Tua Ulu, Dolok Ulu, and Aek Tarum—Bridgestone contributes to producing a skilled workforce ready to face the challenges of the future industry. This report is expected to be a form of positive feedback from students to the company, providing an objective analysis of the maintenance conditions of the Slab Cutter machine that can be used to improve the efficiency and competitiveness of Bridgestone rubber products in the international market.

Figure 1. Location of PT. Bridgestone Sumatra Rubber Estate (BSRE)

Unlike previous studies that primarily discuss preventive maintenance conceptually or through general downtime reduction, this study contributes by integrating field-based maintenance observation with measurable operational performance indicators, including downtime percentage, motor thermal behavior, and output loss estimation in the slab cutting stage of natural rubber processing. This study provides a micro-level mechanical and operational analysis of slab cutter maintenance, which remains underexplored in existing rubber industry maintenance literature.

2. Literature Review

2.1 Machine Maintenance Management in the Manufacturing Industry

Machine maintenance management is a fundamental element in manufacturing production systems, aiming to ensure equipment reliability, process continuity, and consistent product quality. According to industrial asset management principles, maintenance is understood not only as a technical repair activity but as an integrated system encompassing the planning, control, and continuous evaluation of machine performance. Effective maintenance management directly contributes to reduced downtime, stable production capacity, and operational cost efficiency.

In the context of the rubber processing industry, the elastic, sticky, and variable water content characteristics of the raw material require a more disciplined machine maintenance system than in rigid material-based manufacturing industries. Previous research has shown that machine failures in the rubber industry are generally triggered by wear of cutting components, accumulation of material residue, and mismatching maintenance intervals with the actual machine workload (Gultom et al., 2016).

2.2 Preventive Maintenance as a Machine Reliability Strategy

Preventive maintenance is a planned maintenance approach performed before a machine failure occurs with the goal of maintaining optimal operational conditions. This strategy emphasizes routine inspection, cleaning, lubrication, and component replacement based on specified time intervals or operating hours. Maintenance management literature confirms that preventive maintenance is more effective than the run-to-failure approach because it reduces emergency repair costs and lost production time.

Empirical research in various manufacturing sectors shows that consistent preventive maintenance can reduce downtime by 30–50% and increase the lifespan of critical machine components (Umsida, 2022). In the rubber processing industry, routine cleaning of latex residue and blade sharpening have been shown to be dominant factors in maintaining stable cutting and milling machine performance (Polbangtan Manokwari, 2021).

2.3 Reliability Centered Maintenance (RCM) in Production Systems

Reliability-Centered Maintenance (RCM) is a reliability-based maintenance approach that focuses on identifying critical machine functions, failure modes, and their operational impacts. Unlike conventional, periodic preventive maintenance, RCM emphasizes risk analysis and failure prioritization to determine the most effective maintenance actions.

Several studies have shown that implementing RCM on heavy-duty production machines can increase machine availability and reduce total maintenance costs by up to 20% (UMM Journal, 2020). In the rubber industry, RCM is relevant for early-process machines such as slab cutters, as their failure can have a systemic impact on the entire subsequent production line, from milling and drying to the quality of the crumb rubber produced.

2.4 Slab Cutter Machine and Its Operational Characteristics

The slab cutter machine functions as a pre-processing unit that reduces raw rubber slabs into smaller, more uniform pieces. Technical literature indicates that slab cutter performance is greatly influenced by blade sharpness, transmission system stability, and the appropriateness of motor power to the cutting load (Razul Harfi et al., 2022).

Blade material is a critical aspect in the design and maintenance of this machine. The use of 440C stainless steel is reported to offer advantages in wear resistance, sharpness stability, and hygienic safety for crumb rubber products. Blade maintenance not only reduces cut quality but also significantly increases motor load and energy consumption, potentially causing further damage to the machine's electrical system.

2.5 The Relationship Between Machine Maintenance and Rubber Production Efficiency

Production efficiency in the rubber industry is significantly influenced by machine reliability early in the process. Research shows that irregularities in the size of rubber slabs increase drying time, energy consumption, and the risk of final product defects. Therefore, the quality of the slab cutter's output is directly correlated with the yield and quality of crumb rubber.

Studies in the rubber and related machinery industries report that implementing structured preventive maintenance can improve production efficiency and reduce material waste (Ilmubersama, 2023). These findings reinforce the view that machine maintenance not only has technical impact but also strategic value in achieving sustainable production targets.

2.6 Field Work Practice (PKL) as a Source of Empirical Industrial Data

In the context of engineering education, Field Work Practice (PKL) serves as a real-world, experiential learning medium that allows students to directly observe industrial production systems. Vocational education literature indicates that PKL significantly contributes to understanding work systems, identifying operational problems, and developing students' analytical competencies (Wibowo Ari, 2021).

The data from fieldworker observations has strong empirical value when linked to maintenance management theory and actual industrial practices. Therefore, integrating field findings with theoretical foundations makes fieldworker reports not merely descriptive but also analytical and applicable to industrial management development.

3. Research Methodology

3.1 Research Design

This study employs an industrial case study approach with a mixed qualitative–quantitative descriptive analysis. The case study design is appropriate because the research focuses on an in-depth examination of maintenance practices and their operational impacts on a specific production asset within its real industrial context. The qualitative component is used to describe maintenance procedures, failure characteristics, and operator–machine interactions, while the quantitative component is applied to evaluate maintenance performance using measurable operational indicators such as downtime, production loss, and motor thermal behavior.

This methodological combination enables a more comprehensive assessment of maintenance effectiveness by linking observed maintenance activities to quantifiable production performance outcomes, thereby strengthening the empirical contribution of the study.

3.2 Object of Study and Observation Scope

The object of this study is one unit of a Slab Cutter machine operating at PT Bridgestone Sumatra Rubber Estate (BSRE), which functions as the initial cutting stage in the natural rubber processing line. The slab cutter plays a critical role in determining material flow continuity and size uniformity before subsequent milling and drying processes.

The technical and operational characteristics of the observed machine are defined as follows:

1. Number of machines observed: 1 unit Slab Cutter
2. Installed capacity: approximately 3–4 tons per hour
3. Motor specification: 75 HP, 1,450 rpm
4. Operational schedule: 1 shift per day
5. Shift duration: 8 hours of continuous operation
6. Observation period: approximately 1–2 months

Observations were conducted during normal production conditions to capture realistic workload variations, maintenance practices, and machine behavior under actual industrial operating constraints.

3.3 Data Collection Methods

Data collection was carried out using multiple sources to ensure empirical robustness and data triangulation:

1. Direct Field Observation
   Continuous observations were performed on machine operation, component conditions, and routine maintenance activities. Particular attention was given to blade cleanliness, transmission belt condition, motor temperature, bearing lubrication, and cooling system performance.
2. Maintenance and Production Records
   Secondary data were obtained from daily production reports and maintenance logbooks, which documented downtime duration, failure frequency, and corrective actions taken during the observation period.\
3. Semi-Structured Interviews
   Interviews were conducted with machine operators and maintenance technicians to obtain contextual information regarding common failure modes, maintenance decision-making, and operational challenges. Interview data were used to support and validate observational findings rather than as the primary analytical basis.

3.4 Maintenance Performance Indicators

To address the effectiveness of maintenance activities quantitatively, several maintenance performance indicators were employed. These indicators were selected based on their relevance to production continuity, machine reliability, and operational efficiency in industrial maintenance management.

Table 1 Performance indicator with measurement

Performance Indicator	Measurement Basis
Downtime Percentage	(Total Downtime / Total Available Operating Time) × 100%
Lost Production	Downtime duration × machine capacity (tons/hour)
Motor Thermal Stability	Average motor casing temperature during operation (°C)
Maintenance Effectiveness	Reduction in frequency of unplanned failures over the observation period

Downtime data were accumulated monthly to identify dominant failure categories, while motor thermal stability was evaluated through repeated temperature readings under comparable operating conditions. Maintenance effectiveness was assessed by comparing failure occurrences before and after the implementation of routine preventive maintenance activities.

3.5 Data Analysis Technique

The collected data were analyzed using a descriptive analytical approach. Quantitative data related to downtime, failure frequency, and production loss were tabulated and interpreted to identify maintenance-related performance trends. Qualitative findings from observations and interviews were analyzed to explain the mechanical and operational causes underlying the observed performance outcomes.

Triangulation was applied by cross-referencing observational results, maintenance records, and interview insights to ensure data consistency and analytical validity. The analysis emphasizes the relationship between preventive maintenance actions and their direct operational impacts rather than predictive or statistical inference.

4. Results and Discussion

4.1 Observation Findings of Existing Machine Conditions

Based on observations at the PT Bridgestone Sumatra Rubber Estate processing unit, the slab cutter used is a heavy-duty unit designed to reduce rubber material at high capacity. Objective field observations indicate that the machine operates under fluctuating load conditions, depending on the hardness level of the rubber slabs received from the plantation division.

The following is a table of technical specifications and conditions of the main components that were successfully documented during the observation activities:

Table 2. Technical specifications and main conditions

Component main	Technical/Material Specifications	Observation Conditions	Strategic Function
Knife Cutter	High Tensile Steel/Stainless 440c	Accumulation of sap residue on sharp edges	Quickly reduce the dimensions of rubber slabs
Electric motor	75HP – 1,450 Rpm	Stable operating temperature at 65°C	Main driving force source
System Transmission	V-Belt Type A/B with Pulleys	Mild slip symptoms were found at peak loads.	Transmits torque from the motor to the blade rotor
Shaft Bearing	Heavy Duty Roller Bearings (NSK Japan)	Minimal vibration, adequate lubrication	Supports stable rotor shaft rotation
Hopper Inlet	Steel Frame (1510x1040 mm)	Mild corrosion in the material contact area	Raw material entry route for rubber slabs
Frame	Robust carbon steel plate	Sturdy structure, mounted on a concrete foundation	Resists mechanical vibrations during cutting

The above data indicates that structurally, the Slab Cutter machine at BSRE is in excellent condition, but requires special attention to the blade area and transmission system to maintain efficiency. Daily observations noted that the buildup of rubber residue on the blade can increase cutting resistance, which, if not cleaned regularly, will result in uneven rubber cut edges and uneven particle sizes.

Figure 2. (Illustration) BSRE Lump

4.1 Implementation of Preventive Maintenance Schedule

During the internship period, a structured maintenance schedule was observed, implemented by the technical department. This maintenance was divided into several frequency levels to ensure machine reliability was maintained without disrupting strict daily production targets.

Table 3. Frequency levels to ensure machine reliability

Maintenance Frequency	Types of Maintenance Activities	Success Indicators	Impact on Efficiency
Daily (H)	Cleaning of sap residue & water spraying	The knife is clean of sticky clumps.	Prevent overheating & motor overload
Weekly (M)	V-Belt tension inspection & bearing lubrication	Optimal belt tension, no squeaking sound	Power transmission efficiency up to 98%
Monthly (B)	Resharpening or replacing blades	Uniform & sharp cutting results	Reducing electricity consumption per ton of rubber

Observations show that adherence to the daily (H) schedule is crucial. On days where cleaning was delayed due to high production volumes, electric motor casing temperatures were recorded at 5-10% above normal. This indicates that basic maintenance has direct implications for the plant's energy efficiency. (Gultom, Mursalin, & Rahmi, 2016)

4.2 Damage and Downtime Data Analysis

Secondary data from daily production reports during the observation period was accumulated to identify critical failure points. Based on the records, the majority of machine downtime was caused by minor issues that could have been prevented through more stringent preventive maintenance.

Table 4. Daily reports during the observation period

Damage Category	Frequency of Events (Per Month)	Average Downtime Duration	The main cause
Dull / Jammed Knife	4 times	45 Minutes	Hard material contamination in the slab
V-Belt Slip Belt	2 times	20 Minutes	Belt material fatigue and overload
Motor Overheating	1 time	60 Minutes	Motor ventilation is blocked by dust or high mechanical load
Sensor / Electrical Fault	1 time	30 minutes	Engine vibrations loosen cable connections

The implication of these findings is that 245 minutes of downtime per month for a single slab cutter machine can result in a loss of approximately 12-16 tons of raw rubber (assuming a capacity of 3-4 tons/hour). This figure demonstrates that improving reliability through preventive maintenance has significant economic value for PT Bridgestone. Simply reducing blade jamming can significantly improve the company's productivity.

4.3 Working Mechanism and Cutting Dynamics

The Slab Cutter machine operates on the principle of high rotor rotation, which drives a vertical cutting blade to strike a rubber slab that enters via gravity or a conveyor. The cutting force (Fc) generated by the blade depends heavily on the motor torque and the sharpness of the blade angle. Based on cutting machine design theory, the cutting force must exceed the maximum shear stress of the rubber at operating temperature.

Figure 3. Slab Cutter Technique

Machine Name	: Slab Cutter
Machine Function	: Raw Material Cutter
Motor	: 75 HP, 1,450 Rpm
Speed	: 58 rpm
Capacity	: 6,500 tons/dr

Field observations show that when raw rubber slabs have a high-water content, the rubber tends to be stickier and increases friction between the blade and the material. This requires a cooling system (water spray) to operate continuously to reduce heat caused by friction and prevent the rubber from melting again and sticking to the blade surface. The use of 440C Stainless Steel blade material has proven effective in maintaining sharpness longer than ordinary carbon steel, while also preventing rust contamination in crumb rubber products.

4.4 Analysis of Implications of Observation Findings

These observational findings have profound implications for PT Bridgestone's operational management. First, the efficiency of crumb rubber production is highly dependent on the initial cutting stage. If the slab cutter fails to produce uniform pieces (for example, pieces exceeding 10 cm in size), the subsequent crushing process in the hammer mill will be slower and more energy-intensive. Second, regular preventive maintenance has proven to be a key factor in reducing emergency repair costs. Repairs performed after a machine breakdown cost an average of three times more than routine maintenance, as they often involve replacing major components such as burned-out shafts or motors.

Furthermore, the implications for the quality of the final product cannot be ignored. The consistency of the cut size produced by a well-maintained slab cutter ensures that the drying process in the dryer is homogeneous. Rubber particles of uniform size dry simultaneously, thus avoiding the problem of "white spots" (the center of the rubber is still wet) or "over-drying" which can damage the physical properties of Bridgestone crumb rubber. This is vital for Bridgestone to maintain the quality standards of the premium product used in aircraft tires and high-end vehicles.

4.5 Observation Limitations

While these observations provide a comprehensive overview of the engine's maintenance status, several limitations should be noted. First, the observation period during the internship (approximately 1–2 months) was insufficient to observe long-term component failure cycles such as gear wear on the gearbox or degradation of the engine frame structure. Second, the motor performance data collection was based solely on external sensor readings and surface temperature observations, without in-depth dynamic electrical load testing using specialized energy meters. Third, the economic analysis was based on industry-standard cost estimates, as confidential internal company financial data was not fully accessible to the internship students.

4.6 Technical Recommendations Based on Discussion

Based on the analysis above, there are several strategic recommendations to increase the efficiency of rubber products at PT Bridgestone:

1. Maintenance Logbook Digitalization: Replacing manual logging with a tablet-based digital input system allows operators to monitor motor temperature trends and bearing vibration in real time. This allows for early detection of failures before damage occurs. Cooling System Optimization: Regularly inspecting the water spray nozzles in the blade area to ensure even water flow, preventing heat buildup that accelerates blade dulling.
2. Autonomous Maintenance Operator Training: Providing more intensive training to operators to be able to perform light maintenance tasks such as V-belt adjustment and sensor cleaning without having to wait for the maintenance technician team, in accordance with the principles of Total Productive Maintenance. (Yusrizal, 2024). Spare Parts Quality Audit: Ensures consistent use of blades with certified materials (such as 440C steel) to maintain cutting durability over 300 operating hours before resharpening.

Figure 4. Pully Technique

4.7 Mechanical Implication of Blade Wear and Motor Load

The mechanical performance of the slab cutter machine is strongly influenced by the condition of the cutting blades, particularly in relation to cutting resistance and motor load behavior. Natural rubber slabs exhibit high elasticity and shear resistance, requiring sufficient cutting force to achieve effective size reduction. When blade sharpness deteriorates due to wear or contamination by rubber residue, the effective cutting angle increases, resulting in higher cutting resistance during operation.

Field observations revealed that delayed blade cleaning and resharpening led to a noticeable increase in mechanical load on the driving system. This condition was reflected by an increase in motor casing temperature of approximately 5–10% above normal operating levels, indicating elevated torque demand and higher electrical energy consumption. Increased motor load not only reduces energy efficiency but also accelerates wear on auxiliary components such as transmission belts and shaft bearings.

From a mechanical perspective, the increased cutting resistance caused by blade dullness generates higher reaction forces on the rotor shaft. This condition intensifies bearing stress and vibration levels, which, if sustained, may shorten bearing service life and increase the probability of unplanned machine shutdowns. Therefore, blade condition functions as a critical mechanical variable that directly affects cutting dynamics, motor loading, and overall machine reliability.

These findings emphasize that blade maintenance should not be regarded solely as a routine housekeeping activity, but rather as a strategic mechanical control parameter in slab cutter operation. Maintaining optimal blade sharpness and cleanliness contributes to stable torque transmission, controlled motor temperature, and reduced mechanical fatigue within the system.

4.8 Quantitative Analysis of Downtime and Production Loss

Quantitative analysis was conducted using secondary data obtained from daily production reports and maintenance logbooks during the observation period. The analysis indicates that the slab cutter machine experienced an average monthly downtime of approximately 245 minutes, primarily caused by preventable mechanical issues.

Based on the installed machine capacity of 3–4 tons per hour, this downtime corresponds to an estimated production loss of 12–16 tons of raw rubber per month. This production loss represents a significant operational inefficiency, considering the slab cutter's role as the initial processing unit that determines material flow continuity throughout the entire rubber processing line.

Further categorization of downtime events shows that blade-related failures accounted for approximately 60% of total downtime occurrences, followed by transmission belt slippage and motor overheating. Blade jamming and dull cutting edges were commonly associated with the accumulation of rubber residue and delayed maintenance actions. These findings demonstrate that a substantial proportion of downtime events could be mitigated through stricter adherence to preventive maintenance schedules, particularly daily cleaning and periodic blade resharpening.

The quantitative results confirm that preventive maintenance effectiveness can be directly evaluated through measurable performance indicators rather than qualitative observation alone. Reducing blade-related failures has the potential to significantly decrease downtime duration, stabilize production output, and enhance overall operational efficiency. Consequently, maintenance activities targeting critical cutting components yield disproportionate benefits relative to their implementation cost.

5. Conclusion

This study demonstrates that disciplined preventive maintenance significantly improves slab cutter operational reliability, as reflected by reduced downtime, stabilized motor thermal conditions, and improved production continuity. The implementation of a disciplined preventive maintenance strategy, particularly in the aspects of daily cleaning of sap residue and inspection of the transmission system, has been proven to be able to reduce unplanned downtime that is detrimental to the company's daily productivity. Observations show that well-maintained machines not only operate with more stable energy consumption (motor temperature maintained at around 65°C), but also ensure uniformity in the size of raw rubber pieces. This particle uniformity is a technical prerequisite for optimizing the milling and drying processes in subsequent production stages, which directly impacts the physical quality of the final crumb rubber product.

The results of this study briefly state that adherence to weekly and monthly routine maintenance schedules has a positive correlation with reducing the frequency of failure of critical components such as cutting blades and transmission belts. By minimizing the occurrence of stuck blades and motor slippage, PT Bridgestone can maximize daily output to consistently reach the design capacity of 4 tons per hour. Therefore, investment in asset maintenance management is not just an additional cost, but a strategic strategy to maintain the company's competitiveness in the global market through high operational efficiency and superior product quality in accordance with Bridgestone's vision.

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