

Funding, Competition, and Regulatory Reform in State-Owned Railways: Rethinking Rail Transport Performance in Developing Economies under the Fourth Industrial Revolution

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ABSTRACT

State-owned railway enterprises in developing economies face increasing pressure to modernize in response to the technological and institutional transformations associated with the Fourth Industrial Revolution (4IR). Despite their strategic importance for freight mobility, regional trade, and sustainable transport systems, many parastatal railway organizations continue to experience declining performance due to inadequate infrastructure investment, intensified competition from road transport, and weak regulatory governance. This study examines how these structural factors collectively influence the performance of Zambia Railways Limited (ZRL), a representative state-owned railway enterprise in Sub-Saharan Africa. Drawing on Institutional Economics, Infrastructure Governance theory, and Contingency Management Theory to analyze the institutional and operational dynamics shaping railway sector performance in developing economies. An integrative literature review methodology was adopted, synthesizing empirical studies, policy reports, and scholarly literature published between 2010 and 2025. Sources were obtained from academic databases and development repositories, including JSTOR, Google Scholar, ScienceDirect, and institutional publications. The findings indicate that funding adequacy alone is insufficient to improve railway performance without effective governance systems, institutional accountability, and strategic policy coordination. The study further reveals that rising competition from road transport, coupled with weak regulatory enforcement and limited organisational adaptability, continues to undermine the competitiveness of parastatal railway enterprises. In the context of the 4IR, digital technologies such as predictive maintenance systems, automated logistics platforms, and data-driven operational management present significant opportunities for improving railway efficiency and sustainability. However, successful technological transformation depends on a supportive institutional framework, sustainable financing mechanisms, and organizational readiness for innovation. The study concludes that revitalizing railway systems in developing economies requires integrated reform strategies that align infrastructure investment, governance structures, regulatory effectiveness, and technological modernization within a coherent institutional framework. The paper contributes to infrastructure governance and transport policy discourse by providing a multidimensional perspective on railway sector reform under the evolving conditions of the Fourth Industrial Revolution.

KEYWORDS: *Rail reform, infrastructure governance, Zambia Railways Limited, Fourth Industrial Revolution, transport policy, institutional capacity, railway modernization.*

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1. Introduction

Rail transport remains a strategic component of national and regional economic systems, particularly for the movement of bulk commodities, cross-border freight, and long-distance cargo. In developing economies, state-owned railway enterprises have historically played an important role in supporting industrialization, trade integration, and transport connectivity (Foster & Briceno-Garmendia, 2010; World Bank, 2019). However, many parastatal railway systems across Sub-Saharan Africa continue to experience declining operational performance, deteriorating infrastructure, low freight competitiveness, and persistent financial instability (Blumenfeld et al., 2019; AfDB, 2022).

The emergence of the Fourth Industrial Revolution (4IR) has intensified pressure on transport systems to modernize through digital logistics integration, automated freight management, predictive infrastructure monitoring, and data-driven operational systems (Schwab, 2017; Kumar & Agarwal, 2021). While advanced railway networks are increasingly adopting smart transport technologies and integrated multimodal logistics systems, many state-owned rail enterprises in developing economies remain constrained by weak institutional capacity, fragmented regulatory environments, and unstable infrastructure financing frameworks (OECD, 2017; World Bank, 2023).

At the same time, liberalized road freight markets have significantly reshaped transport competition across developing economies. Road transport often provides greater flexibility, shorter delivery times, and lower operational restrictions, resulting in substantial shifts of freight traffic away from rail systems (ZIPAR, 2021; Lall, Wang, & Deichmann, 2020). These competitive pressures have exposed structural weaknesses within many parastatal railway enterprises, particularly in countries where infrastructure investment and regulatory coordination remain inadequate.

Zambia Railways Limited (ZRL) reflects many of these broader institutional and transport-sector challenges. Despite its strategic role in supporting Zambia's mining sector, regional trade corridors, and freight mobility, ZRL continues to face infrastructure deterioration, limited capital investment, declining market share, and weak operational competitiveness relative to road transport (Fred Mwila, 2016; World Bank, 2023). Policy interventions aimed at revitalizing rail transport, including regulatory reforms and freight reallocation measures, have produced limited outcomes due to enforcement constraints and institutional coordination challenges.

This paper therefore, examines how funding adequacy, market competition, and regulatory governance interact to shape railway sector performance in developing economies under the evolving conditions of the Fourth Industrial Revolution. Drawing on Institutional Economics, Infrastructure Governance Theory, and Contingency Management Theory, the study synthesizes contemporary literature to propose an integrated institutional perspective for understanding railway sector reform and transport modernization in Sub-Saharan Africa.

2. Conceptual Framework

This study adopts an integrated conceptual framework combining Institutional Economics, Infrastructure Governance Theory, and Contingency Management Theory to examine the structural and institutional drivers of railway performance in developing economies under the Fourth Industrial Revolution, as illustrated in fig. 1 below:

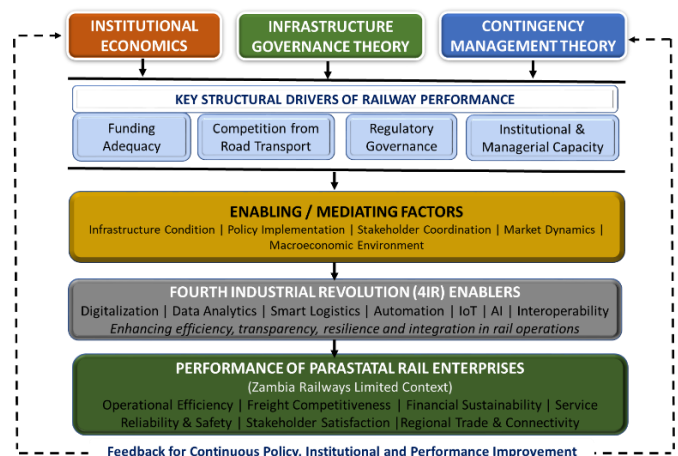


Figure 1: Integrated conceptual framework for analyzing parastatal railway performance under the 4IR

Institutional Economics emphasizes the role of formal and informal institutional arrangements in shaping organizational performance and economic outcomes (North, 1990; Williamson, 2000). Within the railway sector, regulatory frameworks, financing systems, and governance structures influence investment decisions, operational efficiency, and accountability mechanisms.

Infrastructure Governance theory complements this perspective by highlighting the importance of sustainable financing, regulatory clarity, and coordinated infrastructure planning (Foster & Briceno-Garmendia 2010). In capital-intensive sectors such as rail transport, long-term investment frameworks and effective governance systems are critical for infrastructure

maintenance, operational reliability, and sector competitiveness.

Contingency Management Theory further suggests that organizational performance depends on the alignment between internal institutional capacity and external environmental conditions (Donaldson, 2001). In the railway context, these external pressures include competition from the road transport, changing logistics systems, market liberalization, and technological disruption associated with the 4IR.

By integrating these theoretical perspectives, the study conceptualizes railway performance as the outcome of interactions among institutional governance, infrastructure financing, regulatory coordination, and competitive transport dynamics. This framework provides a basis for understanding the structural constraints affecting ZRL and similar railway enterprises in developing economies.

3. Methodology

This study employed an integrative literature review methodology to critically examine the interrelationships among funding adequacy, transport competition, regulatory governance, and railway performance within developing economies, with particular reference to parastatal railway systems under Fourth Industrial Revolution transformation pressures. The integrated review approach was considered appropriate because it allows the synthesis of theoretical, empirical, and policy-oriented literature from diverse disciplinary perspectives, thereby providing a comprehensive understanding of institutional and operational challenges affecting railway performance.

The study relied exclusively on secondary data obtained from peer-reviewed journal articles, conference papers, institutional reports, policy documents, and international development publications relating to railway transport systems, infrastructure governance, and public sector enterprise performance. Relevant literature was systematically searched from internationally recognized academics databases, including Google Scholar, JSTOR, ScienceDirect, and the African Development Bank repository, among other regional development databases. Additional grey literature was obtained from government transport policy documents, railway strategic plans, and publications from international transport organizations.

A structured search strategy was adopted to enhance transparency and replicability of the review process. Key search

terms and combinations included “railway funding models,” “rail transport financing,” “transport regulation in Africa,” “competition in rail transport,” “4IR and railway systems,” “infrastructure governance,” “parastatal railway performance,” and “railway modernization in developing economies.” Boolean operators such as AND and OR were applied to refine the search process and improve the relevance of retrieved literature.

The literature identification and screening process was guided by the PRISMA framework to ensure methodological rigor and systematic selection of relevant studies. The initial search generated more than 140 documents across multiple databases. These sources were subsequently screened based on relevance to the study objectives, duplication, publication credibility, and methodological quality. Following abstract review and full-text assessment, 24 key studies were retained for detailed synthesis and analysis.

The inclusion criteria focused on studies published between 2010 and 2025 to ensure the review captured recent developments associated with infrastructure governance reforms, digital transformation, and emerging 4IR technologies within the railway sector. Priority was given to peer-reviewed articles, institutional publications, and empirical case studies addressing railway systems in Sub-Saharan Africa and other comparable developing regions. Studies lacking methodological clarity, outdated policy relevance, or insufficient empirical grounding were excluded from the final review.

To facilitate analytical synthesis, the selected literature was categorized into three major thematic domains aligned with the objectives of the study. The first theme focused on funding adequacy and infrastructure investment, examining the relationship between financial sustainability, capital investment, maintenance financing, and operational efficiency. The second theme addressed competition and modal transport dynamics, particularly the impact of road transport liberalization and market competition on railway performance. The third theme explored regulatory governance and institutional frameworks, emphasizing policy consistency, governance effectiveness, accountability mechanisms, and strategic infrastructure management.

A thematic analytical approach was subsequently employed to synthesize the findings from the selected studies. This approach enabled the identification of recurring patterns, policy gaps, institutional weaknesses, and strategic opportunities influencing railway sector performance in developing

economies. The synthesis further facilitated the development of an integrated conceptual understanding linking institutional governance, financing structures, and competitive pressures to the sustainability and modernization of railway transport systems under the evolving 4IR environment.

4. Literature Review and Synthesis

4.1. Funding Adequacy and Infrastructure Performance

Funding adequacy remains one of the most significant determinants of railway sector performance, particularly in developing economies where transport infrastructure investment is often constrained by fiscal limitations and competing national priorities. Existing literature consistently demonstrates that inadequate and inconsistent financing contributes directly to infrastructure deterioration, operational inefficiencies, reduced service reliability, and declining competitiveness of state-owned railway enterprises. Estache and Serebrisky (2004) argue that weak cost-recovery systems and unstable public financing frameworks frequently prevent railway institutions from conducting timely maintenance, rehabilitating aging infrastructure, and modernizing operational systems. As a result, many railway organizations become trapped in cycles of declining performance and reduced revenue generation.

In Sub-Saharan Africa, rail infrastructure has experienced decades of deferred maintenance and limited capital investment. African Development Bank reports indicate that large portions of the railway network in several African countries are either underutilized or no longer operational due to infrastructure deterioration and insufficient rehabilitation funding. Blumenfeld et al. (2019) similarly observe that railway systems in many low-income economies are characterized by deteriorating track infrastructure, obsolete signalling systems, aging rolling stock, and inadequate network expansion. These deficiencies reduce the ability of railways to compete effectively with road transport, particularly in freight movement where reliability and turnaround time are critical determinants of customer preference. The authors further note that insufficient investment not only affects operational efficiency but also undermines safety standards and long-term institutional sustainability.

The capital-intensive nature of railway operations further intensifies these challenges. Railway infrastructure requires substantial long-term investment for track rehabilitation, locomotive procurement, signalling modernization, and

maintenance systems. Unlike road transport systems, railway infrastructure cannot be sustainably maintained through short-term financing arrangements alone. Sustainable railway performance therefore depends heavily on predictable financing models, strategic government support, and institutional mechanisms capable of attracting both public and private investment (Blumenfeld et al., 2019). In many developing economies, however, fiscal constraints and governance inefficiencies limit the capacity of governments to provide adequate and continuous infrastructure financing.

Recent literature also highlights the growing importance of innovative financing mechanisms in improving railway sustainability. Public-private partnerships (PPPs), infrastructure bonds, concession agreements, and multilateral development financing have increasingly been proposed as alternative approaches to addressing infrastructure deficits in state-owned railway enterprises. Foster and Briceno-Garmendia (2010) argue that infrastructure financing reforms are essential for improving transport system efficiency and supporting broader economic development objectives in Africa. Similarly, Vickerman (2018) emphasizes that long-term transport infrastructure planning must be supported by sustainable financing frameworks that integrate operational efficiency, maintenance planning, and technological modernization.

Within the context of parastatal railway enterprises such as ZRL, inadequate funding has frequently been associated with delayed maintenance schedules, aging locomotive fleets, reduced freight capacity, and declining market competitiveness. Limited financial resources constrain the acquisition of modern railway technologies and reduce the organization's ability to respond effectively to changing transport market demands. Consequently, insufficient funding not only weakens operational performance but also contributes to broader institutional inefficiencies and reduced public confidence in railway transport systems.

4.2. Market Competition and Model Transport Dynamics

Competition from road transport has significantly transformed the transport landscape across developing economies. The liberalization of road freight markets has increased the competitiveness of road transport by providing greater operational flexibility, faster delivery times, and fewer regulatory constraints compared to rail systems. Consequently, many state-owned railways have experienced declining freight

volumes and reduced market share as customers increasingly shift towards road-based logistics service.

In Zambia, road transport currently dominates the freight sector, accounting for over 90% of cargo movement. Existing studies and transport policy reports indicate that clients many clients perceive road transport as more reliable, accessible, and responsive to market demands than rail transport. Factors such as flexibility scheduling, door-to-door service capability, and shorter transit times continue to strengthen the competitive advantage of road freight operators. At the same time, the absence of integrated multimodal logistics systems further weakens the operational competitiveness of railway transport.

The growing modal shift rail to road carries important economic and environmental implications. Rail transport is generally recognized as more energy-efficient and cost-effective over long distances. According to Vickerman (2018), railway systems play a critical role in reducing road congestion, lowering carbon emissions, and supporting sustainable national transport development. However, aging infrastructure, inconsistent service delivery, and limited technological modernization continue to undermine the ability of many railway systems in developing economies to compete effectively with road transport.

The literature further suggests that improving railway competitiveness requires operational modernization, enhanced service reliability, investment in logistics integration, and supportive regulatory frameworks (Foster & Briceno-Garmendia, 2010; OECD, 2017; Gleser & Elbert, 2024). Without such reforms, railway enterprises risk continued market decline despite their strategic importance to national economic development and sustainable transport systems.

4.3. Regulatory Governance and Institutional Capacity

Regulatory governance plays a critical role in determining the performance and sustainability of state-owned railway enterprises. In many developing economies, transport sector performance is influenced not only by infrastructure investment levels but also by the effectiveness of regulatory institutions responsible for policy coordination, enforcement, and operational oversight. Weak regulatory frameworks often contribute to inefficiencies in public transport systems by allowing institutional inefficiencies, poor accountability, and fragmented policy implementation, thereby limiting sector performance.

Studies on infrastructure governance emphasize that regulatory clarity and institutional accountability are essential for sustainable infrastructure management sectors. Estache & Wren-Lewis (2009) argue that weak enforcement mechanism and limited institutional capacity frequently undermine infrastructure reforms in developing countries. Similarly, the Organisation for Economic Co-operation and Development (OECD, 2017) highlights that effective infrastructure governance requires transparent regulatory systems capable of coordinating investment decisions, enforcing compliance, and aligning transport policies with national development objectives.

In the Zambian context, several policy initiatives have been introduced to strengthen the rail sector. One notable example is Statutory Instrument No. 7 of 2018, which aimed to increase rail freight transportation by directing selected bulk cargo movement toward rail systems. However, existing studies and policy reports suggest that enforcement limitations, weak inter-agency coordination, and inadequate infrastructure capacity have constrained the effectiveness of the policy. Without complementary investment and effective monitoring systems, regulatory reforms often fail to generate substantial improvements in railway performance.

Research on African transport governance further indicates that many regulatory institutions face challenges associated with limited technical expertise, financial constraints, and political interference (World Bank, 2019). Consequently, infrastructure policies frequently remain largely declarative rather than operational. The literature therefore suggests that strengthening railway governance requires institutional capacity development, stronger enforcement mechanisms, improved stakeholder coordination, and enhanced monitoring frameworks to support sustainable sector performance.

4.4. Institutional and Managerial Dynamics

Beyond funding and regulatory governance, internal institutional and managerial structures significantly influence the operational performance of state-owned railway enterprises. Institutional economics emphasizes that organizational performance is shaped by formal rules, governance arrangements, incentive systems, and accountability mechanisms. According to North (1990), institutional structures influence decision-making incentives within organizations, while Williamson (2000) highlights the importance of governance systems in managing complex economic institutions efficiently.

In many developing economies, parastatal enterprises operate within institutional environments characterized by bureaucratic processes, politicized decision-making, limited managerial autonomy, and weak performance-based accountability systems. Such conditions often reduce organizational responsiveness and constrain the implementation of long-term operational reforms. Literature on public sector governance suggests that institutional inefficiencies emerge when governance structures fail to align managerial responsibility with organizational performance objectives (Williamson, 2000; Hope, 2016).

The case of ZRL reflects many of these institutional challenges. Existing observations indicate that frequent leadership changes, centralized decision-making structures, and limited operational flexibility have negatively affected the organization's ability to implement sustainable strategic reforms. Fred Mwila (2016) notes that despite the strategic importance of railway transport to Zambia's economic development, weak institutional support and governance inefficiencies have contributed to declining operational performance and reduced competitiveness.

Recent studies further emphasize the growing importance of adaptive and performance-oriented leadership in infrastructure sectors experiencing technological and market transformation. Hope (2016) argue that decentralized management systems, strategic leadership, and performance-based governance frameworks are essential for improving operational efficiency and organizational responsiveness within state-owned enterprises. In the absence of such reforms, many parastatal organizations struggle to modernize operations and compete effectively within increasingly liberalized transport markets.

Generally, the literature suggests that improving railway performance requires institutional reforms that strengthen managerial accountability, strategic planning capacity, organizational flexibility, and operational autonomy. Effective governance and leadership structures therefore remain central to the long-term sustainability and competitiveness of railway enterprises in developing economies.

4.5. Rail Reform in the Fourth Industrial Revolution (4IR)

The Fourth Industrial Revolution (4IR) is transforming transport systems globally through the integration of advanced digital technologies into infrastructure management and logistics operations. Innovations such as predictive maintenance systems, Internet of Things (IoT) monitoring,

automated scheduling platforms, and data-driven decision-making tools are improving operational efficiency, reliability, and service coordination within modern railway systems. These developments are enabling railway operators to optimize asset utilization, reduce maintenance costs, and strengthen integration within multimodal logistics networks.

Despite these advancements, adoption across developing economies remains uneven. Many parastatal railway enterprises continue to face challenges associated with limited financial resources, weak institutional capacity, and inadequate digital infrastructure. Schwab (2017) observes that the 4IR is reshaping global economic and industrial systems by accelerating technological innovation and increasing the need for institutional adaptability and organizational flexibility.

For railway systems in developing economies, digital transformation presents both strategic opportunities and operational challenges. Technologies such as predictive maintenance, real-time freight tracking, and automated operational management can significantly improve efficiency, safety, and service delivery. However, railway organizations that fail to modernize risk declining competitiveness within increasingly technology-driven transport and logistics markets.

Existing literature further indicates that technological advancement alone cannot guarantee improved infrastructure performance. Kumar and Agarwal (2021) argue that successful railway digitalization requires supportive policy frameworks, sustainable infrastructure investment, workforce training, and effective institutional coordination. Consequently, modernization efforts must combine technological adoption with governance and managerial reforms capable of supporting long-term transformation.

In the case of ZRL, modernization initiatives remain constrained by aging infrastructure and institutional limitations. Nevertheless, the 4IR provides opportunities for selective technological adoption that can improve operational management and strengthen competitiveness. Strategic integration of digital systems alongside institutional reforms may therefore assist railway enterprises in developing economies to reposition themselves within modern and sustainable transport networks.

5. Discussion

The reviewed literature demonstrates that the performance of parastatal railway enterprises in developing economies is shaped by the interaction between funding adequacy, market competition, regulatory governance, and institutional capacity.

The case of Zambia Railways Limited reflects how weaknesses across these areas collectively contribute to declining operational performance and reduced competitiveness within the transport sector.

Although inadequate funding is widely recognized as a major constraint affecting railway infrastructure, the literature indicates that financial investment alone is insufficient to address systemic inefficiencies. Estache and Serebrisky (2004) and Foster and Briceno-Garmendia (2010) emphasize that the effectiveness of infrastructure financing depends largely on governance quality, institutional accountability, and long-term investment planning. In the absence of effective resource management systems, infrastructure funding may produce limited and unsustainable operational improvements.

Competition from road transport further compounds these challenges. Liberalized freight markets continue to favour road transport due to its flexibility, accessibility, and shorter delivery times. In Zambia, road transport dominates freight movement, significantly reducing rail's market share (ZIPAR, 2021). Fred Mwila (2016) similarly observes that infrastructure deterioration, slow operational speeds, and limited service coverage have weakened the competitiveness of Zambia Railways Limited. These conditions support the contingency management perspective, which argues that organizational effectiveness depends on the ability of institutions to adapt to changing external market conditions (Lall, Wang, & Deichmann, 2020).

The literature also identifies regulatory governance as a critical factor influencing railway sector performance. While Zambia has introduced policies intended to strengthen rail transport, implementation challenges and weak institutional coordination continue to limit policy effectiveness. According to the Organisation for Economic Co-operation and Development (OECD, 2017) and the World Bank (2019), effective infrastructure governance requires strong enforcement systems, institutional accountability, and coordinated policy implementation. Without these institutional capacities, regulatory interventions are unlikely to produce meaningful changes in transport market behaviour.

The emergence of the Fourth Industrial Revolution (4IR) further increases the need for institutional and operational reform. Digital technologies such as predictive maintenance systems, automated freight management platforms, and integrated logistics networks are transforming railway operations globally. However, successful adoption of these technologies depends on supportive governance systems,

sustainable financing structures, and investment in technological capacity (Schwab, 2017; Kumar & Agarwal, 2021). Where institutional weaknesses persist, railway enterprises risk falling further behind technologically advanced transport systems.

Over and above, the literature suggests that improving railway sector performance requires a coordinated reform approach that integrates infrastructure investment, institutional strengthening, regulatory effectiveness, and technological modernization. Strengthening managerial accountability, improving governance systems, and enhancing organizational adaptability are therefore essential for repositioning railway enterprises within increasingly competitive and technology-driven transport markets.

6. Research Gaps and Future Directions

Despite increasing scholarship on railway sector reform in developing economies, several important research gaps remain regarding the modernization and sustainability of parastatal railway enterprises under the Fourth Industrial Revolution (4IR).

First, limited empirical attention has been given to alternative financing models suitable for state-owned railway systems in developing economies. Existing studies predominantly focus on government subsidies and public investment, with relatively little examination of innovative approaches such as infrastructure bonds, blended finance mechanisms, and performance-based public-private partnerships. Future research should therefore explore sustainable financing strategies capable of supporting long-term infrastructure investment while maintaining institutional accountability and operational efficiency.

Second, the digital readiness of railway enterprises remains insufficiently examined. Although literature increasingly recognizes the importance of technologies such as predictive maintenance, automated freight systems, and digital logistics platforms, few studies investigate the institutional and technological conditions necessary for successful implementation within parastatal railway organizations. Further research on digital transformation strategies would provide important insights into railway modernization under the 4IR.

Third, regulatory enforcement capacity within transport sectors requires deeper investigation. While many developing economies have introduced policies intended to strengthen rail transport, implementation challenges often reduce policy effectiveness. Future studies should therefore examine

mechanisms for improving institutional coordination, regulatory enforcement, and multimodal transport integration.

Fourth, the influence of leadership and managerial capacity within state-owned railway enterprises remains relatively underexplored. Existing literature focuses heavily on infrastructure investment and policy reform, while giving less attention to how leadership practices, organizational culture, and accountability systems affect operational performance. Additional research in this area could improve understanding of how internal governance reforms contribute to institutional transformation.

Finally, comparative cross-country analyses remain limited. Most existing studies focus on single-country case studies, restricting broader policy learning. Comparative research examining funding models, governance systems, and regulatory approaches across multiple developing economies could help identify transferable best practices for railway sector reform.

Addressing these research gaps will require interdisciplinary approaches integrating infrastructure economics, public administration, governance studies, and digital technology perspectives. Such research will be important for supporting evidence-based railway modernization strategies in developing economies.

7. Conclusion

This study examined the influence of funding adequacy, competitive transport dynamics, and regulatory governance on the performance of parastatal railway enterprises in developing economies, using Zambia Railways Limited (ZRL) as a contextual reference point. The review demonstrates that the challenges affecting state-owned railway systems are multidimensional and arise from the interaction of financial, institutional, managerial, and competitive factors.

Drawing on Institutional Economics, Infrastructure Governance Theory, and Contingency Management Theory, the study establishes that sustainable railway performance depends on the alignment of infrastructure investment, governance systems, regulatory effectiveness, and organizational capacity. Although funding remains essential for infrastructure rehabilitation and operational modernization, the literature indicates that financial investment alone cannot resolve systemic inefficiencies without effective governance structures and coordinated policy implementation.

The study further highlights the increasing pressure exerted by road transport competition in developing economies. The dominance of road freight transport has reduced the market relevance of many railway systems, particularly where rail infrastructure remains outdated and service delivery unreliable. These findings reinforce the importance of improving operational efficiency, logistics integration, and institutional responsiveness within railway enterprises.

The Fourth Industrial Revolution (4IR) introduces additional urgency for reform. Emerging technologies such as predictive maintenance systems, digital freight platforms, and data-driven operational management present significant opportunities for improving railway efficiency and competitiveness. However, successful technological transformation depends on institutional readiness, sustainable financing models, and governance systems capable of supporting innovation and long-term modernization.

The case of Zambia Railways Limited reflects broader structural challenges confronting railway systems across many developing economies, including aging infrastructure, weak regulatory coordination, limited institutional capacity, and constrained investment frameworks. Addressing these challenges therefore requires integrated reform strategies that combine infrastructure financing, institutional strengthening, regulatory effectiveness, and technological modernization.

The study concludes that revitalizing railway transport in developing economies requires comprehensive institutional reform rather than isolated policy interventions. Aligning funding mechanisms, governance structures, and modernization strategies within a coordinated framework will be essential for repositioning railway systems as competitive, sustainable, and technologically adaptive components of modern transport networks.

Conflict of Interest Declaration

The authors declare that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest. The institutional affiliations of the co-authors with ZCAS University are acknowledged and disclosed.

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