ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

# Optimizing Light Vehicle Fleet Longevity: Addressing Operational, Environmental and Maintenance Challenges at the Tarkwa Mine Site

Hakim Abdallah

(Ph.D., M.Sc., B.Sc., PMP, GIP)
Engineers and Planners Company Limited, Accra-Ghana, West Africa

Publication Date: 2025/05/02

**Abstract: This study examines the key factors contributing to the short operational lifespan of the light vehicle (LV) fleet managed by Engineers and Planners Company Limited at the Tarkwa Mine in Ghana. The research aims to identify the environmental, operational, and maintenance factors that negatively impact vehicle durability, and to offer recommendations for improving fleet management practices. A mixed-method approach was used, incorporating quantitative analysis of vehicle lifespan data, maintenance logs, and failure rates, alongside qualitative insights from interviews with fleet managers, maintenance staff, and vehicle operators. The findings revealed that harsh environmental conditions, including rough terrain and high temperatures, played a major role in accelerating vehicle wear and tear. Additionally, overloading of vehicles and inconsistent maintenance practices significantly contributed to increased failure rates. Vehicles that missed preventive maintenance sessions had a notably higher failure rate compared to those that followed maintenance schedules. The study also uncovered issues with part selection and procurement policies, where components not designed for the demands of the mining environment were frequently selected, leading to premature mechanical failures. The recommendations emphasize the importance of enforcing load limits, adopting preventive maintenance schedules, investing in advanced diagnostic tools, and revising procurement policies to prioritize durable parts suited for harsh mining conditions.**

***Keywords**: Light Vehicle Fleet, Vehicle Lifespan, Tarkwa Mine, Ghana, Mining Operations, Maintenance Practices.*

**How to Cite:** Hakim Abdallah (2025) Optimizing Light Vehicle Fleet Longevity: Addressing Operational, Environmental and Maintenance Challenges at the Tarkwa Mine Site. *International Journal of Innovative Science and Research Technology*, 10(4), 2156-2163. https://doi.org/10.38124/ijisrt/25apr1456

## I. INTRODUCTION

➢ *Background and Context*

Ghana's mining industry is a critical sector, contributing significantly to the nation's economy. Gold is the most important mineral, and Ghana is currently the leading producer of gold in Africa (Ghana Chamber of Mines, 2020). Tarkwa Mine, operated by Gold Fields Limited, is one of the largest gold mining sites in the country, playing a key role in the overall production of gold. It is known for its advanced mining operations and considerable contribution to Ghana's mining output (Government of Ghana, 2020).

Mining operations require robust logistical support, particularly in personnel and materials transportation. Light vehicle (LV) fleets are crucial in ensuring the smooth transportation of both human resources and equipment across mining sites, which are typically large and rugged (Naidu, Rao & Singh, 2020). The ability to maintain a reliable LV fleet directly influences operational efficiency and minimises downtime, thus contributing to sustainable mining operations (Oliver, Shah & Jones, 2021).

➢ *Problem Statement*

The LV fleet at Engineers and Planners Company Limited, operating at the Tarkwa Mine, has been experiencing a significantly reduced lifespan compared to industry standards. Despite regular maintenance schedules, vehicles in the fleet frequently fail to meet their expected operational life, leading to high maintenance costs, frequent downtime, and operational disruptions (Burger & Buehlmann, 2021). This premature deterioration poses both financial and logistical challenges, warranting a thorough investigation into the underlying causes.

➢ *Research Questions*

- What are the primary factors leading to the short lifespan of the LV fleet?
- How do operational and maintenance practices affect vehicle durability?

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

➢ *Objectives of the Study*

- To identify factors contributing to the rapid decline of the LV fleet
- To assess the impact of operational practices on vehicle lifespan

➢ *Significance of the Study*

The findings of this study are critical for Engineers and Planners Company Limited as they provide actionable insights that can lead to improved vehicle lifespan, reduced downtime, and cost savings. For the broader mining industry, this study can contribute to best practices in LV fleet management, offering insights into maintaining vehicle longevity under harsh mining conditions. Additionally, understanding equipment maintenance challenges within such environments can help in optimising operations and improving the overall sustainability of mining practices (Smith, Brown & Williams, 2020).

## II. LITERATURE REVIEW

### *A. Vehicle Lifespan in Mining Operations*

The lifespan of vehicles in mining operations varies significantly based on factors such as the type of vehicle, its utilization, and the environmental conditions in which it operates. Global standards and benchmarks for vehicle longevity in mining typically estimate the lifespan of light vehicles (LVs) to range between 5 to 8 years under optimal conditions (Bock, Söldner, & Mieg, 2019). In contrast, heavy-duty vehicles, such as haul trucks, have longer lifespans, sometimes exceeding 12 to 15 years (Garcia, Perez, & Fernandez, 2023). The disparity in these benchmarks can be attributed to the varying stress levels, load capacities, and operational demands placed on light versus heavy vehicles.

Manufacturers often provide baseline lifespans for vehicles operating in industrial environments, but these estimates are frequently adjusted by companies to reflect site-specific conditions such as harsh terrain, temperature extremes, and operational load (Savage, Evans, & Smith, 2022). This results in significant deviations from manufacturer recommendations, with many LVs in the mining sector, particularly in challenging environments, failing to meet their expected lifespan due to accelerated wear and tear (Burger & Buehlmann, 2021).

### *B. Factors Affecting Vehicle Durability*

In mining environments, vehicle durability is profoundly impacted by environmental factors such as terrain, climate, and the presence of abrasive materials like dust and rocks. Studies have shown that vehicles operating in open-pit mines are subjected to increased levels of mechanical stress, which accelerates component wear, particularly in suspension systems and tires (Oliver, Shah, & Jones, 2021). Additionally, extreme temperatures and high levels of dust can reduce the effectiveness of lubricants, clog air filters, and lead to engine overheating, further compromising vehicle durability (Zhang, Li, & Lin, 2021).

Maintenance practices are another critical determinant of vehicle lifespan. Preventive and predictive maintenance approaches have proven effective in extending the operational life of mining vehicles by identifying potential issues before they result in costly breakdowns (Yang, Zhang, & Wang, 2019). However, a lack of adherence to maintenance schedules, insufficient resources, and the use of low-quality replacement parts can undermine these strategies, leading to reduced vehicle durability (Hossain, Akther, & Uddin, 2022).

Operational load, including overloading vehicles and exceeding recommended speeds, significantly contributes to mechanical failures. Studies have found that aggressive driving, improper load management, and failure to adhere to manufacturer guidelines on vehicle usage can shorten the lifespan of LVs by up to 30% in mining operations (Kumar, Pandey, & Pandey, 2020). These operational stressors compound the already harsh environmental conditions, making it essential for mining companies to implement strict operational guidelines to safeguard vehicle durability (Gorjian, Kamali, & Momeni, 2020).

### *C. Maintenance Strategies in Mining Fleets*

Several best practices have emerged as effective in maintaining vehicle fleets in mining operations. Proactive maintenance strategies, such as scheduled inspections and real-time vehicle monitoring, are essential for identifying early signs of mechanical failure (Smith, Brown, & Williams, 2020). The use of telematics and condition-based monitoring systems has been widely adopted in mining fleets, enabling companies to predict component failures and schedule maintenance accordingly (Garcia et al., 2023).

However, despite the proven benefits of proactive maintenance, many mining companies continue to struggle with implementing these practices consistently. Common pitfalls include resource constraints, leading to deferred maintenance and the use of substandard parts during repairs, which further exacerbates vehicle deterioration (Naidu, Rao, & Singh, 2020). Moreover, companies that fail to invest in staff training and technology often find themselves reliant on reactive maintenance approaches, resulting in higher operational costs and reduced vehicle longevity (Oliver et al., 2021).

### *D. Case Studies*

Several case studies provide insights into the management of vehicle fleets in mining environments. A notable study conducted in Australia examined the implementation of telematics in a gold mining company, demonstrating how predictive maintenance strategies reduced vehicle downtime by 15% and extended the lifespan of the fleet by 20% (Smith et al., 2020). The study emphasised the importance of integrating data analytics with fleet management to improve decision-making and optimise vehicle usage.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

Another relevant case study from the United States highlighted the success of a coal mining company in implementing driver training programmes and eco-driving techniques, which contributed to a 10% reduction in fuel consumption and a 25% extension in vehicle lifespan (Jones & Patel, 2022). The study stressed the need for ongoing driver education to ensure adherence to safe and efficient driving practices.

In Chile, a copper mining company adopted alternative fuel technologies and hybrid vehicles to reduce environmental impact while extending the operational lifespan of its LVs. The integration of hybrid vehicles, coupled with rigorous maintenance schedules, resulted in a 30% reduction in fuel costs and a significant increase in vehicle durability (Garcia et al., 2023).

*E. Identified Gaps*

Despite the significant body of research on vehicle fleet management in mining operations globally, there remains a notable gap in focused studies on LV fleets within Ghanaian mines. Most studies have concentrated on heavy-duty vehicles, leaving a void in understanding the unique challenges faced by LVs in Ghana's mining sector. These vehicles are often subjected to intense operational demands yet receive less attention in terms of research and strategic interventions (Amponsah-Tawiah & Dartey-Baah, 2022).

Given the importance of LVs in supporting critical mining operations, particularly in personnel transport and light material handling, there is an urgent need for research that specifically addresses the factors influencing their lifespan in Ghanaian contexts. Identifying the challenges and opportunities in improving LV fleet management can contribute significantly to the efficiency and sustainability of mining operations in the country (Burger & Buehlmann, 2021).

## III. METHODOLOGY

*A. Research Design*

This study adopts a mixed-method research design, integrating both quantitative and qualitative approaches to comprehensively investigate the factors affecting the short lifespan of the light vehicle (LV) fleet at Engineers and Planners Company Limited (E&P) at the Tarkwa Mine site. A mixed-method approach is appropriate because it allows for the combination of numerical data, which provides objective insights into vehicle usage and lifespan, with qualitative perspectives from individuals directly involved in the management and operation of the vehicles (Creswell & Creswell, 2018).

The quantitative component involves the collection and analysis of vehicle performance data, such as lifespan records, maintenance logs, and failure rates, providing measurable insights into the fleet's operational efficiency. On the other hand, the qualitative component includes interviews with key personnel, such as fleet managers, maintenance staff persons operating the LVs, to gather deeper insights into the operational challenges, maintenance practices, and contextual factors that may not be captured through quantitative data alone (Bryman, 2019). By integrating these two methods, the study aims to produce a well-rounded understanding of the issue.

*B. Study Area Description*

Tarkwa Mine, located in the Western Region of Ghana, is one of the largest gold mining operations in the country, managed by Gold Fields Ghana Limited. The mine site is characterized by open-pit mining activities, which necessitate the use of extensive logistical support, including fleets of light and heavy vehicles for the transportation of personnel, materials, and equipment (Gold Fields, 2022). Tarkwa Mine plays a crucial role in Ghana's mining industry, contributing significantly to the country's gold production (Ghana Chamber of Mines, 2020).

Engineers and Planners Company Limited (E&P) is a key service provider at the Tarkwa Mine, responsible for delivering critical services, including vehicle and equipment maintenance, transportation, and infrastructure development. The company manages a significant fleet of light vehicles used for various operational purposes within the mine. The efficient operation of these vehicles is critical to maintaining the overall productivity of the mine, as they facilitate the movement of personnel and equipment across the expansive site (Engineers & Planners, 2021).

*C. Data Collection Methods*

The quantitative data for this study were derived from operational records relating to E&P's light vehicle fleet at the Tarkwa Mine. Key data points included vehicle lifespan records, detailing the number of operational years for each vehicle in the fleet; maintenance logs, which provided insights into the frequency and nature of repairs and maintenance activities; and failure rates, indicating the incidence of mechanical breakdowns and other operational failures (Hossain, Akther, & Uddin, 2022).

Data on vehicle usage patterns were also collected to assess the workload endured by each vehicle. These data points were sourced from E&P's internal fleet management system, which tracked vehicle performance, fuel consumption, and maintenance schedules. Statistical techniques, such as descriptive statistics and regression analysis, were applied to these data to identify patterns and trends in vehicle lifespan and failure rates (Garcia, Perez, & Fernandez, 2023).

To complement the quantitative data, qualitative data were gathered through semi-structured interviews with individuals involved in the day-to-day management and operation of the fleet. Interview participants included fleet managers, maintenance personnel, and vehicle operators, who were well positioned to provide insights into operational challenges, maintenance practices, and factors not readily captured in the quantitative data, such as driver behaviour and environmental conditions (Naidu, Rao, & Singh, 2020).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

The interviews focused on understanding the contextual challenges faced by the fleet, including the maintenance regimes in place, issues with vehicle allocation, and operational demands. Thematic analysis was employed to identify recurring themes and patterns from the qualitative data, providing a deeper understanding of how human factors and operational practices influenced vehicle lifespan (Bryman, 2019).

### *D. Data Analysis Techniques*

For the quantitative data, descriptive statistics were used to summarise the operational lifespan of vehicles, their maintenance history, and the frequency of breakdowns. Additionally, inferential statistical methods, such as regression analysis, were employed to explore relationships between different variables, including vehicle age, operational conditions, and failure rates (Oliver, Shah, & Jones, 2021). These analyses helped identify key factors contributing to the rapid deterioration of the fleet.

Correlation analysis was also applied to assess the strength and direction of relationships between the operational load on the vehicles and their failure rates. This analysis revealed whether certain types of usage, such as heavy loading or operations on rough terrain, were more likely to lead to vehicle failures (Yang, Zhang, & Wang, 2019).

For the qualitative data gathered from interviews, thematic analysis was employed to identify patterns and themes that emerged from participants' responses. This method involved coding the qualitative data, categorising it into key themes, and interpreting these themes to gain insights into operational challenges and the effectiveness of existing maintenance practices (Creswell & Creswell, 2018).

The thematic analysis focused on identifying operational inefficiencies, gaps in maintenance strategies, and other contributing factors to the short lifespan of the vehicles. By triangulating the quantitative data with qualitative insights, the study provided a comprehensive view of the factors affecting the fleet's performance (Bryman, 2019).

### *E. Ethical Considerations*

Ethical considerations were paramount in this study, particularly regarding the collection of data from individuals. All interview participants were required to provide informed consent before participating in the study. Consent forms outlined the purpose of the research, the types of data to be collected, and participants' rights, including the right to withdraw from the study at any time (Resnik, 2020).

To ensure data confidentiality, all information collected was anonymised, and no identifying information about the participants or the company was shared in the final report without explicit permission. Data were stored securely and were accessible only to authorised personnel involved in the research process. Additionally, any sensitive data, particularly those related to company operations or financial information, were handled with the utmost care to ensure that no proprietary information was disclosed (Resnik, 2020).

## IV. RESULTS

### *A. Quantitative Findings*

An analysis of the light vehicle (LV) fleet at Engineers and Planners Company Limited revealed significant discrepancies between expected and actual vehicle lifespans. Vehicles within the fleet had an average operational lifespan of 3.5 years, which is below the global industry standard of 5 to 8 years for mining operations (Bock, Söldner, & Mieg, 2019). 60% of the fleet failed to meet the expected lifespan, exhibiting mechanical breakdowns or significant maintenance requirements before reaching their third year of operation.

The failure patterns indicated that the most frequent issues were related to suspension systems, engine cooling systems, and tire wear. Suspension failures accounted for 35% of breakdowns, while engine cooling issues were responsible for 22%. A review of the maintenance schedules revealed inconsistencies, with approximately 40% of vehicles missing scheduled preventive maintenance at least once annually. Vehicles that missed maintenance schedules exhibited a 40% higher failure rate than those that adhered to regular maintenance (Savage, Evans, & Smith, 2022).

### *B. Qualitative Insights*

The qualitative data gathered from interviews with fleet managers, maintenance personnel, and vehicle operators provided further insight into the operational challenges and maintenance issues experienced by the light vehicle (LV) fleet. Several key themes emerged from these interviews:

- *Harsh Environmental Conditions:*

Interviewees emphasised the impact of the rough terrain and extreme temperatures at the Tarkwa Mine site. Drivers reported that navigating steep inclines and rocky terrain placed significant stress on vehicle suspensions and tyres, accelerating wear and tear. Dust and high heat contributed to frequent engine cooling issues, particularly in vehicles operating within the open-pit mining areas (Naidu, Rao, & Singh, 2020).

- *Operational Overloading:*

Many operators admitted that vehicles were frequently overloaded beyond their design capacity. This was often driven by operational demands requiring fewer trips to transport materials and personnel across the mine site. The interviews confirmed that overloading was a consistent factor in mechanical failures, particularly affecting suspension and tyre systems (Zhang, Li, & Lin, 2021).

- *Inconsistent Maintenance Practices:*

Maintenance personnel highlighted logistical challenges, including delays in obtaining replacement parts and insufficient time allocated for preventive maintenance. Numerous vehicles were kept in operation beyond their

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

recommended maintenance schedules due to the high demand for transport services across the site, leading to compounded wear and mechanical breakdowns (Hossain, Akther, & Uddin, 2022).

*C. Key Observations*

The study revealed a strong correlation between operational practices and vehicle failure rates. Vehicles subjected to overloading, rough terrain, and inconsistent maintenance schedules exhibited significantly higher failure rates compared to those operated under less stressful conditions. The correlation coefficients (r) for key variables are presented in Table 1.

The analysis of the correlation data revealed that operational load (r = 0.76) had a strong positive correlation with vehicle failure rates. This indicated that overloading vehicles was a significant contributor to mechanical breakdowns. When vehicles were consistently operated beyond their design capacity, the additional stress on critical components such as suspension systems and engines led to increased failure rates. This strong correlation underscored the importance of managing operational loads to reduce the frequency of vehicle failures.

Missed maintenance (r = 0.82) showed the strongest correlation with vehicle failures, highlighting the critical role that regular upkeep played in maintaining vehicle health. Vehicles that missed scheduled maintenance sessions experienced significantly higher failure rates. This finding emphasised that adhering to preventive maintenance schedules was essential for avoiding breakdowns and prolonging the lifespan of the fleet. The strength of this correlation reinforced the view that maintenance practices were among the most important factors in ensuring vehicle reliability.

Terrain difficulty (r = 0.68) demonstrated a moderately strong correlation with vehicle failure rates, suggesting that harsh environmental conditions contributed to accelerated wear and tear. Operating vehicles on uneven surfaces or steep inclines placed additional stress on mechanical components, increasing the likelihood of failure. This moderately strong effect pointed to the need for selecting vehicles specifically designed to withstand harsh environments and for implementing strategies to mitigate the impact of such conditions.

**Table 1: Correlation Coefficients Between Key Operational Factors and Vehicle Failures**

| Variable Pair | Correlation Coefficient (r) | Interpretation |
|---|---|---|
| Operational Load vs. Vehicle Failures | 0.76 | Strong positive correlation |
| Missed Maintenance vs. Vehicle Failures | 0.82 | Strong positive correlation |
| Terrain Difficulty vs. Vehicle Failures | 0.68 | Moderate positive correlation |

Source: Author’s Construct September 2024

A regression analysis was performed to determine the relationship between vehicle failure rates and three key independent variables: operational load (overloading), terrain difficulty, and missed preventive maintenance sessions. The results are summarised in Table 2. The regression analysis revealed key insights into how these variables impacted vehicle failure rates.

Firstly, operational load (overloading) was found to have a significant influence on vehicle failures, with a coefficient (B) of 0.450. This indicated that for every unit increase in operational load, the vehicle failure rate increased by 0.450 units. The positive and statistically significant relationship (p-value = 0.000) confirmed that overloading was a major predictor of mechanical breakdowns, particularly in critical components such as suspension systems and engines. This finding aligned with previous research, which demonstrated that overloading placed additional stress on vehicles, leading to more frequent and severe breakdowns (Smith, Brown, & Williams, 2020).

Terrain difficulty also played a notable role in increasing vehicle failure rates, with a coefficient (B) of 0.320. For every unit increase in terrain difficulty, vehicle failure rates rose by 0.320 units. This relationship was statistically significant (p-value = 0.001) and supported the understanding that harsh terrains, such as those encountered in mining environments, accelerated wear and tear on vehicles. The moderately strong effect observed was consistent with existing studies demonstrating the impact of rough and uneven terrain on vehicle performance, particularly in mining operations where vehicles were subjected to intense physical stress (Burger & Buehlmann, 2021).

Finally, missed maintenance sessions emerged as the most critical factor influencing vehicle failure rates, with a coefficient (B) of 0.620. For every missed preventive maintenance session, the vehicle failure rate increased by 0.620 units. This finding was highly significant (p-value = 0.000) and underscored the importance of adhering to scheduled maintenance. The strong effect of missed maintenance highlighted how neglecting routine upkeep exacerbated wear on vehicle components, resulting in more frequent breakdowns. This finding supported the broader literature, which emphasised the role of preventive maintenance in extending vehicle lifespans and reducing operational disruptions (Garcia, Perez, & Fernandez, 2023).

Taken together, these findings illustrated the critical need for operational improvements, such as enforcing load limits, addressing terrain-related challenges, and ensuring adherence to maintenance schedules, to reduce vehicle failure rates and enhance overall fleet performance.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

**Table 2: Regression Analysis Results for Key Factors Affecting Vehicle Failures**

| Variable | Coefficient (B) | Standard Error | t-Statistic | p-Value |
|---|---|---|---|---|
| Intercept | 1.2 | 0.32 | 3.75 | 0.000 |
| Operational Load (Overloading) | 0.45 | 0.085 | 5.29 | 0.000 |
| Terrain Difficulty | 0.32 | 0.07 | 4.57 | 0.001 |
| Missed Maintenance Sessions | 0.62 | 0.092 | 6.74 | 0.000 |
| **$R^2$ = 0.82, Adjusted $R^2$ = 0.80** | | | | |

Source: Author's Construct September 2024

## V. DISCUSSION

### A. *Interpretation of Results*

This study aimed to identify the factors contributing to the short lifespan of the light vehicle (LV) fleet operated by Engineers and Planners Company Limited (E&P) at the Tarkwa Mine site. The research questions focused on uncovering the main causes of vehicle failures and assessing how operational practices, environmental factors, and maintenance strategies influenced vehicle durability. The findings provided clear answers to these questions through both quantitative and qualitative analyses.

The quantitative data demonstrated that operational practices, particularly overloading and inconsistent maintenance schedules, significantly contributed to increased vehicle failure rates. Environmental factors, such as rough terrain and extreme temperatures, were also found to play a substantial role in accelerating wear and tear. Statistical analysis indicated that vehicles operating under these harsh conditions, especially those that missed scheduled preventive maintenance, had considerably higher failure rates. These results directly addressed the first research question by identifying operational load, terrain difficulty, and missed maintenance as the primary determinants of reduced fleet lifespan.

The regression and correlation analyses further clarified the second research question by quantifying the impact of these factors. Missed maintenance sessions exhibited the strongest influence on vehicle failures, followed by overloading and terrain difficulty.

### B. *Interpretation of Results from Correlation and Regression Analysis*

The correlation and regression analyses were instrumental in understanding the relationships between operational load, missed maintenance sessions, terrain difficulty, and vehicle failure rates in the E&P fleet. The results offered a comprehensive view of how each factor contributed to vehicle failures, aligning with existing literature on fleet management under harsh conditions.

➢ *Correlation Results*

The analysis revealed strong positive correlations between vehicle failures and key factors:

- Operational Load ($r = 0.76$): A strong correlation between overloading and mechanical breakdowns confirmed that vehicles subjected to excessive load experienced accelerated failure, particularly in suspension and engine systems. This aligned with Smith, Brown, and Williams (2020), who highlighted overloading as a major stressor on fleet reliability.
- Missed Maintenance Sessions ($r = 0.82$): This exhibited the strongest correlation, underscoring the critical importance of routine preventive maintenance. Savage, Evans, and Smith (2022) also found that proactive maintenance significantly reduces failure rates.
- Terrain Difficulty ($r = 0.68$): Though slightly lower, this still represented a meaningful correlation. Vehicles operating on rough terrains were shown to suffer higher wear, corroborating findings by Burger and Buehlmann (2021).

➢ *Regression Analysis*

The regression model explained 82% of the variance in vehicle failure rates ($R^2 = 0.82$):

- Missed Maintenance Sessions ($B = 0.620$): The most significant predictor. Each missed session increased failure rates by 0.620 units, reinforcing Hossain, Akther, and Uddin's (2022) findings on the value of preventive maintenance.
- Operational Load ($B = 0.450$): Confirmed overloading as a key contributor, consistent with Kumar, Pandey, and Pandey (2020).
- Terrain Difficulty ($B = 0.320$): Though the least impactful, it still played a substantial role in wear and tear, particularly in off-road conditions (Naidu, Rao, & Singh, 2020).

➢ *Comparison with Existing Literature*

The study's findings aligned closely with broader fleet management literature. Naidu et al. (2020) and Kumar et al. (2020) similarly identified terrain and overloading as significant contributors to vehicle failures. However, this study revealed a more pronounced impact of missed maintenance, highlighted by its correlation ($r = 0.82$) and regression coefficient ($B = 0.620$), than in earlier studies. This suggests that the extreme operating environment at Tarkwa exacerbated the consequences of maintenance lapses.

➢ *Identified Factors Contributing to Short Lifespan*

- Environmental Factors: Rough terrain and extreme temperatures accelerated vehicle wear, particularly affecting suspension systems and tyres (Burger & Buehlmann, 2021).
- Operational Practices: Overloading and aggressive driving habits intensified mechanical stress, raising failure rates (Kumar et al., 2020).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456

- Maintenance Strategies: Missed preventive maintenance was the most critical factor, confirming previous findings (Hossain et al., 2022).
- Part Selection and Procurement Policies: Use of unsuitable parts due to cost-driven procurement practices reduced durability (Bock, Söldner, & Mieg, 2019).

➢ *Implications for Stakeholders*

- Profitability: Frequent breakdowns inflated operational costs and disrupted mining operations. Improved maintenance and operational discipline could enhance profitability.
- Safety: Mechanical failures posed safety hazards in a high-risk environment. Addressing these through better maintenance and load management could improve workplace safety (Zhang et al., 2021).
- Operational Efficiency: Reduced vehicle downtime through improved practices would enhance overall productivity (Oliver, Shah, & Jones, 2021).

## VI. RECOMMENDATIONS

*A. Operational Improvements*

Comprehensive operator training programmes should be implemented, focusing on safe driving, load management, and compliance with capacity limits (Zhang et al., 2021). Real-time load-monitoring systems could also help manage overloading (Smith et al., 2020).

*B. Maintenance Strategies*

A centralised preventive maintenance schedule, supported by telematics and predictive diagnostic tools, should be adopted to track vehicle health and enable timely interventions (Yang et al., 2019; Savage et al., 2022).

*C. Policy Changes*

Procurement should shift from cost-minimisation to durability-based decision-making, incorporating a Total Cost of Ownership (TCO) approach. This involves sourcing high-quality, heavy-duty parts suitable for mining environments (Kumar et al., 2020; Bock et al., 2019).

*D. Future Research*

Future studies should:

- Evaluate the long-term effects of the proposed interventions;
- Investigate the environmental impacts of mining fleet operations;
- Expand qualitative research to understand human factors;
- Explore AI integration for predictive maintenance (Garcia et al., 2023; Hossain et al., 2022).

## VII. CONCLUSION

*A. Summary of Findings*

The study identified four core causes of the short lifespan of E&P's LV fleet at Tarkwa:

- Overloading and aggressive driving significantly raised failure rates (Smith et al., 2020).
- Harsh terrain and climatic conditions caused accelerated mechanical wear (Burger & Buehlmann, 2021).
- Missed preventive maintenance had the strongest impact on vehicle breakdowns (Savage et al., 2022).
- Unsuitable vehicle and part selection undermined fleet durability (Kumar et al., 2020).

*B. Study Limitations*

- The findings were context-specific and may not generalise beyond Tarkwa.
- Incomplete historical data may have limited the precision of analysis.
- A larger qualitative sample could provide richer insights (Hossain et al., 2022).

*C. Final Thoughts*

Improving operator behaviour, enforcing load limits, and adopting predictive maintenance are essential to prolonging vehicle lifespan. Revising procurement strategies to favour durability and functionality will reduce long-term costs and ensure operational resilience (Garcia et al., 2023; Yang et al., 2019).

Ultimately, implementing these changes will not only reduce vehicle failures but also enhance safety, profitability, and sustainability for E&P.

## REFERENCES


[1]. Amponsah-Tawiah, K., & Dartey-Baah, K. (2022). Compliance with environmental regulations in the mining sector: A case study of Ghana. *Resources Policy, 79*, 102127.

[2]. Bock, T., Söldner, M., & Mieg, H. A. (2019). Factors influencing vehicle procurement decisions in the mining industry: An exploratory study. *Journal of Cleaner Production, 220*, 986-995.

[3]. Bryman, A. (2019). *Social research methods* (5th ed.). Oxford University Press.

[4]. Burger, K., & Buehlmann, U. (2021). Challenges in the operation of mining vehicles under rough conditions. *International Journal of Mining Science and Technology, 31*(3), 517-523.

[5]. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

[6]. Engineers & Planners. (2021). *Corporate profile: Engineers and Planners Company Limited*. Retrieved from https://www.eandpghana.com/corporate-profile

[7]. Garcia, R., Perez, F., & Fernandez, A. (2023). Sustainable fleet management in the mining industry: A review of current practices and future directions. *Resources Policy, 80*, 102043.

[8]. Garcia, R., Perez, F., & Fernandez, A. (2023). Sustainable fleet management in the mining industry: A review of current practices and future directions. *Resources Policy, 80*, 102043.

[9]. Ghana Chamber of Mines. (2020). Mining in Ghana - What future can we expect? Retrieved from https://ghanachamberofmines.org/media/4p1h5psn/mining-in-ghana-what-future-can-we-expect.pdf

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25apr1456


[10]. Gold Fields. (2022). *Tarkwa Mine Overview*. Retrieved from https://www.goldfields.com/tarkwa
[11]. Gorjian, N., Kamali, M., & Momeni, E. (2020). Telematics application in mining: A systematic review. *Resources Policy, 67*, 101669.
[12]. Government of Ghana. (2020). Minerals and Mining Act 2006 (Act 703). Retrieved from https://www.mlnr.gov.gh/wp-content/uploads/2019/04/Minerals-and-Mining-Act-2006-Act-703.pdf
[13]. Hossain, M. A., Akther, M., & Uddin, M. R. (2022). Vehicle maintenance management in the mining sector: A systematic review. *International Journal of Mining Reclamation and Environment, 36*(1), 32-49.
[14]. Jones, S., & Patel, M. (2022). Predictive maintenance in light vehicle fleet management: A case study of a coal mining company in the United States. *International Journal of Mining Science and Technology, 32*(1), 111-119.
[15]. Kumar, A., Pandey, M. K., & Pandey, S. K. (2020). Light vehicle fleet management in mining operations: A case study of Indian mining sector. *International Journal of Mining and Mineral Engineering, 11*(4), 319-335.
[16]. Naidu, R., Rao, P., & Singh, R. (2020). Light vehicle fleet management in mining: A comprehensive review. *International Journal of Mining Science and Technology, 30*(5), 735-741.
[17]. Oliver, S., Shah, M., & Jones, J. (2021). Preventive maintenance optimization for light vehicle fleets in the mining industry. *Reliability Engineering & System Safety, 218*, 107821.
[18]. Resnik, D. B. (2020). *Research ethics: A philosophical guide to the responsible conduct of research*. Cambridge University Press.
[19]. Savage, R., Evans, D., & Smith, J. (2022). Optimization of light vehicle fleet scheduling in mining operations: A case study. *International Journal of Mining Science and Technology, 32*(2), 265-273.
[20]. Smith, J., Brown, M., & Williams, A. (2020). Proactive maintenance strategies in light vehicle fleet management: A case study of a gold mining company in Australia. *Journal of Cleaner Production, 251*, 119622.
[21]. Yang, Y., Zhang, L., & Wang, S. (2019). Predictive maintenance of light vehicle fleets in the mining industry using machine learning techniques. *Journal of Cleaner Production, 238*, 117918.
[22]. Zhang, Y., Li, S., & Lin, B. (2021). The effects of driver training on improving driving safety in the mining industry: A systematic literature review. *Safety Science, 141*, 105296.