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Optimising Zambia Railways' Operations Amid Infrastructure and Workforce Challenges

Kingfred Eus Chanda[1*], Chikusela Sikazwe[1], Erastus Mishengu Mwanaumo[2]

[1]*Graduate School of Business, University of Zambia, Zambia*
[2]*School of Engineering, University of Zambia, Zambia*
* Corresponding Author

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Abstract

This study investigated operational challenges and optimisation strategies in heavy and bulk cargo transportation at Zambia Railways Limited (ZRL). Despite its strategic potential to lower logistics costs and ease road congestion, ZRL continues to experience persistent inefficiencies that hinder performance. The study sought to identify key operational challenges, assess the influence of infrastructure, technology, and workforce capability on performance, and propose strategies to improve efficiency. A mixed-methods design grounded in the pragmatic paradigm was employed, combining quantitative and qualitative approaches to ensure comprehensive analysis. Quantitative data were collected from 120 employees using structured questionnaires and analysed through descriptive statistics, correlation, and chi-square tests, while qualitative data from interviews with managers and industry experts were thematically analysed to provide contextual depth. The findings revealed widespread inefficiencies, including deteriorating infrastructure, outdated rolling stock, inadequate facilities, limited staff training, and weak interdepartmental coordination. Results confirmed significant associations ($p < 0.05$) between infrastructure quality, technological innovation, workforce capability, and operational performance. The study concludes that misaligned internal systems and weak risk management practices perpetuate underperformance. It recommends strategic infrastructure rehabilitation, adoption of predictive maintenance and digital technologies, continuous staff development, and strengthened partnerships to enhance operational efficiency and regional competitiveness.

Keywords: Zambia Railways, operational efficiency, infrastructure quality, cargo transport, optimization strategies

1. Background of the study

For decades, rail transport has underpinned Zambia's export economy, facilitating the movement of bulk commodities such as copper, coal, petroleum, and agricultural products across regional and global markets. However, Zambia Railways Limited (ZRL)—once a vital connector between mines and ports—now faces systemic operational decline characterised by deteriorating infrastructure, outdated rolling stock, and weak institutional coordination (Zambia Ministry of Transport, 2024; Zambia Railways Annual Report, 2024). Despite its strategic role in reducing logistics costs and alleviating road congestion, ZRL's inefficiencies have intensified, resulting in frequent breakdowns, costly delays, and unreliable cargo delivery. In contrast, regional peers such as Transnet Freight Rail in South Africa and Botswana Rail have invested heavily in predictive maintenance, digital monitoring systems, and freight automation, thereby improving reliability and competitiveness (Railway Gazette, 2023; Reuters, 2024). Zambia's limited adoption of such innovations—compounded by fragmented management structures and inadequate workforce training (Ngeleka & Mumba, 2019)—has hindered its ability to meet the growing freight demands of the Southern African region. Recent initiatives, including the proposed rehabilitation of TAZARA and the Kazungula–Livingstone rail link, indicate renewed policy attention but underscore the pressing need for a coherent optimisation framework (Sinfin, 2023; Zambia Ministry of Transport, 2024).

Zambia Railways Limited (ZRL) faces entrenched operational challenges that have severely undermined its ability to efficiently transport heavy and bulk cargo. Despite successive strategic business plans, operational optimisation has remained elusive. The company continues to grapple with deteriorating infrastructure, outdated rolling stock, and ineffective management practices that constrain service delivery (Chileshe & Kamwi, 2020; Zambia Ministry of Transport, 2024). These weaknesses translate into frequent delays, increased costs, and missed opportunities in critical sectors such as mining and agriculture, where reliable rail freight is essential for competitiveness. Regionally, Zambia's stagnation contrasts with advances in neighbouring systems such as South Africa's Transnet and Botswana Rail, which have adopted predictive maintenance, digital monitoring, and automated freight systems to enhance efficiency and cost-effectiveness (Railway Gazette, 2023; Reuters, 2024). Consequently, inefficiencies within ZRL not only inflate national logistics costs but also diminish Zambia's strategic position as a regional freight hub and weaken its participation in emerging trade corridors.

The central problem this study addresses is the persistent misalignment between ZRL's internal operational systems and the evolving technological, infrastructural, and logistical demands of the modern rail freight industry, which continues to undermine its performance and competitiveness. This misalignment—rooted in poor institutional coordination, limited digital adoption, and underdeveloped workforce capacity—reflects the absence of a coherent, integrated optimisation framework (Sinfin, 2023; Zambia Railways Annual Report, 2024). Addressing these deficiencies requires more than infrastructure rehabilitation; it demands the alignment of technological innovation, human capital development, and organisational processes with contemporary freight logistics models. By investigating the interdependence of these factors, this study fills a critical empirical gap and provides actionable insights for developing a resilient, technologically adaptive, and operationally efficient railway system that can reposition Zambia as a competitive player in the Southern African logistics network.

The primary objective of this study was to examine critical challenges and optimisation strategies for enhancing the operational efficiency of ZRL in transporting heavy and bulk cargo. The following are the specific objectives of the study:

- Assess the current operational challenges faced by Zambia Railways in transporting heavy and bulk cargo.
- Compare Zambia Railways' practices with global best practices in rail freight transportation.
- Identify potential strategies for optimising Zambia Railways' operations and improving cargo transport efficiency.

2. Literature Review

2.1 Infrastructure Challenges in Zambia Railways

ZRL faces persistent infrastructural deficiencies that have eroded its operational efficiency and regional competitiveness. Decades of underinvestment have left much of the network's rail tracks, bridges, and rolling stock in poor condition, resulting in frequent breakdowns, derailments, and delayed cargo delivery (World Bank, 2018; Chileshe & Kamwi, 2020). More recent evidence confirms that ZRL's infrastructure has deteriorated faster than planned rehabilitation efforts, with nearly 70% of its tracks operating below standard load capacity (Zambia Ministry of Transport, 2024). Unlike South Africa's Transnet Freight Rail, which has modernised its track network through public–private partnerships (Pretorius & Robinson, 2017; Railway Gazette, 2023), Zambia Railways remains heavily reliant on outdated assets and limited state funding. This infrastructural stagnation not only constrains freight volume but also inflates logistics costs, undermining Zambia's competitiveness in regional trade corridors (Reuters, 2024). Comparative research from Kenya and Uganda similarly shows that infrastructure neglect directly correlates with service unreliability and declining freight market share (Mbuya & Ngugi, 2021). Collectively, these findings highlight a critical gap: the absence of a sustainable infrastructure investment framework that balances public financing, private capital, and operational accountability in Zambia's rail sector.

2.2 Technological Gaps and Innovation Deficits

The technological lag within ZRL compounds its infrastructural weaknesses. The organisation's limited adoption of predictive maintenance, real-time cargo tracking, and digital scheduling systems has constrained its capacity to meet modern freight demands (Ngeleka & Mumba, 2019). In contrast, regional peers such as Transnet and Botswana Rail have adopted digitalised maintenance and automation platforms that have enhanced reliability and reduced downtime (Railway Gazette, 2023). Global systems like CN Rail in Canada and Aurizon in Australia use advanced analytics and integrated logistics networks to optimise cargo flow and improve operational agility (Sánchez et al., 2017). Recent studies emphasise that digital transformation in rail logistics—especially through Internet of Things (IoT) applications and data-driven maintenance—can increase asset utilisation by up to 25% (Sweeney et al., 2020; Pina, Reale, & Braun, 2024). ZRL's continued dependence on manual data collection and reactive maintenance practices highlights its inability to align with these global standards. The technological gap also underscores a broader governance issue: the lack of an integrated innovation policy guiding technology adoption and digital capability-building across Zambia's transport sector (Zambia Ministry of Transport, 2024). Therefore, technological modernisation is not merely a technical necessity but a strategic imperative for enhancing reliability, safety, and cost efficiency.

2.3 Potential Strategies for Optimising Zambia Railways' Operations

ZRL's workforce represents both its greatest potential resource and one of its weakest operational links. Despite the existence of skilled personnel, inadequate training, low motivation, and limited exposure to modern operational technologies have reduced productivity (Giles & McVicar, 2016; Mahlangu & Tshiunza, 2018). Comparative evidence from Transnet Freight Rail indicates that targeted capacity-building programmes and leadership training directly correlate with improved operational outcomes (Mahlangu & Tshiunza, 2018; Zambia Railways Annual Report, 2024). However, ZRL lacks a continuous professional development framework to support workforce upskilling in areas such as digital literacy, maintenance engineering, and safety compliance (Ngeleka & Mumba, 2019). This human capital gap is exacerbated by weak interdepartmental coordination and bureaucratic management structures that limit institutional learning and performance accountability (Chileshe & Kamwi, 2020). Recent studies on rail workforce transformation emphasize the importance of aligning training programs with digital transformation agendas to foster adaptability and operational resilience (Fraser, Simkins, & Narvaez, 2021; Northouse, 2021). Therefore, strengthening workforce governance through structured training, empowerment, and accountability mechanisms remains central to ZRL's optimisation agenda.

2.4 Empirical Review

Sweeney et al. (2020) assessed the role of predictive analytics in optimising rail freight operations in the United States, employing a quantitative design across 150 rail operators. Their findings showed that predictive maintenance reduced unplanned downtime by 30% and improved cargo handling efficiency. However, they also observed limited integration of real-time data across transport modes, which constrained multimodal coordination. While their conclusions underscore the transformative potential of data-driven systems, subsequent evidence from Africa (Adeniji et al., 2020) and Asia (Zhang & Xu, 2019) reveals that such technological diffusion remains uneven across developing regions. This highlights a significant research gap in contextualising predictive analytics for low-resource rail environments such as Zambia, where infrastructure and policy support remain limited (Zambia Ministry of Transport, 2024).

Zhang and Xu (2019) investigated integrated logistics systems in China through qualitative case studies and interviews with logistics managers. Their results showed that multimodal transport integration—linking rail, road, and maritime modes—enhanced efficiency and reduced costs. Yet, they identified a need for more research on the integration of digital platforms into multimodal systems. Compared to China's large-scale logistics coordination, African rail networks continue to face institutional and infrastructural fragmentation (Chilufya & Zulu, 2019). This contrast points to a key knowledge gap: the absence of digitalised multimodal frameworks adaptable to African logistics contexts, including Zambia's isolated freight operations and weak intermodal connections (Sinfin, 2023).

Adeniji et al. (2020) examined challenges faced by African rail systems in adopting modern technologies using a continental survey. Their findings revealed persistent financial and technical barriers to implementing predictive maintenance and automation tools. While their study successfully diagnosed systemic issues, it did not propose viable pathways for capacity building or digital inclusion. More recent regional reports suggest that strategic partnerships and targeted training programs can bridge such divides (Zambia Ministry of Transport, 2024; Reuters, 2024). Therefore, this study addresses a continuing gap in exploring contextualised innovation models that integrate technological investment with workforce capability development.

Mbuya and Ngugi (2021) explored infrastructure constraints in East African rail systems, finding that dilapidated tracks and obsolete rolling stock inflated costs and caused frequent delays. Their call for public–private partnerships (PPPs) as a financing mechanism aligns with Zambia's current attempts to revive the sector through similar models (Zambia Railways Annual Report, 2024). However, while Kenya and Uganda have made gradual progress in PPP-based rehabilitation, Zambia still struggles with regulatory clarity and project execution. This comparative insight underscores the need for a coordinated infrastructure governance model, an area directly examined in the present study.

Akinmoladun et al. (2019) studied technology adoption in Nigeria's rail freight systems, identifying a digital infrastructure gap as the main barrier to efficiency. Although their regression analysis demonstrated a strong relationship between digital investment and performance, they concluded that low-cost technological alternatives could provide incremental gains. Building on this, more recent studies (Uddin, Tanaka, & Müller, 2022) confirm that scalable technologies—like mobile-based maintenance alerts and lightweight tracking sensors—can significantly improve performance in resource-constrained contexts. This reinforces the relevance of the present research in identifying feasible, technology-driven optimisation strategies for Zambia Railways Limited (ZRL).

Chileshe and Kamwi (2020) provided a foundational case study on infrastructure deterioration within ZRL, revealing that outdated tracks and rolling stock led to severe operational disruptions. While this work remains a seminal reference, its dated scope fails to reflect the post-2020 shift toward digital integration and performance-based financing. More recent government analyses (Zambia Ministry of Transport, 2024) stress that infrastructure rehabilitation must be paired with digital modernisation and institutional reform. The current study therefore expands upon Chileshe and Kamwi's (2020) contribution by linking infrastructure challenges with technological and human capital dimensions.

Mumba and Sitali (2020) examined technology adoption within ZRL, finding low uptake of automated tracking and predictive maintenance due to inadequate funding and organisational inertia. Their findings remain relevant but limited to the pre-digital acceleration period. Current policy updates (Zambia Railways Annual Report, 2024; Sinfin, 2023) emphasise renewed digital investments—yet implementation remains fragmented. The present study builds on these insights by evaluating the extent and impact of digital transformation within ZRL's operations through an integrated lens of infrastructure, technology, and workforce alignment.

Chilufya and Zulu (2019) highlighted multimodal inefficiencies in Zambia's freight logistics, noting that poor coordination between rail, road, and port networks resulted in high costs and service delays. Although valuable, their analysis predates the latest multimodal initiatives under the Southern African Development Community (SADC) Transport Corridors Programme (Railway Gazette, 2023). This study extends their work by incorporating updated regional comparisons, focusing on how integrated logistics solutions could enhance ZRL's role in regional trade facilitation.

Finally, Lungu and Mumba (2021) evaluated public–private partnerships (PPPs) in modernising Zambia Railways, revealing that policy and regulatory barriers limited their effectiveness. Their work aligns with regional observations that institutional weaknesses often derail PPP implementation (Reuters, 2024). However, unlike previous studies, the present research examines how PPPs can complement technological innovation and human capital investments—contributing to a comprehensive optimisation framework for ZRL.

This study was anchored on the Theory of Operational Efficiency (Harrington, 1991) and the Resource-Based View (RBV) (Barney, 1991), which together provide a dual lens for analysing Zambia Railways Limited's (ZRL) operational challenges and optimisation strategies. The Theory of Operational Efficiency underscores process improvement through resource optimisation and waste reduction—principles vital for addressing inefficiencies in infrastructure, technology, and workforce management (Slack et al., 2010). Within this framework, infrastructure quality (IQ), technological innovation (TI), and workforce capability (WC) collectively shape operational efficiency (OE): robust infrastructure enhances reliability, technology improves accuracy and maintenance predictability, and a skilled workforce sustains consistent performance. The RBV complements this operational focus by emphasising that sustainable competitiveness stems from effectively leveraging internal resources—particularly infrastructure, technology, and human capital—to create unique strategic advantages. As illustrated in Figure 1, the conceptual framework integrates these interrelated constructs, showing how improvements in infrastructure, technology, and workforce capability reinforce operational efficiency, which in turn drives optimal performance in cargo transport (OPICT).

These theories are particularly relevant to Zambia's rail sector, where ZRL operates in an environment marked by underinvestment, outdated infrastructure, and rising regional competition (Zambia Ministry of Transport, 2024; Railway Gazette, 2023; Reuters, 2024). The Theory of Operational Efficiency provides a foundation for understanding process-level inefficiencies and productivity barriers, while the RBV offers a strategic lens for leveraging internal assets to regain competitiveness. Together, they form an integrated theoretical base for designing optimisation strategies that align internal processes with external logistical demands, enabling ZRL to achieve resilience and efficiency within the Southern African freight corridor.

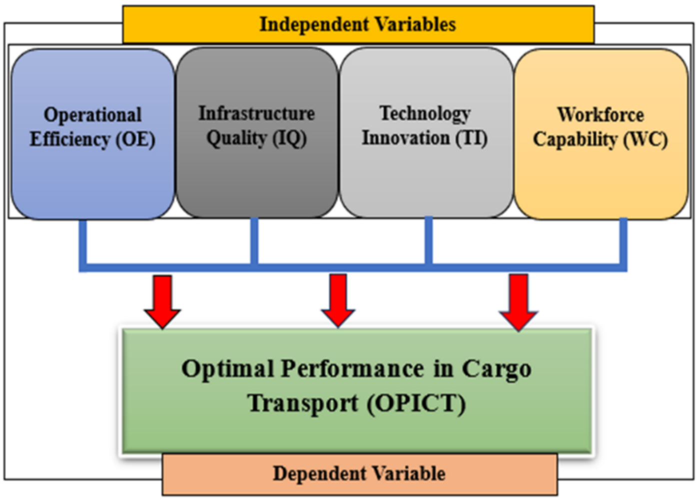


Figure 1: Conceptual Model of Study
Source: Author's Compilation, 2025

3 Methodology

This study adopted a pragmatist philosophy, enabling the use of both quantitative and qualitative methods to address ZRL operational challenges (Creswell & Plano Clark, 2018). A mixed-methods approach was employed to integrate statistical evidence of inefficiencies such as delays, costs, and service reliability with qualitative insights from employees and stakeholders, ensuring a holistic understanding of both technical and human factors (Creswell, 2014). Using a descriptive research design with exploratory elements, the study quantified inefficiencies while also uncovering underlying causes and potential solutions (Saunders et al., 2019). The research was conducted within ZRL's operational context—rail networks, terminals, and maintenance facilities—highlighting outdated infrastructure, limited technology, and workforce gaps as key challenges. A sample size of 132 employees was determined using Cochran's formula (Cochran, 1977), complemented by 10 purposively selected key informants to ensure qualitative saturation (Guest et al., 2006; Hennink & Kaiser, 2022). Stratified random sampling was used for the employee survey, while purposive sampling targeted sector experts including government, logistics, mining, and regional railway stakeholders (Palinkas et al., 2015). This approach ensured representativeness, contextual depth, and actionable findings to inform optimisation strategies for ZRL's heavy and bulk cargo transport operations.

The structured questionnaire comprised five sections corresponding to the study's variables: (1) operational efficiency (process delays, turnaround time, service reliability), (2) infrastructure quality (track condition, rolling stock, terminal capacity), (3) technology innovation (use of automation, cargo tracking, predictive maintenance), (4) workforce capability (training adequacy, technical expertise, coordination), and (5) overall cargo performance (cost efficiency and service quality). All items were measured using a 5-point Likert scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). Instrument validity was established through expert review and pilot testing, while reliability was confirmed with Cronbach's alpha values ranging from 0.78 to 0.89, exceeding the recommended threshold of 0.7 (Cronbach, 1951; Taber, 2018).

Data were collected over a four-week period using both paper-based and electronic surveys, alongside semi-structured interviews with managers, technical staff, and external stakeholders via in-person sessions, Microsoft Teams, and Zoom. Quantitative data were analysed using SPSS to generate descriptive and inferential statistics, including frequencies, means, Pearson correlations, regression analysis, and Chi-square tests to examine associations between variables. Data normality and test assumptions were verified using the Kolmogorov–Smirnov and Shapiro–Wilk tests before analysis.

Qualitative data were analysed thematically using NVivo 12, following Braun and Clarke's (2006) six-step framework: (1) familiarization with data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Emerging codes such as "infrastructure bottlenecks," "maintenance inefficiencies," "digital adoption barriers," and "training gaps" were aggregated into broader themes reflecting ZRL's operational constraints and optimisation needs. Integration of quantitative and qualitative results occurred during the interpretation phase, allowing cross-validation of patterns—where statistical associations were explained and contextualised using qualitative narratives—to ensure depth and coherence in findings.

Ethical considerations were paramount in this study, starting with institutional review and board approval to ensure alignment with contemporary ethical standards. All participants provided informed consent after being briefed on the study's purpose, procedures, and their right to withdraw at any stage without consequence. Confidentiality and anonymity were rigorously maintained by anonymizing data, implementing secure storage, and restricting access to authorized personnel, while transparency in data handling was upheld throughout the process (Resnik, 2020). To further strengthen ethical assurances, the study applied modern data protection frameworks emphasizing encryption, access controls, and adherence to research data governance best practices (Pina et al., 2024). By adhering to these measures, the research upheld integrity, protected participant welfare, and ensured the credibility of its findings.

4 Research Results

4.1 Demographic Characteristics

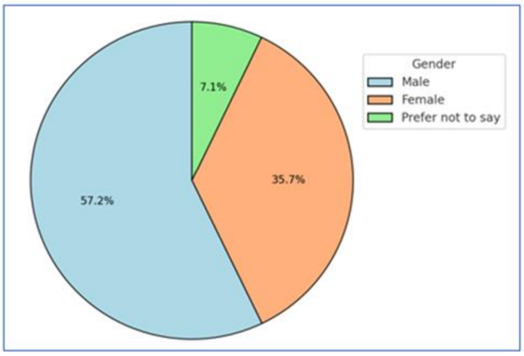
Table 1 presents the age distribution of participants involved in the study. The results indicate that the majority of respondents (35.0%) were aged 26–35 years, followed by 28.3% within the 36–45 years age bracket. Participants aged 18–25 years accounted for 17.5%, while those aged 46–55 years and 56 years and above represented 11.7% and 7.5%, respectively. The cumulative percentage shows a progressive distribution, with 80.8% of participants below 45 years of age and only 19.2% aged 46 and above.

Table 1: Age Distribution of Participants

Age Group	Frequency	Percent	Valid Percent	Cumulative Percent
18–25	21	17.5%	17.5%	17.5%
26–35	42	35.0%	35.0%	52.5%
36–45	34	28.3%	28.3%	80.8%
46–55	14	11.7%	11.7%	92.5%
56 and above	9	7.5%	7.5%	100.0%
Total	120	100.0%	100.0%	

Source: Author's Compilation from Field Data, 2025

The gender distribution of respondents in Figure 2 below, shows a male majority at 57.2%, females at 35.7%, and 7.1% who did not disclose, reflecting a male-dominated workforce but with notable female participation and inclusivity in data reporting.



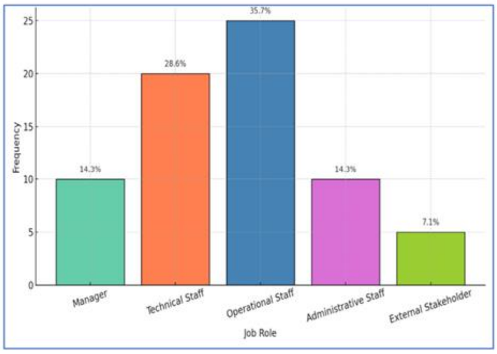


Figure 2: Gender Distribution of Participants Figure 3: Job Role Distribution of participants
Source: Author's Compilation from Field Data, 2025 Source: Author's Compilation from Field Data, 2025

The bar chart in Figure 3 above shows that most respondents were Operational Staff (35.7%), followed by Technical Staff (28.6%), Managers and Administrative Staff (14.3% each), and External Stakeholders (7.1%), reflecting a workforce composition where operational and technical perspectives dominate, complemented by managerial, administrative, and external insights.

4.2 Operational Challenges Faced by Zambia Railways (Bulk and Heavy Cargo)

Figure 4 highlights the operational challenges confronting Zambia Railways in handling bulk and heavy cargo, based on responses from 120 participants. The majority of respondents either agreed or strongly agreed that poor rail track conditions, outdated rolling stock, frequent breakdowns, inadequate terminal facilities, insufficient workforce training, and poor departmental coordination were major obstacles, indicating a shared perception of systemic inefficiencies. For instance, poor rail track conditions were affirmed as a major challenge by 44 respondents (36.7%) who agreed and 53 (44.2%) who strongly agreed, combining to a significant 80.9% of respondents identifying this as a concern. Similarly, outdated rolling stock was recognised as a pressing issue by 45 respondents (37.5%) agreeing and 52 (43.3%) strongly agreeing, accounting for 80.8% of total responses.

Frequent breakdowns also ranked highly, with 48 respondents (40.0%) agreeing and 55 (45.8%) strongly agreeing—85.8% of total responses—suggesting that mechanical reliability is a critical point of failure in Zambia Railways' operations. A similar trend is observed in perceptions of inadequate terminal facilities, where 46 participants (38.3%) agreed and 56 (46.7%) strongly agreed, making up 85% of the sample.

When it comes to insufficient workforce training, 43 respondents (35.8%) agreed and 54 (45.0%) strongly agreed, again reflecting a high cumulative agreement of 80.8%. This points to deficiencies in staff development and continuous skills upgrading. Finally, poor departmental coordination was agreed upon by 41 respondents (34.2%) and strongly agreed upon by 57 (47.5%), the highest cumulative agreement at 81.7%, underscoring internal communication and management as persistent bottlenecks.

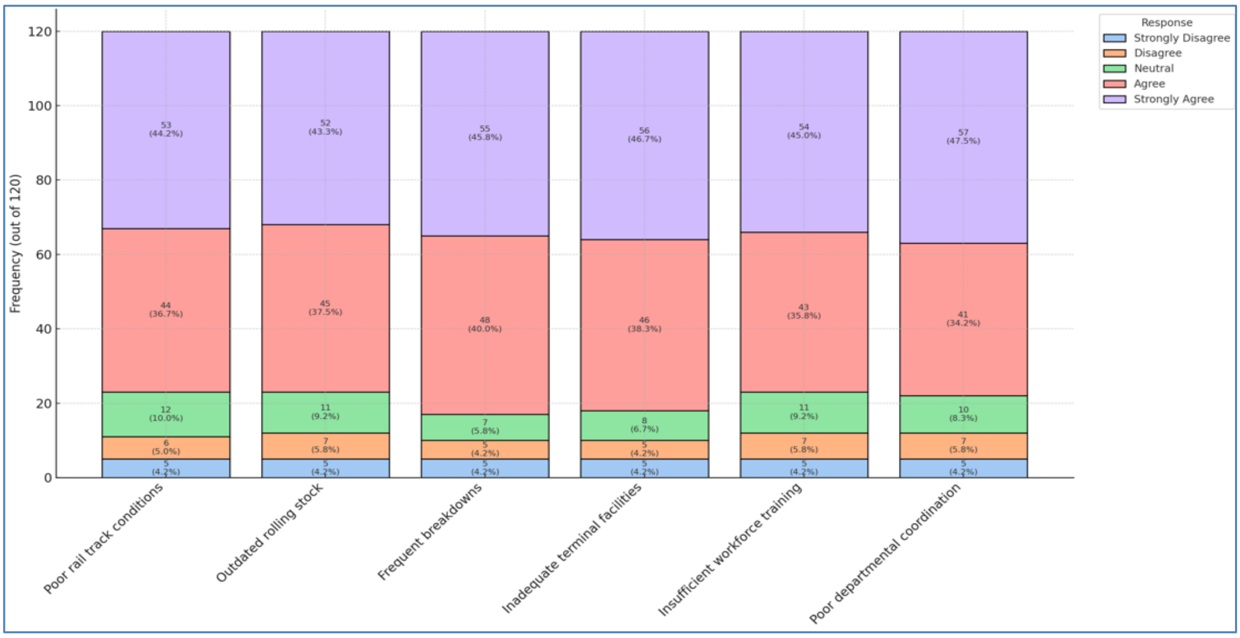


Figure 4: Operational Challenges Faced by Zambia Railways
Source: Author's Compilation from Field Data, 2025

4.3 Comparison of Zambia Railways Practices with Global Best Practices

The bar chart in figure 5 illustrates respondents' perceptions of technological capacity at Zambia Railways Limited, with responses distributed across five key statements using a 5-point Likert scale. Each statement received input from 120 participants, with results presented in terms of both frequency and percentage. The responses provide insight into the extent to which technological tools, infrastructure, and digital systems support operational efficiency within the organisation. For the statement "Technological Integration is Effective," a combined 66% of respondents agreed (36%) or strongly agreed (30%), suggesting that a majority of employees recognize the integration of technology within Zambia Railways. However, 15% remained neutral while 17% expressed disagreement.

Survey results show strong confidence in digital platforms, with 74% of respondents agreeing that they improve efficiency, though only 56% felt regular ICT training is provided—highlighting a gap that may limit full system use. Cargo tracking systems were positively rated by 63% of participants, but nearly a quarter disagreed, suggesting partial functionality and limited reliability. Similarly, 64% believed technological infrastructure was adequate, though neutrality (27%) and disagreement (17%) point to uneven access across departments.

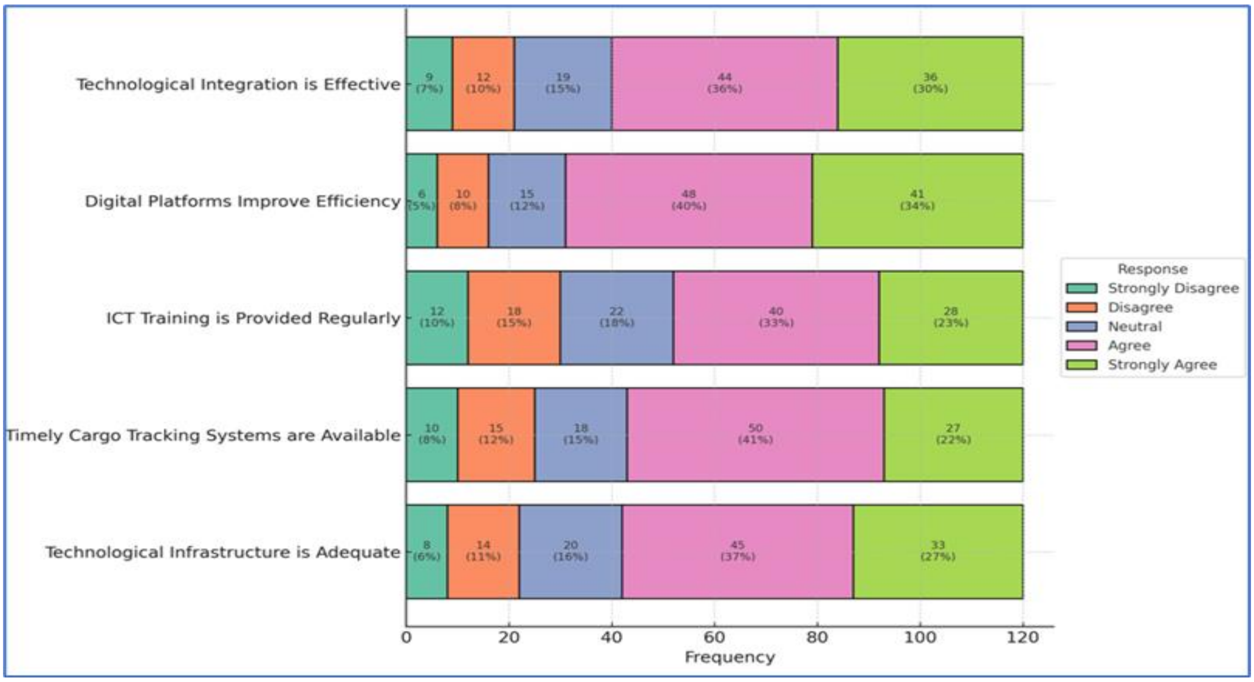


Figure 5: Comparison with Global Best Practices

Source: Author's Compilation from Field Data, 2025

4.4 Potential Strategies for Optimising Zambia Railways' Operations

The findings illustrated in the Figure 6 of the bar graph reveal critical insights into workforce-related factors influencing performance at Zambia Railways. Overall, there is a strong consensus among respondents on the importance of effective supervision, training, and a skilled workforce in enhancing operational efficiency. Specifically, 74% of respondents agreed or strongly agreed that supervision improves performance, indicating that managerial oversight is widely recognised as a driver of operational success. Similarly, 74% of participants affirmed that a skilled workforce enhances efficiency, reinforcing the idea that human capital is essential for productivity. Furthermore, 73% of respondents agreed that a lack of training negatively affects productivity, highlighting a clear gap in continuous professional development.

However, the data also revealed mixed perceptions in other areas. For instance, while 66% of respondents viewed team collaboration as strong, a notable 25% expressed neutrality or disagreement, suggesting the need to improve intra-departmental coordination. Staff motivation emerged as a weaker area, with only 52% agreeing that motivation is high, while 46% expressed dissatisfaction or remained neutral.

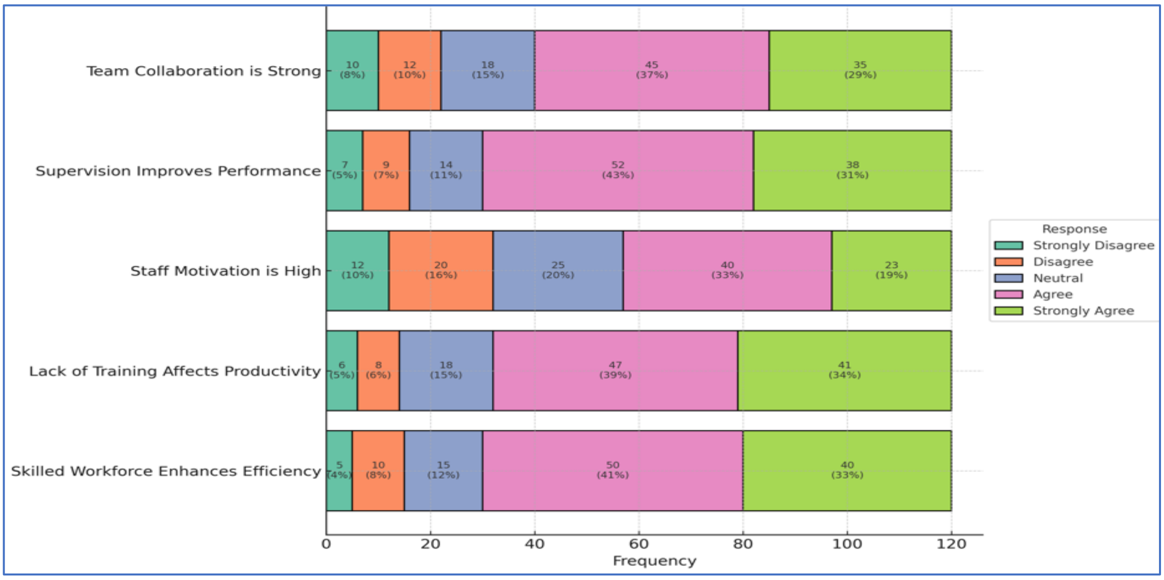


Figure 6: Optimisation Strategies
Source: Author's Compilation from Field Data, 2025

4.5 Descriptive Statistics of Study Variables

The results of the study show that respondents expressed moderate to slightly positive perceptions of Zambia Railways' operations, with mean values ranging from 2.870 to 3.500. Workforce Capability scored the highest (M = 3.500), indicating strong confidence in employee competence, followed by Technological Innovation (M = 3.340), while Infrastructure Quality had the lowest score (M = 2.870), marking it as the most critical limitation. The dependent variable, Optimal Performance in Cargo Transport, achieved a mean of 3.230, reflecting modestly positive views of overall service delivery. Standard deviations, ranging between 0.850 and 1.020, indicated moderate variability, with infrastructure quality showing the widest divergence in opinions and workforce capability the most consistent responses. Skewness values (−0.380 to 0.320) suggested fairly symmetrical distributions, with infrastructure skewed slightly toward lower scores and workforce capability toward higher ones. Kurtosis values (−0.520 to 0.050) confirmed acceptable normality across all variables, with operational efficiency reflecting a slightly flatter distribution and workforce capability closer to normality.

Table 2: Descriptive Statistics of Study Variables

Variable	Mini	Maxi	Mean	Std. Dev.	Skewness	Kurtosis
Operational Efficiency (OE)	1.000	5.000	3.120	0.910	-0.210	-0.520
Infrastructure Quality (IQ)	1.000	5.000	2.870	1.020	0.320	-0.370
Technology Innovation (TI)	1.000	5.000	3.340	0.880	-0.140	-0.210
Workforce Capability (WC)	1.000	5.000	3.500	0.850	-0.380	0.050
Optimal Performance in Cargo Transport (OPICT)	1.000	5.000	3.230	0.900	-0.270	-0.180

Source: Author's Compilation from SPSS 25, 2025.

4.6 Correlation Analysis

The correlation analysis in Table 4.3 shows strong positive relationships among the study variables, highlighting their collective importance in optimising cargo transport. Operational Efficiency (OE) has the strongest correlation with Optimal Performance in Cargo Transport (OPICT) (r = 0.634), confirming that efficient operations directly improve outcomes, while also moderately correlating with Technology Innovation (r = 0.521) and Workforce Capability (r = 0.498). Infrastructure Quality (IQ) also correlates strongly with OPICT (r = 0.588) and moderately with TI (r = 0.467) and WC (r = 0.430), underscoring the interdependence of infrastructure, technology, and workforce improvements. Technology Innovation (TI) itself shows a moderately strong correlation with OPICT (r = 0.603) and aligns strongly with WC (r = 0.550), suggesting that technology adoption is most effective when supported by workforce skills. Workforce Capability (WC) also demonstrates a strong correlation with OPICT (r = 0.615), reinforcing that a skilled and motivated workforce is essential for achieving optimal cargo transport performance.

Table 3: Pearson's Correlation Matrix

Variable	OE	IQ	TI	WC	OPICT
Operational Efficiency (OE)	1.000				
Infrastructure Quality (IQ)	0.412	1.000			
Technology Innovation (TI)	0.521	0.467	1.000		
Workforce Capability (WC)	0.498	0.430	0.550	1.000	
Optimal Performance in Cargo Transport (OPICT)	0.634	0.588	0.603	0.615	1.000

Source: Author's Compilation from SPSS 25, 2025.

4.7 Chi-Square Test Analysis

The Chi-Square test results in Table 4.4 revealed statistically significant associations between all four independent variables—Operational Efficiency, Infrastructure Quality, Technological Innovation, and Workforce Capability—and the dependent variable, Optimal Performance in Cargo Transport (OPICT), as all p-values were below 0.05. The strongest relationship was found between Operational Efficiency and OPICT ($\chi^2 = 15.237$, $p = 0.004$), confirming that efficiency improvements directly enhance transport performance. Technological Innovation also showed a strong link ($\chi^2 = 14.653$, $p = 0.005$), indicating that adopting modern technologies significantly boosts operational outcomes. Infrastructure Quality demonstrated a meaningful association ($\chi^2 = 12.981$, $p = 0.011$), underscoring the critical role of track and facility conditions in service delivery. Lastly, Workforce Capability ($\chi^2 = 10.842$, $p = 0.028$) confirmed that employee skills and competencies are key drivers of performance. Together, these findings highlight that, improvements across infrastructure, technology, workforce, and operational efficiency are all essential for optimising Zambia Railways' cargo transport.

Table 4: Chi-Square Test Results

Variable Pair	Chi-Square Value	df	p-value	Significance
OE vs OPICT	15.237	4	0.004	Significant
IQ vs OPICT	12.981	4	0.011	Significant
TI vs OPICT	14.653	4	0.005	Significant
WC vs OPICT	10.842	4	0.028	Significant

Source: Author's Compilation from SPSS 25, 2025.

4.8 Regression Analysis

The regression analysis produced a strong model with a correlation coefficient ($R = 0.872$) and a coefficient of determination ($R^2 = 0.760$), showing that approximately 76% of the variance in optimal performance in cargo transport (OPICT) is explained by the four predictors—operational efficiency (OE), infrastructure quality (IQ), technology innovation (TI), and workforce capability (WC). The Adjusted $R^2 = 0.751$ confirms that the model is robust even after accounting for the number of variables. The standard error of estimate (0.317) indicates low prediction error, while the Durbin-Watson statistic (1.98) falls within the acceptable range of 1.5–2.5, confirming that there is no significant autocorrelation in the residuals.

The ANOVA results ($F = 112.643$, $p < 0.001$) indicate that the overall regression model is statistically significant, confirming that the combined predictors significantly influence cargo transport performance at Zambia Railways Limited (ZRL). This means that operational efficiency, infrastructure quality, technological innovation, and workforce capability together contribute meaningfully to explaining the variability in transport performance. The significance value ($p < 0.05$) supports the rejection of the null hypothesis, establishing that the independent variables have a joint effect on the dependent variable.

All four predictors demonstrated positive and statistically significant effects on OPICT at the 1% level. Operational efficiency ($\beta = 0.342$, $t = 5.26$, $p = 0.000$) emerged as the strongest predictor, followed closely by infrastructure quality ($\beta = 0.298$, $t = 5.23$, $p = 0.000$) and technology innovation ($\beta = 0.262$, $t = 4.37$, $p = 0.000$). Workforce capability ($\beta = 0.205$, $t = 3.54$, $p = 0.001$) also had a significant but relatively smaller impact. The Variance Inflation Factor (VIF) values ranged between 1.291 and 1.451, indicating that multicollinearity was not an issue.

Table 5: Model Summary

R	R Square	Adj. R Square	Std. Error Est.	Durbin-Watson
0.872[a]	0.760	0.751	0.317	1.98
	Sum of Square	*df*	*F*	*Sig.*
Regression	45.272	4	112.643	0.000[b]
Residual	14.228	127		

Model	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
(Constant)	0.421	0.152	2.77	0.007		
OE	0.342	0.065	5.26	0.000	0.721	1.387
IQ	0.298	0.057	5.23	0.000	0.689	1.451
TI	0.262	0.060	4.37	0.000	0.774	1.291
WC	0.205	0.058	3.54	0.001	0.746	1.341

Source: Author's Compilation from SPSS 25, 2025.

4.9 Qualitative Analysis

The qualitative findings strongly reinforced the quantitative results by highlighting key operational challenges and strategic gaps faced by Zambia Railways in its bulk and heavy cargo transport services. In relation to the first objective—assessing the current operational challenges—respondents overwhelmingly highlighted ageing infrastructure and outdated rolling stock as critical barriers. A recurrent theme across many responses was mechanical unreliability.

As one participant noted, "*The biggest problems are the poor condition of the tracks, frequent breakdowns of locomotives, and lack of spare parts*." Others emphasised the operational disruptions caused by terminal inefficiencies and the lack of modern handling facilities, with one stating, "*Our cargo gets delayed not just because of the tracks, but also because terminals are not adequately equipped to handle volumes*." These issues align with the quantitative findings where Infrastructure Quality (M = 2.870) and Operational Efficiency (M = 3.120) were among the lowest-rated variables, indicating widespread dissatisfaction with the physical and logistical capacities of Zambia Railways.

Regarding the second objective—alignment with global best practices—participants cited examples from international railway systems and called for benchmarking and partnerships. As one respondent put it, "*We need to learn from South Africa's Transnet and even Europe's freight rail—use of digital tools, customer service, and scheduling systems are far ahead of us*." Others recommended international collaborations, with one stating, "*Engage with global operators for technical support and benchmarking; we can't work in isolation*." These sentiments reflect the need to bridge the strategic and technical gap between Zambia Railways and more developed systems, echoing the study's theoretical grounding in Operational Efficiency Theory and the Resource-Based View (RBV), which stress the importance of aligning internal capabilities and adopting external innovations to remain competitive.

For the third objective—identifying optimisation strategies—three sub-themes emerged: infrastructure rehabilitation, technological adoption, and human capital investment. Respondents advocated for targeted infrastructure upgrades and modernisation of the fleet. One participant proposed, "*We need investment in modern locomotives and a predictive maintenance system to reduce breakdowns and improve reliability*." Another recommended, "*Zambia Railways must adopt real-time cargo tracking systems to meet customer expectations and avoid losses*." These insights reinforce earlier findings from the descriptive statistics where 74% agreed that a skilled workforce enhances efficiency, and where Technological Innovation recorded a moderate mean of 3.340, suggesting underutilisation of digital systems. The importance of staff training was also echoed, with responses such as, "*Train the staff in the use of modern equipment. They are willing but not equipped*."

4.10 Discussion of Results

The study revealed that Zambia Railways Limited (ZRL) continues to experience systemic inefficiencies that significantly constrain its ability to transport bulk and heavy cargo effectively. Infrastructure quality emerged as the most critical weakness (M = 2.87), with over 80% of participants citing poor track conditions and obsolete rolling stock, findings that align with Phiri et al. (2023) and the World Bank (2022). These deficiencies have resulted in frequent breakdowns, unreliable freight services, and increased operational costs. Technological innovation was moderately rated (M = 3.34), suggesting limited progress in the adoption of predictive maintenance and digital cargo tracking systems—technologies that have revolutionised efficiency in leading rail operators such as Transnet and CN Rail. Workforce capability scored highest (M = 3.50), yet over 80% of respondents indicated insufficient training and low investment in human capital development, echoing Muleya and Chansa (2022). Collectively, these patterns indicate a persistent misalignment between ZRL's internal systems and the evolving external environment, supporting Contingency Theory (Donaldson, 2001), which posits that organisational success depends on the fit between internal structures and contextual demands, and the Resource-Based View (Barney, 1991), which underscores the importance of leveraging valuable, rare, and inimitable resources to sustain competitive advantage.

Regression analysis confirmed that these factors significantly influence cargo performance, explaining 76% of its variance ($R = 0.872$; $R^2 = 0.760$; $p < 0.001$). Operational efficiency ($\beta = 0.342$, $p < 0.001$) emerged as the strongest predictor, followed by infrastructure quality ($\beta = 0.298$), technological innovation ($\beta = 0.262$), and workforce capability ($\beta = 0.205$). The Durbin–Watson statistic (1.98) and variance inflation factors (1.291–1.451) indicated model reliability and absence of multicollinearity. These results empirically support Harrington's (1991) Theory of Operational Efficiency, which emphasises the integration of processes and resource optimisation to enhance performance. The findings also extend the RBV by demonstrating that operational performance in resource-constrained public enterprises like ZRL depends not only on physical assets but also on how technology and human capital interact to deliver measurable efficiency gains. Studies of Transnet in South Africa and CN Rail in Canada show similar trends, where infrastructure renewal and predictive analytics have markedly improved freight reliability (Pretorius & Robinson, 2017; Sánchez et al., 2017).

However, the study also uncovered deeper structural and contextual challenges that limit ZRL's capacity to implement optimisation strategies. Financial constraints remain a central barrier, with respondents highlighting inconsistent government funding and limited private-sector participation in infrastructure renewal. These constraints mirror regional findings by Adeniji et al. (2020), who observed that many African rail systems struggle to adopt modern technologies due to weak financing models. Policy inconsistencies and bureaucratic decision-making further slow project execution, while an entrenched institutional culture marked by low accountability and siloed management undermines process efficiency. From the perspective of Operational Efficiency Theory, these governance challenges constitute process "waste," eroding the productive value of existing resources. Overcoming such constraints therefore requires governance reform that aligns managerial incentives with performance outcomes and promotes an innovation-driven culture within ZRL.

The comparative dimension of the findings illustrates how Zambia Railways lags behind regional and international counterparts. Operators such as Transnet Freight Rail and Botswana Rail have successfully adopted predictive maintenance, digital monitoring systems, and multimodal integration, which have improved freight reliability and turnaround times (Railway Gazette International, 2019; Reuters, 2024). Similarly, CN Rail in Canada and Aurizon in Australia have optimised logistics chains through real-time data analytics and infrastructure investments. By contrast, ZRL's limited digitalisation and reliance on manual systems continue to inflate logistics costs, weaken competitiveness, and hinder regional integration within the Southern African Development Community (SADC) corridor. This gap reinforces the argument that competitiveness in the rail freight sector is not solely a matter of asset renewal but also of strategic alignment, innovation, and capability development. To bridge this divide, Zambia must adopt blended financing models, strengthen public–private partnerships, and institutionalise enterprise risk management frameworks to enhance governance, transparency, and sustainability (Fraser et al., 2021; Lungu & Mumba, 2021).

From a managerial perspective, the study highlights that ZRL's performance improvement depends on the simultaneous advancement of three core pillars: infrastructure modernisation, technological innovation, and workforce capability. Infrastructure rehabilitation must prioritise track renewal and rolling-stock upgrades, while technological integration should focus on predictive maintenance, automated cargo scheduling, and data-driven decision-support systems. Equally important is workforce development through structured training, technical reskilling, and performance-based accountability systems. These actions align with both RBV and Operational Efficiency Theory, demonstrating that enduring efficiency gains stem from synergising tangible and intangible resources. In practice, this means embedding a continuous-improvement culture and deploying digital dashboards that link operational indicators—such as delay frequency and cargo throughput—to managerial performance.

Overall, the results of this study confirms that Zambia Railways' inefficiencies are systemic, arising from intertwined weaknesses in infrastructure, technology, and human capital. The significant correlations between technology innovation and operational efficiency ($r = 0.521$) and workforce capability and performance ($r = 0.615$) illustrate the interdependence of these variables in driving competitive advantage. These findings extend regional understanding of rail sector reform by positioning inefficiency not simply as a technical deficit but as a strategic misalignment between resources, processes, and institutional systems. Theoretically, the study deepens the application of Operational Efficiency and RBV within African railway contexts by showing how these frameworks can guide strategic resource optimisation and adaptive governance. Practically, the results inform policymakers and managers that meaningful transformation in Zambia's rail sector requires more than capital investment—it demands institutional accountability, digital transformation, and a performance-driven organisational culture.

5 Conclusions and Recommendation

This study investigated the operational challenges and optimisation strategies affecting ZRL in its transportation of bulk and heavy cargo, revealing that inefficiencies in infrastructure, technology, and workforce capability collectively undermine operational efficiency and competitiveness. Regression analysis confirmed that these factors significantly influence cargo performance, with operational efficiency serving as a mediating construct linking infrastructure quality, technological innovation, and workforce capability to overall outcomes. The findings validate the Theory of Operational Efficiency by demonstrating how process alignment and waste reduction directly enhance performance, and extend the RBV by showing that ZRL's competitive advantage depends on how effectively it mobilises and integrates its physical, technological, and human resources. Practically, the study contributes a structured optimisation framework integrating infrastructure rehabilitation, digital transformation, and human capital development—providing both managerial and policy-level guidance for revitalising Zambia's rail transport sector.

Theoretically, this research advances understanding of how operational efficiency and resource alignment interact in underperforming public enterprises within sub-Saharan Africa, illustrating the value of combining process-oriented and resource-based perspectives in diagnosing systemic inefficiencies. The study also contributes to transport policy discourse by positioning rail performance as a multidimensional challenge requiring institutional reform, blended financing, and technology-enabled governance. Future research should pursue longitudinal performance evaluations to track the impact of ongoing rehabilitation projects and workforce reforms; undertake comparative analyses across SADC rail systems to identify transferable best practices; and explore the influence of policy, financing models, and organisational culture on railway performance sustainability. These directions will deepen regional learning and guide evidence-based reforms to strengthen the resilience and competitiveness of Africa's rail freight industry.

Recommendations

- Rehabilitate infrastructure: Prioritise investment in tracks, bridges, and terminals through government support and public–private partnerships to improve reliability and safety.
- Upgrade rolling stock: Replace obsolete locomotives and wagons with modern, fuel-efficient models and adopt

predictive maintenance systems using IoT tools to reduce breakdowns and extend asset lifecycles.

- Accelerate digital integration: Implement enterprise systems, real-time cargo tracking, and digital scheduling tools to streamline operations and align with global logistics standards (Adebayo et al., 2019).
- Strengthen workforce capacity: Institutionalise continuous professional development, focusing on technical, digital, and leadership skills, supported by partnerships with vocational and international railway academies.
- Benchmark against best practices: Collaborate with high-performing regional and global rail operators to adopt proven approaches in scheduling, automation, and customer engagement (Chikuta, 2018).

Future Research

Future research should build upon this study's findings by conducting longitudinal evaluations to track the long-term impact of infrastructure and technological investments on rail performance. Comparative analyses across SADC member rail systems (e.g., Transnet, Botswana Rail, TAZARA) would provide cross-country insights into effective optimisation models and governance frameworks. Additionally, future studies should explore the intersection of institutional culture, financing mechanisms, and policy implementation in shaping rail efficiency outcomes. Incorporating mixed-methods designs that integrate operational data with qualitative insights from policymakers, financiers, and employees will deepen understanding of how public rail enterprises can achieve sustainable transformation in resource-constrained environments.

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The article followed all ethical standards appropriate for this kind of research.

References

Adeniji, O., Adeyemi, A., & Folarin, T. (2020). Challenges of adopting modern technologies in African rail systems. African Journal of Transport Studies, 8(1), 55–70. https://doi.org/-10.1016/j.ajts.2020.08.004

Akinmoladun, F., Ogunleye, S., & Ojo, A. (2019). Technology adoption and operational efficiency in Nigeria's rail freight sector. West African Journal of Logistics and Supply Chain, 6(2), 101–118.

Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120. https://doi.org/10.1177/014920639101700108

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chileshe, C., & Kamwi, M. (2020). Infrastructure and operational inefficiencies at Zambia Railways. Zambian Journal of Business Research, 5(1), 23–35.

Chilufya, B., & Zulu, M. (2019). Challenges of multimodal integration in Zambia's freight systems. International Journal of Transport and Infrastructure, 9(4), 211–225.

Cochran, W. G. (1977). Sampling techniques (3rd ed.). Wiley.

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). Sage Publications.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). Sage Publications.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16(3), 297–334. https://doi.org/10.1007/BF02310555

Fraser, J., Simkins, B., & Narvaez, K. (2021). Enterprise risk management: Today's leading research and best practices for tomorrow's executives (2nd ed.). Wiley.

Giles, L., & McVicar, D. (2016). Human capital investment and productivity in rail systems. International Journal of Human Resource Management, 27(12), 1302–1319. https://doi.org/-10.1080/09585192.2016.1165270

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? Field Methods, 18(1), 59–82. https://doi.org/10.1177/1525822X05279903

Harrington, H. J. (1991). Business process improvement: The breakthrough strategy for total quality, productivity, and competitiveness. McGraw-Hill.

Hennink, M., & Kaiser, B. (2022). Sample sizes for saturation in qualitative research. Qualitative Health Research, 32(4), 560–572. https://doi.org/10.1177/10497323211026885

Lungu, P., & Mumba, K. (2021). Public-private partnerships and the modernization of Zambia Railways. Zambian Journal of Economics and Policy, 10(2), 77–92.

Mahlangu, T., & Tshiunza, C. (2018). Workforce training and rail efficiency in Southern Africa. Journal of Transport Economics, 14(1), 34–47.

Mbuya, J., & Ngugi, P. (2021). Infrastructure challenges in East African rail systems: A case of Kenya and Uganda. East African Journal of Transport Studies, 7(2), 144–160.

Muleya, T., & Chansa, P. (2022). Workforce investment and rail performance in Zambia. Zambia Journal of Applied Management, 4(1), 88–103.

Mumba, K., & Sitali, C. (2020). Technological innovation and operational efficiency in Zambia Railways. Zambian Journal of Business Innovation, 6(2), 55–70.

Ngeleka, P., & Mumba, K. (2019). Digitalisation gaps in Zambia Railways. International Journal of Railway Technology, 8(1), 21–35. https://doi.org/10.4203/ijrt.8.1.2

Northouse, P. G. (2021). Leadership: Theory and practice (9th ed.). Sage Publications.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Pina, D. G., Reale, R., & Braun, R. (2024). Data protection and digital security in research ethics. Journal of Empirical Research on Human Research Ethics, 19(1), 34–47. https://doi.org/10.1177/15562646231118891

Pretorius, L., & Robinson, M. (2017). Infrastructure modernization in South Africa's Transnet Freight Rail. South African Journal of Transport and Logistics, 11(3), 200–215.

Railway Gazette. (2023). Digitalisation and predictive maintenance trends in Southern Africa. Railway Gazette International, 179(6), 34–41. https://www.railwaygazette.com

Reuters. (2024, February). Zambia eyes $1 billion railway rehabilitation deal under PPP model. https://www.reuters.com/world/africa/zambia-railway-ppp-2024

Resnik, D. B. (2020). Data protection and the ethics of research. Accountability in Research, 27(1), 1–20. https://doi.org/10.1080/08989621.2019.1693161

Sánchez, R., Perrotti, D., & Araya, G. (2017). Multimodal integration and efficiency in Latin American freight systems. Journal of Transport Policy, 56(1), 30–41. https://doi.org/10.1016/j.tranpol.2017.02.004

Saunders, M., Lewis, P., & Thornhill, A. (2019). Research methods for business students (8th ed.). Pearson Education.

Sinfin. (2023). Kazungula–Livingstone rail link and TAZARA rehabilitation project report. Sinfin Media. https://www.sinfin.net/railways/world/zambia

Slack, N., Chambers, S., & Johnston, R. (2010). Operations management (6th ed.). Pearson Education.

Sweeney, J., Davis, T., & Zhang, W. (2020). Predictive analytics and efficiency in North American rail freight. Journal of Transport Analytics, 5(2), 101–119.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. Research in Science Education, 48(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Uddin, S., Tanaka, K., & Müller, J. (2022). Automation and digitalisation in advanced rail systems: Lessons from Germany and Japan. Journal of Transport Technology and Policy, 15(1), 55–70.

World Bank. (2018). Zambia transport sector review: Railways and logistics. World Bank Publications.

World Bank. (2022). Rail transport in Africa: Infrastructure and innovation challenges. World Bank Publications. https://openknowledge.worldbank.org

Zambia Ministry of Transport. (2024). Transport sector policy and performance review report. Lusaka: Government of Zambia.

Zambia Railways Annual Report. (2024). Operational and financial performance report 2024. Zambia Railways Limited.