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Analysis of Factors Affecting Premature Tire Damage on Loader Units and Its Impact on Underground Mine Productivity at Pt. Freeport Indonesia

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ABSTRACT: PT. Freeport Indonesia, the largest underground mining company in Indonesia, faces a significant challenge with premature tire damage on its production units. This damage results in costly downtime and negatively impacts mine productivity. This research aims to identify the factors contributing to premature tire damage and analyze their impact on company expenditures. Using a quantitative research method and multiple linear regression analysis techniques, this study found that factors such as "Puncture steel" and "Running flat" have a negative impact on company expenditures. On the other hand, the factor "Rock cut" shows a positive impact on company expenditures. This research provides valuable insights for PT. Freeport Indonesia to develop more effective tire maintenance strategies, reduce downtime, and optimize operational costs.

KEYWORDS: Premature tire damage; Underground mining; Company expenditures; Tire maintenance strategies; Operational costs

1. INTRODUCTION

PT. Freeport Indonesia, a world-class mining enterprise and a pioneer in the Indonesian mining sector, stands as a testament to the nation's rich mineral resources. A joint venture between Freeport-McMoran Corporation (FCX) and Mining Industry Indonesia (MIND ID), the company holds a significant stake in the extraction of copper, gold, and silver, primarily through its extensive underground mining operations in Papua.

Since embarking on its underground expansion in 2011, PT. Freeport Indonesia has been steadily developing a vast network of tunnels, projected to reach an impressive 700 kilometers by 2041, with the potential to extend even further to 1,000 kilometers. This ambitious undertaking is set to prolong the life of the mine for another four decades. Notably, the entirety of these underground operations is managed remotely through a sophisticated control room located 10 kilometers away from the mine itself. The mining process utilizes a combination of stopping and block caving methods across various locations, including the Deep Ore Zone (DOZ), Deep Mill Level Zone (DMLZ), Big Gossan, Kucing Liar, and Grasberg Block Cave (GBC)[1].

Currently, development efforts are concentrated on the DMLZ and GBC mines, with production targets at the forefront. However, these operations are not without their challenges. The presence of wet muck in certain draw point panels poses a considerable risk to workers, with the potential for sudden mudslides containing rocks. To address this, the company employs Load Haul Dump (LHD) equipment for material loading and transportation [2].

In a groundbreaking move for Southeast Asia, PT. Freeport Indonesia, in collaboration with PT. Telkomsel, has implemented 5G technology to enhance the integration, efficiency, and effectiveness of its underground mining operations. This cutting-edge technology facilitates automation, remote control, and improved safety and productivity within the mining environment. As the first company in ASEAN to adopt 5G Mining, PT. Freeport Indonesia sets a precedent for technological innovation in the region.

However, despite these advancements, the company faces ongoing challenges. The demanding nature of underground mining operations, coupled with the heavy reliance on Load Haul Dump loaders, places immense strain on tire performance. Premature tire damage, a frequent occurrence, leads to significant downtime and disrupts production. Data collected from October 2022 to September 2023 reveals a staggering 2463 instances of tire damage across 114 operational units, including AD60 trucks, LHD R1600 loaders, and LHD R1700 loaders in the DMLZ and GBC areas. The financial implications of these tire failures are substantial, with tire-related costs representing the second-largest expense for the company, surpassed only by fuel costs.

This critical issue forms the core of the present research. The study aims to identify and analyze the factors contributing to premature tire damage on production units, and to assess their impact on company expenditures and overall mine productivity. By addressing this pressing concern, PT. Freeport Indonesia can take proactive steps to mitigate tire-related losses, enhance operational efficiency, and ensure the long-term sustainability of its mining operations.

2. RESEARCH METHODS

2.1 Research Design

This research employs a quantitative approach to investigate the impact of premature tire damage on company expenditures. The collected data is analyzed using IBM SPSS (Statistical Package for Social Sciences) software to uncover the relationships between the relevant variables.

2.2 Data Collection

Primary data for this research was obtained from PT. Freeport Indonesia's internal documentation. Specifically, premature tire damage reports and tire scrap reports for the LHD R1600 loader during the year 2023 were the main focus. This data provides valuable insights into the types of tire damage, frequency of occurrences, and their impact on the company's operations.

2.3 Population and Sample

The research population encompasses all Tread Utilization Rate (TUR) data from Bridgestone tires that experienced premature damage in 2023, totaling 453 data points. Given the research's focus on the year 2023 and the availability of complete records for that period, the entire data population is utilized in this analysis.

2.4 Data Analysis Techniques

The data analysis process aims to answer the research questions by examining the relationships between the independent variables (Puncture steel, Rock cut, and Running flat) and the dependent variable (Company Expenses), which is represented by parameters such as Hours Meter (HM) and Tread Utilization Rate (TUR). The independent variables are treated as predictor variables (X) while the dependent variable is the response variable (Y) within the SPSS statistical software environment.

2.4.1 Data Collection and Preparation

Multiple linear regression analysis is employed to test the research hypotheses and assess the influence of various independent variables on the dependent variable. As part of this analysis, F-tests, t-tests, and the coefficient of determination are evaluated.

2.4.2 Normality Test

Skewness and kurtosis tests are conducted to verify the normality assumption of the data. These tests examine whether the distribution of each independent variable significantly deviates from a normal distribution. Data is considered normally distributed if the normal curve on the histogram resembles a bell shape, even in the presence of outliers. The SPSS software is used to generate histograms and calculate skewness and kurtosis ratios. Data is deemed normally distributed if these ratios fall within the acceptable range of -2 to +2.

2.4.3 Descriptive Statistical Analysis

Descriptive statistics are utilized to summarize and present the characteristics of the company data in a meaningful way. This involves calculating and presenting statistical measures such as mean, median, mode, and standard deviation for the variables under investigation. This analysis helps to gain a preliminary understanding of the data distribution and identify any potential outliers or unusual patterns.

2.4.4 Coefficient of Determination Analysis

The coefficient of determination (R-squared) is employed to assess the proportion of variance in the dependent variable that can be explained by the independent variables. It ranges from 0 to 1, with higher values indicating a stronger relationship between the predictors and the response. This analysis helps to quantify the overall explanatory power of the regression model.

2.4.5 Hypothesis Testing

Hypothesis testing is conducted using t-tests (partial) and F-tests (simultaneous). T-tests are used to examine the individual significance of each independent variable in predicting the dependent variable. F-tests, on the other hand, assess the overall significance of the regression model, determining whether the independent variables collectively have a significant impact on the dependent variable. A significance level of 0.05 is used as the threshold for decision-making in both tests.

In summary, this research employs a combination of data analysis techniques to rigorously examine the relationships between premature tire damage and company expenditures. The findings of this analysis will provide valuable insights for PT. Freeport Indonesia to optimize its tire maintenance strategies and improve overall operational efficiency.

3. RESULT AND DISCUSSION

3.1 Overview of the Research Subject

This study focuses on analyzing premature tire damage in LHD R1600 loaders within the underground mining operations of PT. Freeport Indonesia during the year 2023. Premature tire damage leads to operational downtime and increased company expenses due to the need for new tire purchases. A total of 453 cases of premature tire scrap from 47 LHD R1600 loaders were analyzed. The data used included daily and weekly tire usage reports, as well as the Tread Utilization Rate (TUR) of tires that experienced premature scrap. Three primary factors contributing to tire damage were identified: Puncture Steel, Rock Cut, and Running Flat.

3.2 Normality Test (Skewness and Kurtosis)

A normality test was conducted to ensure that the data is normally distributed, a crucial assumption in regression analysis. The test results showed that although the skewness and kurtosis ratios for the independent variables (X1, X2, X3) were within the acceptable range (-2 to +2), the dependent variable (company expenses) had significantly higher ratio values, indicating potential non-normality in its data distribution.

3.3 Descriptive Statistical Analysis

Descriptive analysis was used to summarize the data characteristics. The results indicated that company expenses in 2023 experienced a significant increase, with a skewness ratio of 68.8 and a kurtosis ratio of 266.

3.4 Multiple Regression Analysis

Multiple regression analysis was performed to examine the influence of the independent variables (Puncture Steel, Rock Cut, and Running Flat) on the dependent variable (company expenses).

3.4.1 F-test (Simultaneous)

The F-test results showed that, simultaneously, the independent variables did not have a significant effect on company expenses (Sig. = 0.068 > 0.05).

Table 1 F-Test

No	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.523	3	2.174	2.594	.068[a]
	Residual	29.343	35	.838		
	Total	35.865	38			
Predictors: (Constant), Running flat (RF), Puncture steel (PS), Rock cut (RC)						
Dependent Variable: Company Expenses (CE)						

3.4.2 Coefficient of Determination (R-squared)

The adjusted R-squared value of 0.112 indicates that only 11.2% of the variance in company expenses can be explained by the independent variables in the model. Other factors not included in this study likely influence the remaining 88.8% of the variance.

Table 2 Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	**.426[a]**	**.182**	**.112**	**$.91562**
a. Predictors: (Constant), Running flat (RF), Punctur Steel (PS), Rock cut (RC)				

3.4.3 t-test (Partial)

Table 3 t-test

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.853	.742		3.846	.000
	Punctur Steel (PS)	-.004	.008	-.072	-.463	.646
	Rock cut (RC)	.022	.009	.414	2.562	.015
	Running flat (RF)	-.013	.009	-.218	-1.369	.180

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	Running flat (RF)	-.013	.009	-.218	-1.369	.180
a. Dependent Variable: Company Expenses (CE)						

a. Puncture Steel: Did not have a significant effect on company expenses (Sig. = 0.646 > 0.05).
b. Rock Cut: Had a significant positive effect on company expenses (Sig. = 0.015 < 0.05).
c. Running Flat: Did not have a significant effect on company expenses (Sig. = 0.180 > 0.05).

3.5 Interpretation of Hypothesis Test Results

a. Hypothesis 1 (Puncture Steel): Rejected. There is insufficient evidence to suggest that Puncture Steel has a significant effect on company expenses.
b. Hypothesis 2 (Rock Cut): Accepted. Rock Cut was found to have a significant positive effect on company expenses. This indicates that an increase in Rock Cut occurrences contributes to higher company costs, likely due to the need for more frequent tire replacements.
c. Hypothesis 3 (Running Flat): Rejected. There is insufficient evidence to suggest that Running Flat has a significant effect on company expenses.

4. CONCLUSION

The results of this study provide valuable insights into the factors influencing premature tire damage in LHD R1600 loaders at PT. Freeport Indonesia. Specifically, Rock Cut was identified as a significant factor that increases company expenses. These findings can be used to develop more effective tire maintenance strategies, reduce downtime, and optimize operational costs.

Further research could explore other factors that may contribute to premature tire damage and develop more accurate predictive models for tire-related company expenses.

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