Preventive Maintenance of Switcher in The Railway Industry

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A B S T R A C T

This study investigates the preventive maintenance of switchers within the railway industry, specifically focusing on practices implemented in Mojokerto Operational Area. Railways are essential for global supply chains, offering efficient transportation of goods and passengers while contributing to economic growth and environmental sustainability. Switchers, as critical components of railway infrastructure, facilitate the movement of trains between tracks and require meticulous maintenance to ensure operational safety and reliability. The research employs a mixed-methods approach, incorporating both qualitative and quantitative data collection through field observations and semi-structured interviews with maintenance personnel. Findings reveal that while scheduled maintenance occurs bi-weekly, challenges persist, particularly concerning the switcher motor, which poses significant risks if not promptly addressed. The study highlights the importance of implementing a Total Productive Maintenance approach, which engages all employees in the maintenance process, thereby enhancing operational efficiency and reducing the likelihood of equipment failure. A cost analysis indicates that maintenance expenditures amount to IDR 486,000.00, while repair costs total IDR 484,000.00, underscoring the financial implications of effective maintenance practices. Proactive maintenance not only mitigates the risk of disruptions but also supports broader sustainability goals within the railway sector. This research contributes valuable insights into the maintenance of railway switchers, emphasizing the need for ongoing evaluation and improvement of maintenance strategies to ensure the safety and efficiency of railway operations.

I. INTRODUCTION

Railways play a pivotal role in the global supply chain and economic landscape, serving as a vital mode of transportation for both goods and passengers (Zhang, and Wang., 2023). The efficiency of rail transport is characterized by its ability to move large volumes of freight over considerable distances with lower operational costs compared to road transport (Høyer, and Høyer., 2020). This efficiency translates into significant economic benefits, as railways facilitate timely deliveries, reduce congestion on highways, and enhance connectivity between urban and rural areas. (Alhaj, and Alhaj., 2020) Furthermore, railways are increasingly recognized for their environmental advantages, particularly in the context of reducing greenhouse gas emissions. Trains are generally more energy-efficient than other forms of transportation, such as trucks and airplanes, owing to their ability to carry substantial loads while consuming less fuel per ton-mile (Zhang, and Liang., 2021). This characteristic positions railways as a sustainable alternative in the quest for a low-emission transportation system, aligning with global efforts to combat climate change and promote environmentally responsible practices within the logistics sector (Mustajib et all., 2025). Consequently, the integration of railways into supply chain strategies not only bolsters economic growth but also contributes to the overarching goal of achieving a more sustainable and resilient transportation infrastructure (Karam, and Al-Masri., 2021).

Switches is critical components of railway infrastructure that facilitate the movement of trains from one track to another (Liu, Q. and Wang., 2022). These mechanical devices consist of several key components, including switch blades, stock rails, a switch machine, and various fastening elements. The switch blades are movable rails that can be aligned to direct the train onto the desired track, while the stock rails remain fixed and serve as the main guiding rails. The switch machine, which can be manually operated or automated, is responsible for moving the switch blades to the appropriate position, ensuring that trains can safely transition between tracks. The role of switches in railway operations is paramount, as they enable efficient train routing, enhance operational flexibility, and optimize the use of railway networks. Their importance is underscored by the fact that improper functioning or failure of switches can lead to severe accidents, including derailments and collisions, thereby posing significant risks to both passenger safety and freight operations. Consequently, regular maintenance and inspection of switches are essential to ensure their reliability and functionality, ultimately contributing to the overall safety and efficiency of railway transportation systems.

Preventive maintenance is a systematic approach to maintaining equipment and machinery that involves scheduled inspections, servicing, and repairs to prevent potential failures and extend the lifespan of assets. This proactive strategy is grounded in the principle of addressing maintenance needs before they escalate into significant malfunctions, thereby minimizing unplanned downtime and reducing repair costs (Yusron et all., 2022). In various industries, including manufacturing, transportation, and utilities, preventive maintenance plays a crucial role in enhancing operational efficiency and reliability. By implementing routine checks and maintenance activities, organizations can identify wear and tear, replace worn components, and ensure that systems operate within optimal parameters. Moreover, preventive maintenance contributes to improved safety by mitigating the risks associated with equipment failure, which can lead to accidents and injuries. The adoption of this maintenance philosophy not only fosters a culture of reliability and accountability within organizations but also aligns with broader sustainability goals by optimizing resource utilization and minimizing waste. In summary, preventive maintenance is an essential practice that enhances asset performance, reduces operational risks, and supports organizational objectives in today's competitive and increasingly complex industrial landscape.

II. METHODS

This study on the preventive maintenance of switchers in the railway industry was conducted within the Department of Signaling, Telecommunications, and Electrical at the 8.8 Mojokerto Operational Area 8 Surabaya of PT Kereta Api Indonesia. The methodology employed in this research consisted of a combination of qualitative and quantitative approaches, aimed at comprehensively assessing the current preventive maintenance practices and their effectiveness.

A. Data Collection

Data were collected through a systematic process involving both field observations and interviews. Field observations were conducted to evaluate the existing maintenance procedures for switchers, focusing on the frequency of inspections, maintenance activities performed, and the overall condition of the equipment. A checklist was developed to standardize the observation process, ensuring that all relevant aspects of the switchers' maintenance were documented comprehensively. In addition to field observations, semi-structured interviews were conducted with key personnel, including maintenance engineers, technicians, and supervisors within the Department of Signaling, Telecommunications, and Electrical. These interviews aimed to gather insights regarding the challenges faced in the maintenance process, the effectiveness of current preventive maintenance strategies, and suggestions for improvement. The interviews were recorded with the consent of the participants and subsequently transcribed for analysis.

B. Data Analysis

The qualitative data obtained from interviews were analyzed using thematic analysis, which involved identifying and categorizing recurring themes related to preventive maintenance practices. This analysis facilitated the identification of common challenges and best practices, providing a comprehensive understanding of the current state of maintenance for switchers. Quantitative data were gathered from maintenance logs and reports, detailing the frequency of maintenance activities, types of interventions performed, and any recorded incidents of switcher failures. Descriptive statistics were employed to analyze this data, allowing for the identification of trends in maintenance practices and their correlation with the operational reliability of switchers.

C. Implementation of Preventive Maintenance Program

Based on the findings from the data analysis, a preventive maintenance program was developed, incorporating best practices identified during the research. This program included scheduled maintenance activities, inspection protocols, and training recommendations for maintenance personnel. The program was designed to be implemented over a six-month period, with periodic evaluations to assess its effectiveness and make necessary adjustments.

D. Evaluation of Effectiveness

To evaluate the effectiveness of the implemented preventive maintenance program, a follow-up assessment was conducted after the six-month implementation period. This assessment involved a repeat of the initial field observations and interviews, as well as the analysis of maintenance logs to compare the frequency of switcher failures before and after the implementation of the program. The results of this evaluation were analyzed to determine the impact of the preventive maintenance program on the reliability and performance of the switchers. Through this comprehensive methodological approach, the study aimed to provide valuable insights into the preventive maintenance of switchers in the railway industry, contributing to enhanced operational efficiency and safety within PT Kereta Api Indonesia.

III. RESULT AND DISCUSSION

A. Processes and Information Flow

The following table outlines the inspection procedures for switcher maintenance, including the benchmark and classification criteria shown on table 1.

TABLE I. PROCESESS AND INFORMATION FLOW IN SWITCHER RAILWAY

No	Checking Method	Benchmark	Classification	
a	Position and condition of the switch motor on the supports	No looseness	OK	No looseness
	Inspect the switch motor box for looseness		NOT OK	looseness
b	Components inside the switch motor box	No foreign materials present	OK	No foreign materials present
	Inspect the components inside the motor; there should be no water, dirt, or other obstructive materials		NOT OK	foreign materials present
c	Manual operation functionality with the crank			
	Connect the crank motor to the input of the manual switch motor (see diagram of the switch motor box)	Cannot be operated from the center, and the crank can be turned easily	OK	Cannot be operated from the center or the crank cannot be turned easily
	While the crank is being turned, the switch should be operable from the center (PPKA)			
	Ensure that the switch cannot be operated by PPKA		NOT OK	Can be operated from the center or the crank cannot be turned easily
	Turn the crank so that the tongue can move			
	The turning action should be light and manageable			

No	Checking Method	Benchmark	Classification	
d	Condition of the lubrication of the moving parts (see diagram of the components inside the switch motor box)	Even and not dry in any part	OK	Even and not dry in any part
-	Inspect moving parts that require lubrication		NOT OK	Not even or has dry parts
e	Cable conditions	No damage, cable connections must not be loose	OK	No Damaged or cable connections are loose
	Inspect the condition of cable connections to equipment; there should be no damage or looseness		NOT OK	Damaged or cable connections are loose

From this table, it can be obtained that there are special standards in the maintenance of the switcher, if the switcher is not suitable or is interpreted as not ok, then repairs are carried out by officers, but if the disturbance cannot be repaired, it is necessary to replace the components that are experiencing wear and tear. So on in the maintenance of the vesel equipment according to the procedure.

B. *Maintenance Cost*

The following are the costs required by Signaling, Telecommunications, and Electrical at the 8.8 Mojokerto Operational Area 8 Surabaya for maintenance and repair of switchers:

TABLE II. COST ON SWITCHER

Equipment	Price (IDR)	Unit	Total Cost (IDR)
Maintenance of Switches			
Meter	95,000.00	1	95,000.00
Proof 2-5 mm	150,000.00	1	150,000.00
WD 40 333 ml	50,000.00	3	150,000.00
Brush	2,000.00	1	2,000.00
Majun	6,000.00	2	12,000.00
English Wrench	77,000.00	1	77,000.00
Total for Maintenance			Rp 486,000.00
Repair of Switches			
Avo Meter	250,000.00	1	250,000.00
English Wrench	71,000.00	1	71,000.00
Screwdriver Set	50,000.00	1	50,000.00
Hammer	67,000.00	1	67,000.00
Pliers	46,000.00	1	46,000.00
Total for Repair			Rp 484,000.00

Table 2 reveal it can be obtained that the cost is divided into two classifications, the first is maintenance costs and the second is repair costs. This cost includes costs for repairs and maintenance at other stations under the supervision of signal, Telecommunications, and Electrical at the 8.8 Mojokerto Operational Area 8 Surabaya. From the analysis presented in the table, it is evident that the total cost for the maintenance of switches amounts to IDR 486,000.00, while the total cost for the repair of switches is slightly lower at Rp 484,000.00. The equipment that incurs the highest cost in the maintenance category is the Avo Meter, which is priced at IDR 250,000.00, whereas the least expensive item is the brush, costing only IDR 2,000.00. In terms of implications, the higher costs associated with maintenance equipment, particularly the Avo Meter, highlight the necessity for investment in quality tools that ensure the effective operation of switchers. This investment is crucial for the long-term reliability and safety of railway operations. Conversely, the lower costs of repair equipment suggest that while repairs may be less expensive upfront, they may indicate a reactive approach to maintenance, potentially leading to higher long-term costs due to increased downtime and the risk of equipment failure. Ultimately, a balanced approach that prioritizes preventive maintenance while judiciously managing repair costs is essential for optimizing operational efficiency and ensuring the safety and reliability of railway systems.

C. *Productivity*

Productivity can be defined as the ratio of service value to input used. The number of switcher in Signal, Telecommunications, and Electrical at the 8.8 Mojokerto Operational Area 8 Surabaya is 30 units. Maintenance of money orders is carried out once every 2 weeks, which means that in 1 month 2 maintenance is conducted. The following is a list of the number of wires that are actively maintained (maintenance) at each station under the control of the Signal, Telecommunications, and Electrical at the 8.8 Mojokerto Operational Area 8 Surabaya

TABLE III. LIST ON SWITCHER PER AREA

Station	Active Switcher Number	Maintenance Frequencies (month)
Mojokerto	W23, W25, W31, W87, W99, W105	2
Tarik	W23, W25, W37, W31, W27, W83, W87, W89, W93, W105	2
Krian	W19, W25, W37, W89, W93, W105	2
Kedinding	W19, W27, W99, W105	2
Bolaran	W29, W27, W89, W95	2

The labour hours used by Negative check (PNC) to perform the maintenance of the money orders is 64 hours. The following is the calculation of PNC's partial productivity on money order maintenance. Average number of switcher served per month = 60 units . Special labor hours for money order maintenance = 64 hours per month. PNC productivity in the maintenance of money orders of 93% shows high productivity because it is close to 100%. It similar to (Jufriyanto et all., 2023)

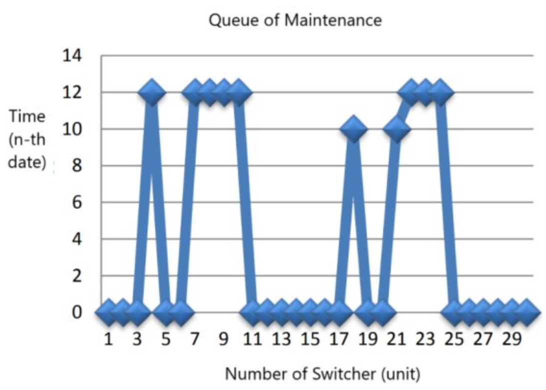

Fig. 1. Queue of Switcher Railway Maintenancec

Based the figure 1 it can be obtained that there is a queue in the maintenance of wires on the maintained wires starting from Mojokerto Station, Tarik, Kedinding, Krian, and Boharan Station. This can occur due to delays in maintenance because there are disturbances on other tracks that must be resolved first. So that the vesel is delayed in maintenance and will be maintained after the more important disturbance is resolved.

D. Quality Assurance

VP Quality Assurance and GCG Responsible for developing quality management policies that include standards and quality assurance systems based on ISO standards, evaluating the implementation of quality assurance systems and managing continuous quality improvement. Quality improvement, ensuring compliance and implementation of GCG through the management of the whistleblowing system, as well as monitoring the implementation of the Superior Performance Assessment Criteria (SPAC) system, as well as monitoring the implementation of SPAC for SOEs within the Company.

Preparation of a quality assurance system that includes: preparation of strategies, policies and quality management plans; establishment of quality standardization based on ISO standards, implementation guidelines and quality assessment guidelines; socialization of activities and quality management models. socialization of activities and quality management models that have been determined to be implemented: follow-up on various findings / feedback on implementation inconsistencies / non-compliance and increasing employee competence on the Quality Management System.

Follow-up process of audit findings. Quality Management System (QMS) and SPI audits, monitoring the process of implementing a quality assurance system based on ISO standards in units, making recommendations on audit results to be followed up, making audit schedules for all units: management surveillance audits, certification audits and recertification audits, as ISO internal auditor coordinator (lead auditor), as a representative of the Management Representative (MR) Centre and monitoring the implementation of the BUMN SPAC within the company. Quality costs are costs that need to be incurred by the company that are needed to meet standardized quality. In the maintenance of the SINTEL department's own switcher service maintenance, there are costs that must be incurred to meet the quality shown on table 4

TABLE IV. QUALITY COST OF SWITCHER

Material	Table Column Head		
	Number	*Price*	*Total*
WD 40 330ml	3	IDR 150.000,00	IDR 162.000,00
Majun	2 kg	IDR 12.000	

From the table 4 can be obtained information that the materials used for maintenance switcher each month that must be spent by SINTEL Mojokerto Station is Rp. 162,000.00. The cost does not include the cost of repairs, because in the repair of wesel less need certain materials, only using tools whose cost details are contained in the cost. However, these costs include maintenance of other stations under SINTEL Mojokerto, including Tarik Station, Boharan, Krian, and Kedinding Station.

IV. CONCLUSION

Switcher is part of the railway which is a vulnerable point on the train, so it must be carefully maintained so that all components of the switcher must be in the correct position, undamaged and safe for the train to pass and as early as possible known any deviations, damage, lack of components are quickly resolved. In this practical work at PT. KAI, there is routine maintenance once every 2 weeks for each switcher , but there are still some disturbances such as disturbances in the switcher needle, switcher tongue and switcher motor. However, among the problems that occur, the switcher motor has the least number of problems, namely 2 times, but the problem of the switcher motor can cause the most fatal disturbance if it is not handled immediately because it triggers the train to crash and mess up the train schedule. A 20% problem with the switch motor will affect the train schedule deadline by 80%. In identifying the problems that occur in the switcher motor, to solve these problems, an approach using the Total Productive Maintenance method can be used. TPM is a maintenance concept that involves all employees to solve the problem of machine interference, replacement, maintenance, and prevention of interference.

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