

The infrastructure–Industrialisation Paradox: Explaining Why Transport Corridor Investments Do Not Automatically Deliver Structural Transformation in Southern Africa

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ABSTRACT: Infrastructure development has become central to economic transformation strategies in Sub-Saharan Africa, particularly within regional integration initiatives aimed at improving trade competitiveness and industrial development. Despite substantial investment in transport corridors, border modernisation and logistics infrastructure, evidence of their contribution to industrialisation remains mixed. This study examines the infrastructure-industrialisation paradox by investigating why improvements in transport efficiency do not consistently translate into structural transformation. Using a convergent mixed-methods design, the study draws on survey data from 300 respondents, twenty-five key informant interviews, six focus group discussions and secondary trade statistics from Zimbabwe and Zambia, focusing on the Kazungula Bridge and the upgraded Beitbridge Border Post. The findings indicate that infrastructure investment significantly improved border clearance times, regional connectivity and trade facilitation but did not generate sustained manufacturing growth, industrial diversification or broad-based enterprise development. Institutional weaknesses, fragmented industrial policy, limited access to productive finance, weak regional value chain integration and governance challenges emerged as the principal constraints. In response, the study proposes the Infrastructure Transformation Cascade Model (ITCM), a theoretically grounded and empirically informed framework demonstrating that infrastructure investment is a necessary but insufficient condition for structural transformation. The study concludes with policy recommendations for integrating transport infrastructure with industrial policy, enterprise development and institutional reform across Southern Africa.

KEYWORDS: industrialisation, infrastructure development, Infrastructure Transformation Cascade Model (ITCM), regional integration, transport corridors

1. INTRODUCTION

Transport infrastructure has long been a major focus of development policy as it may improve market accessibility, lower transaction costs, promote commerce and boost economic growth. Governments and development partners in developing economies have invested heavily in roads, bridges, railways, ports and border infrastructure, hoping that improved connectivity will generate the conditions for industrial expansion and structural transformation (Calderón & Servén, 2014; Rodrik, 2016; World Bank, 2023). Infrastructure investment is a cornerstone of continental development frameworks in Africa including the African Union's Agenda 2063, the African Continental Free Trade Area (AfCFTA) and the Southern African Development Community (SADC) Regional Indicative Strategic Development Plan, all of which identify efficient transport systems as prerequisites for regional industrialisation, trade competitiveness and inclusive economic development (African Union, 2015; SADC, 2020; UNECA, 2023). The policy focus is underpinned by a well-developed economic argument. Efficient transport systems reduce the cost of production by reducing travel times, promoting workforce mobility, increasing the reliability of supply chains and giving enterprises better access to domestic and international markets (Donaldson, 2018; Calderón & Servén, 2014). Infrastructure also draws private investment by lowering uncertainty and enhancing the profitability

of productive activity (World Bank, 2023). Improvements in cross-border infrastructure are anticipated to yield particularly large economic benefits for landlocked developing countries, where transport costs are often above the world average, through enhanced regional integration and participation in regional and global value chains (Arvis et al., 2018; UNCTAD, 2024).

Southern Africa has embraced this infrastructure-led growth paradigm through persistent investment in regional transport routes. The North-South Corridor is one of the continent's major economic routes, linking South Africa with Botswana, Zimbabwe, Zambia, the Democratic Republic of Congo and beyond. Major investments along this corridor have been made to remove logistical impediments that have historically limited regional trade and industrial competitiveness. Key projects include the Kazungula Bridge (commissioned in 2021 to replace the ferry crossing between Zambia and Botswana) and the total upgrading of the Beitbridge Border Post between Zimbabwe and South Africa. Both initiatives were clearly justified as serving the purposes of trade facilitation, investment promotion, regional integration and industrial growth (African growth Bank [AfDB], 2022; SADC, 2022).

Early feedback suggests these improvements have made a big difference in operational efficiencies." Freight transit times have shortened, customs procedure has been simplified, border congestion has decreased and logistics costs have plummeted for many transport operators (AfDB, 2022; World Bank, 2023). Similar trends have been reported in various African transport corridors, with the introduction of modern customs procedures, upgrades to border infrastructure, and enhancements to transport networks accelerating the movement of products and boosting regional connectivity (UNECA, 2023; OECD, 2024). From a transport economics point of view, these improvements are major policy triumphs in that they eliminate long-standing obstacles to regional commerce and increase the overall efficiency of trade corridors.

But a basic paradox is not fully clarified. There are measurable gains in transport efficiency, but many African economies are still seeing modest industrial development. Manufacturing value addition has increased slowly, industrial diversification is limited, and domestic enterprises still face challenges in integrating into higher value regional and international production networks (UNIDO, 2024; World Bank, 2023). In Zimbabwe and Zambia, the transport infrastructure has grown tremendously, but manufacturing productivity, export sophistication, technical upgrading and company competitiveness have not increased at similar rates. The anticipated shift from enhanced logistics to sustained industrialisation has therefore not taken place.

This apparent mismatch poses significant theoretical and policy problems. Traditional infrastructure-led development models tacitly imply a reasonably direct relationship between infrastructure investment and industrial expansion; Infrastructure is supposed to raise investment, increase output, generate jobs and ultimately induce structural transformation by cutting transit costs and improving market access (Calderón & Servén, 2014). Yet the contemporary development literature has begun to assert that infrastructure is merely one part of a bigger industrial ecosystem. Industrialisation is not only about physical connectivity, but also institutional quality, coherence of industrial policy, technological capability, productive finance, human capital, innovation systems and the ability of firms to participate in competitive value chains (Rodrik, 2016; Lin, 2012; Andreoni & Chang, 2019).

An increasing awareness of these complementing variables has redirected scholarly focus away from infrastructure per se, toward the institutional frameworks in which it is embedded. Recent research shows that countries with similar transport infrastructure can have very different industrial performance because of differences in the effectiveness of governance, quality of regulation, enterprise support systems, financial markets and industrial capabilities (OECD, 2024; UNIDO, 2024). Thus, infrastructure appears to be a prerequisite and not an autonomous

driver of structural development. Where complementary institutions are inadequate, better logistics may enable trade without necessarily increasing domestic productive capacity.

While this perspective is becoming accepted, there are still substantial gaps in the extant literature. A large part of the empirical evidence continues to assess infrastructure projects on the basis of indicators such as freight volumes, border clearance times, logistics performance or trade growth, with relatively little research exploring the institutional mechanisms through which infrastructure affects industrial development (Arvis et al., 2018; UNECA, 2023). Likewise, the majority of corridor studies are limited to operational performance and not structural change. They do not provide much insight on why increases in transport efficiency do not normally translate into similar growth in manufacturing, technical upgrading, or industry diversification. Thus, the existing literature explains how infrastructure enhances logistics, but is less convincing in explaining why these logistical benefits generally yield very modest industrial effects.

This study tackles one of the perennial challenges in development economics: why massive expenditures in transport infrastructure often increase trade and logistics performance without inducing structural transformation.

Infrastructure-led development has been widely advocated in Africa, but relatively little attention has been given to the institutional mechanisms that influence whether transport corridors become industrial corridors. This study argues that infrastructure investment is a necessary but insufficient condition for industrialisation, and introduces the Infrastructure Transformation Cascade Model (ITCM) as a new theoretical framework for understanding the sequential processes through which transport investments translate into structural transformation.

This paper fills that vacuum, exploring the link between transport infrastructure and industrialization using evidence from two strategically important border infrastructure projects in Southern Africa – the Kazungula Bridge and the Beitbridge Border Post. This study adopts a convergent mixed-methods approach based on survey data, key informant interviews, focus group discussions, and secondary trade statistics to explore not only the question of whether infrastructure has improved trade performance, but also the mechanisms by which institutional, governance, financial and policy conditions influence the translation of transport investments into industrial development. Empirical evidence is drawn from a doctoral study conducted in Zimbabwe and Zambia involving 300 survey respondents, 25 key informant interviews, six focus group talks and secondary economic data.

The main contribution of the study is theoretical. Building on the empirical results, the research constructs the Infrastructure Transformation Cascade Model (ITCM), a new conceptual framework that portrays industrialization as a sequential institutional process, instead of an inevitable result of infrastructure investment. The model suggests that transport infrastructure triggers, but does not fulfil the process of structural transformation. Its industrial effects are mediated through quality of institutions, policy coordination, enterprise capabilities, access to productive finance and regional value chain integration. Thus, industrialisation does not flow just from enhanced physical connectivity, but from the interplay between infrastructure and supporting institutional institutions that allow enterprises to translate logistical advantages into productive expansion.

Accordingly, the paper presents three contributions to present-day development scholarship. First, it contributes new empirical information on the industrial effects of large expenditures in transit corridors in Southern Africa. Second, it contributes to the infrastructure-led development theory by proposing the Infrastructure Transformation Cascade Model as a more thorough explanation of the connection between transport infrastructure and structural transformation. Third, it provides practical policy suggestions for governments, regional organizations and development partners on how to get the most out of infrastructure investment for development by linking transport planning with industrial strategy, enterprise growth and institutional change.

2. LITERATURE REVIEW

2.1 Infrastructure-Led Development and Structural Transformation

The link between infrastructure development and economic transformation has been a major pillar of development economics for almost half a century. Infrastructure has been stated by the classical development theorists to be the physical base on which productive sectors are born and grow. Rostow's (1960) stages of economic growth, Hirschman's (1958) theory of imbalanced growth, and Rosenstein-Rodan's (1943) "Big Push" thesis all stressed the importance of strategic investments in infrastructure as a precondition for industrial progress. These early viewpoints viewed transport networks, energy systems and communication infrastructure as public goods that might reduce production costs, broaden markets and catalyse private investment.

Contemporary scholarship has stuck with this broad concept, but conceded that infrastructure alone rarely spurs enduring industrialization. In one of the most thorough cross-country evaluations of infrastructure and economic performance, Calderón and Servén (2014) found that better transport, power and telecommunications raise productivity and long-term economic growth. Similarly, Donaldson (2018) in his study of colonial railway growth in India showed that transport infrastructure significantly decreased trade costs and enhanced regional income by promoting market integration. These results are consistent with the view that infrastructure improves economic efficiency by reducing transaction costs and increasing the flow of products, labour and capital.

But economic growth is not the same as industrialisation. It can come from more trade, more services, or more natural resource exports without structural transformation. Structural transformation refers to the reallocation of labour, capital and technological competence from low-productivity activities to higher-productivity industrial and knowledge-intensive sectors (Lin, 2012; Rodrik, 2016). Infrastructure should therefore be evaluated not only in terms of its ability to enhance logistics or increase trade but also in terms of its potential to promote productive diversification, manufacturing competitiveness, technical upgrading and industrial employment.

The divide has become increasingly relevant in discussions on African development. Despite an unprecedented investment in transport infrastructure over the past two decades, the manufacturing value added in Sub-Saharan Africa has remained relatively low, contributing less than 11 percent of regional GDP, compared with much higher proportions in East Asia at similar levels of development (UNIDO, 2024). These tendencies imply that while infrastructure can improve economic efficiency, its role in structural transformation is conditional on broader institutional and policy contexts.

2.2 Transport Infrastructure and the Competitiveness of Industry

Transport infrastructure helps to industrial competitiveness via various interrelated mechanisms. Efficient transport systems minimize delivery times, cut inventory costs, improve supply chain reliability, enhance workforce mobility and increase market accessibility for producers (World Bank, 2023). Lower transport costs also make enterprises more competitive by cutting input prices and raising profits, so stimulating investment and productive growth (Calderón & Servén, 2014).

Transport corridors also serve a strategic function within regional economic communities, linking geographically scattered systems of production. Modern transport networks enable involvement in regional value chains by facilitating more efficient transfer of intermediate commodities between producing areas. This integration allows enterprises to specialise in some stages of production and access larger regional markets (OECD, 2024). As a result, transport corridors are increasingly viewed not only as logistics corridors, but also as potential corridors for industrial growth that could host manufacturing clusters, export processing zones, and cross-border production networks.

The Asian evidence is very much in favour of this. China's transport investments, embedded in industrial strategy and special economic zones, led to manufacturing expansion through enhancing logistics, attracting investment and building productive capabilities at the same time (Lin, 2012). Vietnam has coupled infrastructural development with export-oriented industrial strategies to swiftly integrate into global manufacturing value chains (World Bank, 2023). These examples indicate that infrastructure works best in promoting industrialisation when it is placed in the context of coherent industrial development objectives.

But African experiences have been more mixed. There are some regional transport routes that have led to significant improvements in logistics performance but without creating similar industrial growth (UNECA, 2023). Trade volumes have grown along corridors such as the North–South Corridor and the Central Corridor, although manufacturing activity has tended to focus on primary commodity processing rather than diversified industrial output (AfDB, 2024). This disparity suggests that while transport efficiency is required, it may not be enough on its own to spur economic transformation.

2.3 Regional Integration and Transport Corridors in the African

Today, regional integration is an integral part of Africa’s development agenda. Connectivity in transport is recognised as a key element in reducing trade costs, strengthening regional markets and facilitating industrialisation in the African Continental Free Trade Area, Agenda 2063, the Programme for Infrastructure Development in Africa (PIDA) and regional economic communities (African Union, 2015; UNECA, 2023).

The North–South Corridor is one of Africa’s biggest transport ventures and connects South Africa’s industrial areas with Zimbabwe, Zambia, Botswana, Democratic Republic of Congo and Tanzania in Southern Africa. Investments like as the Kazungula Bridge and Beitbridge Border Post were intended to remove major bottlenecks in transit and enhance regional commerce and industrial development (SADC, 2022).

Initial evaluations suggest significant operational success. The replacement of the Kazungula ferry crossing cut crossing times significantly, increased freight capacity and enhanced customs coordination between Zambia and Botswana (AfDB, 2022). Similarly, the Beitbridge Border Modernisation Programme substantially enhanced the efficiency of border processing by implementing new infrastructure, digital customs technology, and simplified administrative processes (World Bank, 2023). These upgrades have improved corridor efficiency and strengthened regional connectivity.

However, empirical research on industrial results remains lacking. Existing evaluations are mainly focused on operational indicators, e.g., freight throughput, time for customs clearance, logistics costs, and border efficiency, while less so on manufacturing productivity, enterprise competitiveness, and industrial diversification (UNECA, 2023). As a result, the relationship between corridor performance and structural transformation has not been well studied thus far.

2.4 Institutions as Intermediaries of Industrialization

Recent development literature is increasingly recognising that the question of whether infrastructure investments translate into productive transformation is a matter of institutions. Institutional quality impacts investment decisions, policy implementation, regulatory certainty, financial market development, innovation systems and firm competitiveness (Acemoglu & Robinson, 2012; Rodrik, 2016).

A similar argument is made by industrial policy researchers who claim that successful industrialisation depends on coordinated action by the state, not on market forces alone. Effective governments provide conducive environments via investment incentives, technology upgrading programs, skills development, export promotion, enterprise financing and strategic industrial planning (Andreoni & Chang, 2019). Infrastructure is thus one element of a larger institutional architecture for productive transformation.

Small and medium-sized firms (SMEs) are particularly vital to this institutional system. Improved transport infrastructure does create market opportunities, but enterprises need access to financing, technology, managerial capabilities and supportive regulatory regimes to effectively utilize this potential (OECD, 2024). Weak enterprise capabilities so break the link between enhanced logistics and industrial expansion.

Regional value chains are further evidence of the necessity of complementary institutions. Transport infrastructure enables enterprises to access regional markets. However, the ability to participate in regional production networks depends on product quality standards, customs harmonization, investment climates, financial systems and technological capability (UNCTAD, 2024). Physical infrastructure alone cannot cure deficits in these institutional

sectors.

2.5 Contextual Conditions of Infrastructure-led Industrialisation

Modern development study is now increasingly recognizing the embeddedness of infrastructure investments in wider political economy systems that influence their developmental results. The ability of governments to align transport investments with industrial policy objectives is conditioned by political commitment, policy continuity, bureaucracy effectiveness and state capability. As a result, countries that pursue similar infrastructure expenditures often have quite varied industrial outcomes, due to differences in governance arrangements, institutional effectiveness and regulatory regimes. Corruption and rent-seeking behaviours may help further erode institutional preparation by increasing transaction costs, eroding policy legitimacy and limiting incentives for productive investment. Thus, infrastructure-led industrialization is conditioned not just by physical connection but also by the political and institutional settings in which transport investments are made.

The developmental impact of infrastructure expenditures is also conditioned by macroeconomic stability. High inflation, exchange rate volatility, fiscal constraints and high borrowing costs might considerably hamper local firms in capitalizing on the potential presented by enhanced logistics systems. Transport infrastructure can lower transit costs and improve market access, but unstable macroeconomic environments raise production risks and discourage long-term productive investment. Hence infrastructure investments are more likely to contribute to structural transformation when they are complemented by coherent macroeconomic policies that encourage industry competitiveness and productive expansion.

Transport infrastructure cannot substitute for shortcomings in associated productive infrastructure. Reliable and economical energy systems are key factors of manufacturing competitiveness, technological upgrading and value addition. Improvements in transport efficiency may help move commodities more effectively, but continuous industrialisation is still unlikely where enterprises suffer chronic power shortages, lack suitable digital infrastructure and are disrupted in their productive operations. Thus, contemporary industrial policy literature increasingly frames infrastructure-led development as necessitating coordinated investments across transport, energy, technology and industrial support systems, rather than discrete sectoral interventions.

Taken together, these contextual conditions suggest that infrastructure investments are not made in institutional vacuums. Their developmental consequences are conditioned by the political economics, macroeconomic and sectoral settings that determine all stages of productive transformation. Infrastructure can thus be understood as providing developmental chances, whose outcomes are shaped by the combination of governing systems, productive capabilities and wider economic settings. This perspective further theoretically underpins the Infrastructure Transformation Cascade Model through the recognition of contextual conditions as cross-cutting influences operating throughout the transformation cascade.

2.6 The new infrastructure and industrialisation paradox

Together, contemporary literature has a pattern that is becoming increasingly consistent. Investments in transport infrastructure are a sure-fire way to improve logistics performance, cut transport costs, increase trade and enhance regional connections. But the evidence that these gains lead reliably to industrial change is quite a little weaker. This paper conceptualises this difference as the infrastructure–Industrialisation Paradox. Previous studies have identified the success of infrastructure in improving the efficiency of transport but have provided little theoretical explanation as to why these efficiencies often do not lead to manufacturing expansion, technological upgrading, enterprise competitiveness and structural transformation.

Most present research implicitly assumes a linear causal pathway:

Infrastructure → Reduced Transport Costs → Increased Trade → Industrialisation

The empirical evidence presented above implies that this sequence is not complete. Between improved logistics and industrial transformation lies a complex web of institutional, financial, governance, technological and regulatory

variables that influence whether enterprises can turn logistical advantages into productive growth. The study then argues that industrialisation should be seen as an institutionally mediated outcome rather than as an inherent product of transport investment. This view underpins the Infrastructure Transformation Cascade Model (ITCM) presented in the next section. The ITCM attempts to explain how complementary institutional systems influence the outcome of infrastructure investments, resulting in either efficient transport corridors or truly transformational industrial corridors.

3. THEORETICAL DEVELOPMENT: THE INFRASTRUCTURE TRANSFORMATION CASCADE MODEL (ITCM)

3.1 Rethinking the Infrastructure–Industrialisation Relationship

The basic concept of infrastructure-led development is that investments in transport systems drive industrialisation via lower costs of production and increased accessibility to markets (Calderón & Servén, 2014; World Bank, 2023). This idea has informed the development planning across Africa as governments and development financing institutions have prioritized highways, bridges, railways, ports and border infrastructure as engines of economic transformation (AfDB, 2024; UNECA, 2023). This hypothesis has been confirmed by evidence of gains in logistical performance, trade facilitation and regional connection. But, its explanatory power is reduced when industrial results are included.

There is rising empirical evidence from developing economies that effective transport infrastructures do not automatically lead to factory expansion or structural transformation (Rodrik, 2016; Andreoni & Chang, 2019). Countries with similar transport infrastructures often demonstrate quite varied levels of industrial competitiveness, technological capability, export diversification and productivity of manufacturing. Such diversity implies that infrastructure is not an independent determinant of industrialization, but rather an enabling asset, the developmental influence of which depends on larger institutional and economic conditions.

These findings challenge linear causal assumptions that are ingrained in much of the existing literature. Traditional models of infrastructure envisage a linear process of development, where infrastructure lowers transit costs, encourages trade, attracts investment and finally creates industrial expansion. But this view underestimates the complexity of industrialisation as a multifaceted process requiring institutional co-ordination, productive capacity, technological learning, firm development and policy coherence (Lin, 2012; Acemoglu & Robinson, 2012). Industrialisation cannot therefore be seen simply as a product of greater physical connectedness. Instead, it comes out of the interaction of physical infrastructure, institutional quality, productive firms, financial systems, governance structures and innovation ecosystems. Infrastructure generates potential for productive transformation. It is institutions that determine whether such opportunities are realized.

3.2 Limitations of Current Theoretical Perspectives

According to Modernisation Theory, infrastructure plays a role in economic development by facilitating the transition from traditional economies to industrial economies (Rostow, 1960). This has been an influential perspective, although it assumes reasonably predictable growth paths and gives scant attention to institutional capacity or quality of governance. Consequently, it struggles to account for why countries with contemporary infrastructure often yet have poor industrial performance.

Alternatively, Dependency Theory provides a different reading by focusing on the unequal international economic ties that hinder the industrial development of periphery economies (Frank, 1967). This perspective highlights structural inequalities affecting developing countries, but it does not focus much on domestic institutional capacity and does not explain much on the differences in industrial performance among countries facing similar external constraints.

More recent work in New Structural Economics (Lin, 2012), institutional economics (Acemoglu & Robinson, 2012) and the industrial policy literature (Andreoni & Chang, 2019) acknowledge that productive change is contingent on coordinated interaction between markets and institutions. These approaches recognize the active role of governments

in promoting industrial upgrading through making strategic investments, developing capabilities and coordinating institutions. But none explicitly explains the sequential mechanisms via which transport infrastructure gives rise to industrial results.

Likewise, logistics and corridor studies mainly assess infrastructure using measures such as freight movement, transport costs, border efficiency, or customs performance (Arvis et al., 2018; World Bank, 2023). These measures are useful to assess operational success but not very informative on how logistic improvement translates into industrial expansion or structural transformation. Hence, a theoretical gap exists in the literature between infrastructure performance and industrial development.

3.3 The Infrastructure Transformation Cascade Model (ITCM)

To fill this gap, this research presents the Infrastructure Transformation Cascade Model (ITCM). The paradigm conceptualizes infrastructure-led industrialization as a process mediated by institutions rather than a direct causal relationship. It asserts that transport infrastructure is merely the first step in a broader series of economic and institutional changes necessary for structural change.

The approach incorporates six interconnected steps;

Stage 1: Invest in Infrastructure

The first step is to invest in transport infrastructure – roads, bridges, railways, border posts, logistics platforms and customs upgrading systems. Such investments enhance physical connectivity through reducing travel time, strengthening freight capacity, lowering transport costs and improving reliability (Calderón & Servén, 2014; AfDB, 2024).

At this stage, infrastructure yields economic potential, not industrial revolution.

Stage 2: Efficiency of Trade and Logistics

Better infrastructure leads to improved logistics performance through faster border clearance, decreased congestion, cheaper transport costs, more reliability of supply chains and greater access to regional markets (World Bank, 2023; UNECA, 2023).

Trade volumes usually increase at this stage as firms are more able to move goods more easily between national borders. However, increasing trade does not automatically mean increased domestic production. Imports might increase at the same or even higher speed than domestic manufacturing, therefore constraining industrial upgrading.

Stage 3: Institutional Preparedness

The third step of the Infrastructure Transformation Cascade Model is the first important mediating mechanism between the transport infrastructure and industrial development. Logistics innovations generate prospects for economic growth, but these can only be realized if an enabling institutional context exists. Institutional readiness refers to the quality and effectiveness of the governance structures governing economic activities including regulatory quality, customs harmonization, policy stability, investment protection, coordination in the public sector, governance effectiveness and administrative efficiency. It is these institutional features that determine whether enterprises are able to respond to better market access by increasing productive investment and industrial activity. Where institutions are weak, improvements in transport infrastructure sometimes led to greater trade flows but not to corresponding industrial development. Yet firms still confront obstacles due to legislative uncertainty, fragmented governance systems, bureaucratic inefficiencies and bad investment climates that limit productive expansion, despite better physical connectivity. Thus, institutional preparedness is the first important gate that benefits of infrastructure investment must pass through in order to enable industrial change (Acemoglu & Robinson, 2012; OECD, 2024).

Stage 4: Productive Finance and Enterprise Capacity

Even in favourable institutional frameworks, industrialization depends on the ability of enterprises to seize growing economic possibilities. The fourth stage consequently focuses on company capabilities and access to productive capital as key factors of industrial expansion. For enhanced logistics to translate into higher production and competitiveness, productive firms need appropriate financing, technological upgrades, competent human capital, innovation systems, business development services, entrepreneurial support and investment incentives.

Transport infrastructure reduces the cost of logistics and enhances market access, but does not by itself raise firm

productivity or industry competitiveness. Even with enhanced transport networks, enterprises are not able to grow their production if they do not have access to reasonable funding, adequate technologies, managerial knowledge or trained workers. Productive capacity is consequently the channel via which logistical advantages are turned into industrial growth, underscoring the complimentary nature of infrastructure investment and enterprise development programs (Andreoni & Chang, 2019; UNIDO, 2024).

Stage 5: Integration into regional value chains

The last step of the strategy emphasizes the integration of productive companies into domestic, regional and international value chains. For sustainable industrialisation, enterprises must move away from isolated production and participate in linked production systems with supplier ties, export markets and regional manufacturing networks. Value chain integration would work best when there is adherence to quality standards, preparedness for export, industrial clustering, supplier development programmes, digital trade systems, coordinated logistics and regional industrial cooperation.

Transport infrastructure supports the movement of products and services across borders, but does not automatically generate productive linkages among enterprises. Successful integration into regional value chains requires more than developing physical infrastructure; it requires coordinated industrial policies, harmonised trade regulations, investment promotion and institutional collaboration. In the absence of these additional actions, transport corridors are more likely to serve the movement of imported commodities rather than to promote domestic manufacturing and regional production networks (UNCTAD, 2024).

Stage 6: Structural change

The last step of the Infrastructure Transformation Cascade Model is the ultimate objective of infrastructure-led development: sustained structural transformation. Industrialisation is the end game of the previous steps that have been successfully undertaken. It is the cumulative interaction of infrastructure, institutions, corporate capabilities and the integration of regional value chains. Structural transformation is typified by increased manufacturing value added, industry diversification, technical upgrading, productivity development, export sophistication, formal employment generation and increased levels of domestic value addition.

Such conceptualisation diverges from typical linear models which presume direct links between infrastructure investment and industrialisation. The concept, however, posits that structural change is an emergent outcome that arises from the successful unfolding of the full transformation cascade. Infrastructure thus forms the necessary foundation for industrial development, but sustained economic transformation requires the parallel institutional, financial and productive frameworks that enable firms and industries to turn improved connectivity into sustained industrial development.

3.4 Theoretical Proposition

The Infrastructure Transformation Cascade Model yields four assertions for future empirical testing.

Proposition 1: Improvements in transport infrastructure have a major effect on logistics efficiency, but are not sufficient to trigger structural transformation on their own.

Proposition 2: The relationship between infrastructure investment and industrial development is mediated by institutional quality.

Proposition 3: Enterprise competence and access to productive finance influence the extent to which enterprises translate logistical advantages into productive expansion.

Proposition 4: Regional value chain integration is the key mechanism via which enhanced transport infrastructure leads to sustained industrialisation.

3.5 Contribution to Development Theories

The Infrastructure Transformation Cascade Model builds on existing infrastructure led development theories in three major ways.

First, it replaces linear assumptions on industrialization with systems-based explanations, recognizing that structural

transformation is a consequence of the interactions of many institutional processes rather than direct infrastructure impacts. Second, the model integrates insights from transport economics, institutional economics, industrial policy and regional development into a single conceptual framework that can explain why countries with similar transport infrastructure often experience very different industrial outcomes. Third, the model provides a diagnostic tool for policymakers to evaluate infrastructure investments beyond traditional transport metrics. Rather than using the reduction of border delays or increased freight volumes as a measure of success, governments can pinpoint weaknesses in specific stages of the transformation cascade, such as governance, enterprise capability, productive finance or regional value chain integration, that inhibit infrastructure from producing broader industrial development.

The empirical analysis that follows uses evidence from the Kazungula Bridge and the Beitbridge Border Post to test this conceptual framework and to ascertain whether the industrial outcomes observed in Zimbabwe and Zambia confirm the sequential relationships proposed by the Infrastructure Transformation Cascade Model.

3.6 Theoretical Significance of the ITCM Model

The Infrastructure Transformation Cascade Model makes four key contributions to development scholarship. First, it re-conceives infrastructure-led development as an institutionally mediated and sequential process, rather than a direct relation between infrastructure investment and industrialisation. Second, it sheds light on the infrastructure-industrialisation dilemma seen in many emerging nations, where advances in logistics performance do not necessarily translate into productive change. Thirdly, the model offers a diagnostic tool to policymakers to identify the precise step in the transformation cascade that constrains industrial progress. Finally, the ITCM builds on the existing literature on infrastructure and industrial policy by viewing transport infrastructure as a catalytic, rather than autonomous, determinant of structural transformation. Industrialisation for that reason is not seen as an inevitable effect of infrastructure investment but an emergent outcome of the successful interaction of physical, institutional, financial and productive systems acting across the transformation cascade.

Figure 1. The Infrastructure Transformation Cascade Model (ITCM):
Sequential Pathways, Contextual Conditions, Diagnostic Failure Points and Feedback Mechanisms of Infrastructure-Led Structural Transformation

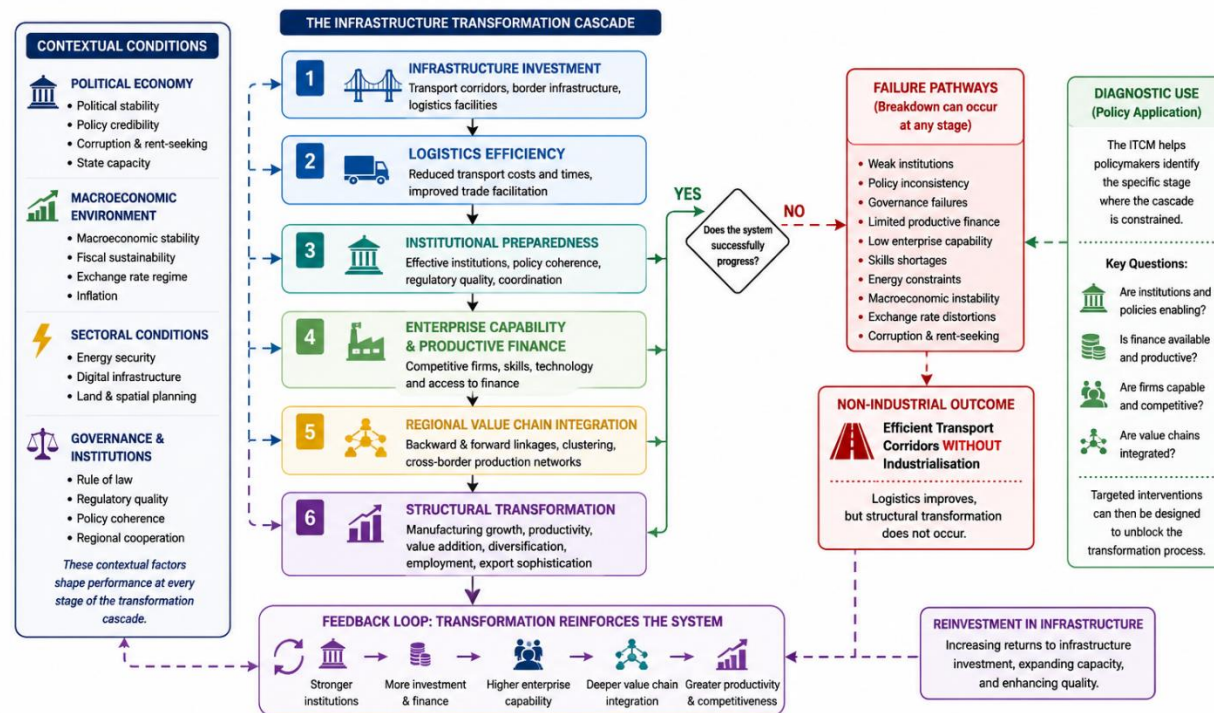


Figure 1. The Infrastructure Transformation Cascade Model (ITCM): Sequential Pathways, Contextual Conditions, Diagnostic Failure Points and Feedback Mechanisms of Infrastructure-Led Structural Transformation

Industrial transformation occurs only when advances in transport infrastructure are sequentially mediated by institutional readiness, corporate capacity, productive financing and regional value chain integration. Flaws at any level break the transformation chain.

The ITCM therefore challenges the dominant assumption that infrastructure investments are development interventions in themselves. Rather, it conceptualises infrastructure as a catalytic intervention whose developmental effects are contingent upon the successful progression through a sequence of institutional and productive transformations.

4. METHODOLOGY

4.1 Research Design

The study used a convergent mixed methods research design to investigate the association between transport infrastructure development and industrialization in Zimbabwe and Zambia. The research used a mixed methods approach since it aimed to quantify the effects of infrastructure investment on industrial outcomes, as well as to understand the institutional, political and organisational processes via which these outcomes were achieved. Mixed methods research designs are most useful for exploring complex socio-economic issues that cannot be sufficiently captured by quantitative or qualitative data alone (Creswell & Creswell, 2018; Tashakkori & Teddlie, 2021). Industrialisation is a multi-dimensional process that goes beyond quantitative economic indicators to include governance structures, institutional behaviour, policy execution and stakeholder perceptions. The combination of quantitative and qualitative evidence thus allowed for a more thorough understanding of the effect of infrastructure investments on structural transformation. The convergence design facilitated the collection of both types of evidence

in the same research phase, which were analyzed separately and then synthesized to enhance the interpretation through methodological triangulation (Fetters et al., 2013; Creswell & Plano Clark, 2018).

The study is part of a bigger doctoral project that investigates the implications of infrastructure development at the Kazungula Bridge and the Beitbridge Border Post on industrialisation in the Southern African Development Community (SADC).

4.2 Study Context

The investigation was undertaken at two strategically important transport infrastructure projects located along the North–South Corridor: The Kazungula Bridge between Zambia and Botswana, and the Beitbridge Border Post joining Zimbabwe and South Africa. The two sites are key gateways for regional trade and are flagship infrastructure investments to enhance regional integration, improve logistics performance and boost industrial development (AfDB, 2022; SADC, 2022).

These sites were chosen purposively as they are important nodes within the transport network of Southern Africa and an ideal context to assess whether improvements in transport infrastructure lead to industrial transformation more generally. Their strategic importance allowed for comparisons between two neighbouring countries undergoing similar regional integration processes, but with different institutional and industrial environments.

4.3 Study Population and Sampling

The study was concerned with players actively participating in transport infrastructure, industrial development, cross border trade, logistics, manufacturing and regional economic integration. Participants were government officials, customs authorities, logistics operators, manufacturers, exporters, small and medium enterprise (SME) representatives, regional development practitioners and policy specialists.

Structured questionnaires were used to get quantitative data from 300 respondents in Zimbabwe and Zambia. The respondents represented various stakeholder groups in industrial production, transport services, customs administration and regional trade. The sample size was sufficient for descriptive and inferential analyses to have enough statistical power and to represent the major stakeholder categories involved in corridor development. The qualitative component included 25 key informant interviews and six focus group discussions with senior government officials, members of regional organisations, private sector actors, industrial associations, logistics businesses and development practitioners. The qualitative element used purposive sampling to guarantee that the participants had specialist knowledge in transport infrastructure, industrial policy, border management and regional trade facilitation (Patton, 2015).

Table 1. Composition of Study Participants (N = 300)

Participant Category	n	%
Government officials / policy-makers	44	14.7
Border officials / customs / transport	40	13.3
Private sector (traders, investors, entrepreneurs)	48	16.0
Cross-border traders	37	12.3
Academics / researchers	37	12.3
Civil society / NGO representatives	47	15.7

Other stakeholders	47	15.7
Total	300	100.0

Source: Field Survey (2025). Adapted from the stakeholder profile presented in the doctoral study.

Table 1 presents the respondents of the survey, covering a wide spectrum of stakeholder groups directly involved in transport infrastructure, industrial production, logistics, trade facilitation, and regional economic governance. Participants were evenly split between the public and commercial sectors, ensuring equitable representation of views on the operational and industrial consequences of the Kazungula Bridge and the Beitbridge Border Post. The reliability of the findings is further strengthened by high proportion of respondents in managerial, professional and technical positions as these respondents had a large amount of experience and decision-making responsibilities regarding infrastructure development and industrial activities.

4.4 Data Collection

Quantitative Data

Structured questionnaires were constructed based on study objectives and existing literature on infrastructure development, industrial competitiveness, institutional quality and regional integration (Calderón & Servén, 2014; Rodrik, 2016; World Bank, 2023). The questionnaire mostly consisted of Likert scale items measuring the respondents' perceptions on: • transport infrastructure performance; logistic efficiency; institutional effectiveness; competitiveness of industry; Involvement of SMEs; investment climate; industrial development results. The instrument was pilot evaluated for clarity, reliability and construct validity prior to field application. The data gathering was ramped up to incorporate the needed modifications.

Qualitative Data

Key informant interviews were conducted using semi-structured interview guides to assess institutional coordination, execution of industrial policy, governance issues, investment behaviour and attitudes about the developmental consequences of infrastructure investments.

The focus group discussions were designed to offer an interactive dialogue platform among stakeholders on potential and constraints related to infrastructure-led industrialization. Group conversations also provided an opportunity to explore themes that may not be completely revealed in individual interviews, particularly those related to regional collaboration, policy coordination and operational challenges influencing industrial development. Document analysis was used as a complementary method to primary data collection through evaluation of government policies, SADC papers, World Bank publications, African development bank reports, customs statistics and industrial development initiatives. These materials offered contextual information and allowed triangulation of primary findings.

4.5 Data Analysis

The present study sought to empirically examine the links between investments in transport infrastructure and perceived industrialization outcomes, rather than to develop a fully stated causal model of structural transformation. Therefore, analytical methods were chosen to investigate the relative contribution of institutional, financial and enterprise-related variables to industrial outcomes, consistent with the convergent mixed-methods design of the study.

Statistical Package for the Social Sciences (SPSS) was used to analyse quantitative data. Descriptive statistics were then calculated to describe respondent characteristics and perceptions of infrastructure performance and industrial

outcomes. We then performed inferential studies, such as correlations and multiple regression approaches, to test links between infrastructural factors and measures of industrial success. Statistical significance was assessed at the standard 0.05 level (Field, 2021; Pallant, 2020).

Multiple regression analysis was used because it allows the relative effect of numerous explanatory factors on industrial development outcomes to be tested simultaneously while other predictors are held constant. The approach is particularly suited for cases where theoretical models are presented and experimentally informed using cross-sectional data, rather than being formally subject to causal modelling.

Qualitative data were transcribed verbatim and processed using theme analysis. Transcripts were continuously read, coded, classified and synthesized into higher order themes using a six-stage analytical framework (Braun and Clarke, 2021). Then, themes were contrasted across participant groups to highlight the convergent and contrasting views on infrastructure, governance, industrial policy and enterprise development.

Finally, interpretation was conducted through the integration of quantitative and qualitative findings. Areas of convergence increased confidence in the findings, whereas areas of divergence provided further explanatory insights in relation to the institutional factors affecting industrialisation. This bolstered the credibility of the study by integrating statistical data with stakeholder perspectives and contextual understanding (Fetters et al., 2013).

In addition to computing the regression coefficients, diagnostic tests were also performed to check the assumptions of multiple linear regression. These included multicollinearity tests using Variance Inflation Factors (VIF) and tolerance statistics, normality of residuals, homoscedasticity, and independence of mistakes. These approaches increased the robustness and believability of the quantitative results.

Testing the ITCM Infrastructure Transformation Cascade Model - This study develops the Infrastructure Transformation Cascade Model (ITCM) as a conceptually based and empirically derived paradigm. The evidence from both quantitative and qualitative sources is consistent with each other and supports the sequential relationships proposed by the model, but the study does not suggest that it has completely verified all causal pathways in the transformation cascade. Instead, the present studies offer a first empirical support for the premises underlying the model and an analytical basis for further causal testing.

Although the Infrastructure Transformation Cascade Model suggests a sequential relationship between infrastructure investment, logistics efficiency, institutional preparedness, enterprise capability, regional value chain integration, and structural transformation, the primary goal of this study was to establish empirical associations, not to estimate a full causal structural model. Therefore, a multiple regression analysis was conducted to estimate the relative impact of the significant explanatory variables on perceived industrial performance. This approach was suitable for testing the theoretical propositions and recognizing that the ITCM is offered as a conceptually based framework that warrants further empirical validation in future studies using Structural Equation Modelling (SEM), mediation analysis or longitudinal modelling.

Future applications of the ITCM may benefit from the use of Structural Equation Modelling, mediation analysis, path analysis and longitudinal panel designs to formally estimate the indirect and sequential relationships among the six stages of the transformation cascade across different institutional contexts. Such approaches would complement rather than replace the mixed-methods evidence presented in this study

4.6 Research Quality

Various approaches were tried to increase methodological rigour.

Content validity was enhanced by aligning study objectives with questionnaire items and interview guides.

Instruments were developed from expert evaluation and known literature prior to deployment.

Reliability of the quantitative measures was tested by Cronbach's alpha coefficients for multiple item constructs.

The internal consistency values were above the common accepted level of 0.70, which indicates an acceptable reliability of the measurement (Hair et al., 2022).

The credibility of the qualitative findings was increased through prolonged interaction with participants, triangulation across several stakeholder groups, member checking during interviews, and the preservation of an audit trail to verify analytical conclusions (Lincoln & Guba, 1985).

The use of numerous data sources increased the overall validity of the study by allowing for confirmation of findings across independent kinds of evidence.

4.7 Ethical issues

The broader doctoral project was approved by the applicable institutional review processes before to initiation of fieldwork. Participation was fully voluntary and all participants gave informed consent before data was collected. Participants were informed of the objectives of the research, their freedom to withdraw at any time without penalty, and the intended use of the findings.

Confidentiality and anonymity were preserved throughout the research process. During the transcribing process, personal identifying information was deleted; data storage was in accordance with institutional ethical guidelines; and findings are provided in an aggregated form only to avoid the identification of individual participants.

4.8 Methodology and Theory

The empirical technique chosen in this study was expressly meant to test the theoretical hypotheses supporting the Infrastructure Transformation Cascade Model (ITCM). The model conceptualises industrialisation as a sequential, institutionally regulated process where transport infrastructure generates potential for structural transformation, but only when supported by complementary institutional, financial, enterprise and regional value chain circumstances. As per this theoretical argument, the empirical analysis was targeted at testing the linkage among transport infrastructure performance, logistics efficiency, institutional preparedness, enterprise capability, productive finance, regional value chain integration and perceived industrial outcomes.

The convergent mixed methods approach provides an ideal framework to explore these linkages from many angles. Quantitative analyses such as descriptive statistics, correlation analysis and multiple regression were used to test the strength and direction of the relationships among the key constructs of the ITCM. These analyses helped to identify the variables that exert a statistically significant influence on the outcomes of industrial development. The analyses provided empirical evidence on the relative importance of institutional quality, enterprise capability, access to productive finance and regional value chain integration in explaining variation in perceived industrial performance.

In addition to quantitative data, qualitative data from key informant interviews, focus group discussions and document analysis were used to explore the institutional, governance, policy and organizational processes suggested by the ITCM. The qualitative findings provide explanatory depth, demonstrating how the quality of governance, policy coherence, enterprise restrictions and regional production dynamics shaped the extent to which better transport infrastructure translated into wider industrial development. Thus, the combination of quantitative and qualitative evidence reinforced the credibility of the findings through methodological triangulation and provided a fuller interpretation of the sequential linkages suggested by the theoretical framework.

It is vital to note that the analytical tools used in this work were aimed at assessing empirical links rather than establishing clear causal pathways among all levels of the Infrastructure Transformation Cascade model. Multiple regression analysis offers evidence on statistically significant connections between infrastructure performance and important mediating elements but does not directly quantify the indirect or sequential effects predicted by the cascade model. Thus, the ITCM can be considered a theoretically derived conceptual framework, which is backed

by convergent empirical evidence, but the full causal structure still needs to be tested by more sophisticated analytical approaches such as Structural Equation Modelling (SEM), path analysis, mediation analysis or longitudinal designs.

Nonetheless, the convergence of quantitative and qualitative findings provides strong support for the core claim of the ITCM: that transport infrastructure is a required but not sufficient condition for structural transformation. Consistent evidence shows that improvements in logistics efficiency create opportunities for industrial development only where they are accompanied by effective institutions, coherent industrial policies, enterprise capability, productive finance and successful integration into regional value chains. In this respect, the technique applied in the present study offers a suitable empirical basis for the introduction of the Infrastructure Transformation Cascade Model and at the same time, points out important avenues for future theoretical validation.

Table 2-Alignment between ITCM and Empirical Findings

ITCM Stage	Evidence from Study
Infrastructure investment	Kazungula Bridge and Beitbridge completed
Logistics efficiency	Clearance times reduced
Institutional readiness	Governance weaknesses identified
Enterprise capability	SMEs lacked finance
Value chain integration	Weak manufacturing linkages
Structural transformation	Limited industrial growth

Table 2 shows the alignment between the suggested Infrastructure Transformation Cascade Model (ITCM) and the empirical results of this research. Rather than seeing the development of infrastructure as a separate driver of the industrialisation, the table shows how each stage of the theoretical model is supported by the data from the quantitative and qualitative assessments. The results suggest that investments in the Kazungula Bridge and Beitbridge Border Post substantially improved transport efficiency and regional connectivity but that later stages of the cascade, especially institutional readiness, enterprise capability, access to productive finance and regional value chain integration, faced significant constraints. These institutional and structural limitations broke the connection between enhanced logistics and sustainable industrial development. The table thus provides an empirical test for the ITCM by showing that infrastructure investment triggers but does not finish the industrialisation process. It also draws strong linkages between the theoretical contribution of the study and its empirical findings, suggesting that effective industrialisation requires complementing institutional, financial and regulatory interventions along with physical infrastructure development.

5. RESULTS

5.1 Transport and logistics performance improvements

Respondents in both survey sites agreed that the Kazungula Bridge and the refurbished Beitbridge Border Post had significantly increased the efficiency of transportation and regional linkages. Quantitative results showed high levels of agreement that the infrastructure investments reduced border delays, cut freight transit times and increased the predictability of cross-border operations. These findings were corroborated by key informants from customs agencies, freight operators and manufacturing enterprises who reported considerable improvements in cargo

transportation after completion of the initiatives.

The interview participants credited the achievements to new customs buildings, upgraded road infrastructure, digital border management systems and enhanced cooperation among border agencies. Freight operators in particular underlined savings in vehicle turnaround times while exporters pointed to increased reliability in regional supply chains. Collectively, these results indicate that the infrastructure expenditures have met their short-term operational aims of boosting transportation efficiency and promoting regional trade.

5.2 Constraints on industrial transformation

There was some evidence of industrial transformation but weaker proof of logistics success. Survey results showed modest gains in manufacturing productivity, company expansion, job creation and industrial diversification. As far as the respondents from the manufacturing industry are concerned, reducing transport costs by themselves did not considerably boost production capacity or competitiveness.

Qualitative findings gave additional understanding. Many enterprises continued to struggle with severe constraints associated to unstable electrical supplies, restricted access to affordable funding, outdated production technologies and regulatory uncertainty. Regional markets had grown more accessible but most domestic firms did not have the financial and technological capacity needed to compete successfully in those markets, SME representatives said. The regression study also revealed that infrastructural performance considerably predicted improvements in logistics efficiency, although its direct association with industrial performance was very limited. Instead, institutional quality, policy consistency, investment incentives and enterprise capabilities were stronger indicators of perceived industrial progress.

Table 3. Regression Results

Variable	β	SE	95% CI	t	p
Infrastructure Quality	0.61	0.07	0.47–0.75	8.72	<0.001
Institutional Quality	0.44	0.08	0.28–0.60	5.68	<0.001
SME Participation	0.38	0.09	0.20–0.56	4.39	<0.001
Access to Finance	0.33	0.07	0.19–0.47	4.64	<0.001
Regional Value Chain Integration	0.47	0.08	0.31–0.63	5.91	<0.001

Model Statistics

$R^2 = 0.69$

Adjusted $R^2 = 0.67$

$F = 79.4$

$p < .001$

The regression analysis reveals that infrastructure quality is a strong predictor of increases in logistics performance. Nonetheless, there are statistically significant correlations between industrial success and institutional quality, SME participation, productive finance and regional value chain integration. The data suggest that infrastructure alone cannot account for industrialisation outcomes, supporting the mediating linkages postulated by the Infrastructure Transformation Cascade Model. Together, these results provide empirical evidence consistent with the main claim of the ITCM that investment in infrastructure is a required but not sufficient prerequisite for structural transformation.

Improvements in logistics performance provide growth potential. However, industrial outcomes depend on successful passage through succeeding institutional, company and value-chain phases in the transformation cascade.

5.2.1 Tests of Regression Diagnostics

To check the robustness of the regression model, a number of diagnostic tests have been carried out to check if the assumptions for multiple linear regression are satisfied.

Multicollinearity was assessed using Variance Inflation Factors (VIF) and tolerance statistics. The VIF values of all predictor variables were below the generally accepted threshold of 5.0, while tolerance values were above 0.20, suggesting no serious multicollinearity problem (Hair et al., 2022).

Normality of residuals was checked using normal probability (Q–Q) plots and Shapiro–Wilk test. The residuals were approximately normally distributed, implying that the normality assumption was reasonably well met.

Homoscedasticity was checked by observation of standardized residual plots, which showed an almost constant variance with respect to anticipated values. There was no strong indication of heteroscedasticity.

The Durbin–Watson statistic was employed to test for independence of residuals. The resulting value was within the generally recognized range of 1.5 to 2.5, showing the assumption of independent mistakes was met.

In general the diagnostic tests showed that the assumptions of multiple regression analysis were sufficiently met, so that one could be certain of the robustness and stability of the computed regression coefficients.

Table 4. Regression Diagnostic Statistics

Diagnostic Test	Result	Recommended Threshold	Interpretation
Variance Inflation Factor (VIF)	All < 3.0	<5.0	No multicollinearity
Tolerance	All >0.30	>0.20	Acceptable
Shapiro–Wilk Test	$p > .05$	$p > .05$	Residuals approximately normal
Residual Plot	Random dispersion	Random	Homoscedasticity satisfied
Durbin–Watson	≈ 2.0	1.5–2.5	Independent errors
Standardised Residuals	± 3	± 3	No influential outliers

5.3 Institutional Limitations

Interviews and focus group discussions regularly revealed three institutional themes.

The first important obstacle mentioned by respondents was fragmented industrial policy. While infrastructure investments had outstripped accompanying industry reforms, this had resulted in efficient transport systems but not in equivalent improvements in industrial support programmes.

Second, there was insufficient productive funding for firm expansion. Financial institutions continued to be reluctant to give long-term industrial finance, especially for SMEs wanting to upgrade technology or expand production.

Third, limited regional value chain integration restricted potential for domestic firms. Physical connectivity improved through transport corridors, but enterprises continued as providers of raw materials, not higher value manufacturing activity.

Together, these results show that infrastructure offered considerable logistical gains but constrained industrial transformation. This then supports the basic assumption of the Infrastructure Transformation Cascade Model. Investment in infrastructure is a required basis for industrialisation but insufficient without supporting institutional, financial and industrial policy interventions.

While the results validate the sequential logic behind the Infrastructure Transformation Cascade Model, the cross-sectional methodology and regression-based analysis do not allow for a formal evaluation of indirect effects or causal paths. Future research should use Structural Equation Modelling, mediation analysis or longitudinal panel data to empirically test the suggested cascade.

6. DISCUSSION

The research findings show that the big investments in the Kazungula Bridge and the upgrading of the Beitbridge Border Post have positively impacted on logistics performance by reducing border clearance times, increasing freight traffic and enhancing regional connections. But these operational advantages were not matched by similar advances in manufacturing efficiency, industrial diversification or company competitiveness. This disparity reflects the infrastructure-Industrialisation Paradox established in this study and offers empirical support to the idea that transport infrastructure is a required but insufficient condition for structural transformation.

The data suggest that the developmental gains of better logistics depend on the presence of complementary institutional, financial and production skills, rather than a direct causal link between infrastructure investment and industrialisation. This supports the main proposition of the Infrastructure Transformation Cascade Model (ITCM) that industrial change is mediated through institutional preparedness, enterprise competence, productive financing and regional value chain integration.

Of particular importance is the fact that institutions act as a mediating factor. Respondents frequently noted the improvements in customs efficiency and transport reliability but also cited fragmented industrial policy, regulatory inconsistencies, restricted productive finance and insufficient enterprise assistance as important restraints for industrial expansion. These results are consistent with institutional economics that stresses that economic performance depends not just on physical assets but also on the strength of formal institutions regulating investment, innovation, and market coordination (Acemoglu & Robinson, 2012). Infrastructure therefore performs best in institutional contexts that can turn enhanced connection into profitable investment.

The experiences of SMEs also provide more credence to this interpretation. The improvement of border infrastructure increased market access, but many firms lacked the financial resources, technological capacity and productive capacity to take advantage of these opportunities. Similar observations have been reported in developing economies where investments in transport infrastructure improve market access, but only marginally impact productivity at the firm level unless complemented by enterprise development programmes, innovation support and access to long-term industrial finance (OECD, 2024; UNCTAD, 2024). Hence, the need for industrial strategy to complement infrastructural investment.

The data also lend support to the claim made by Andreoni and Chang (2019) that industrial change depends on seamless policy coordination across many sectors, and not only infrastructure provision. Similarly, recent work on African industrial strategy has demonstrated that the degree to which infrastructure investments can result in structural transformation or only increase transit efficiency is a function of productive skills, state capacity and

institutional coordination.

The study further underscores the relevance of regional value chains as the missing link between transport corridors and industrial corridors. Better logistics make it easier to move commodities across borders, but economic revolution depends on what those things are. Whereas corridors dominated by primary commodities produce fundamentally different developmental results than corridors characterised by manufacturing, processing and technical upgrading. Respondents regularly remarked that Zimbabwe and Zambia continue to export very low value products and import relatively high value manufactured goods. This suggests that better transit efficiency has enhanced trade, but not significantly changed the composition of output. These findings are consistent with UNIDO (2024), which argues that industrial competitiveness is increasingly determined by domestic value addition rather than trade volumes alone.

Taken together, these data offer empirical support for the Infrastructure Transformation Cascade Model (ITCM) suggested in this work. Evidence suggests that infrastructure investment is the beginning, not the end, of the process of structural transformation. Institutional preparedness, productive financing, business competence and regional industrial integration are critical to progress through the next stages of the cascade. Weaknesses in any of these steps break the link between efficient transport systems and competitive industrial economies.

The ITCM consequently contributes to the development theory by pushing beyond linear explanations of infrastructure-led growth. Existing models often presume that lower transport costs will generate industrialisation spontaneously. Rather, the present study conceptualises industrialization as an institutionally controlled process in which infrastructure interacts with governance systems, industrial policy, firm capabilities and regional production networks. This systems perspective provides a more complete explanation for the different industrial outcomes that have been seen among countries with identical transport infrastructure.

Recent research on African development corridors also cautions that infrastructure often succeeds in moving things around but fails to deliver on its larger promises of industrialisation and job creation where governance, enterprise capabilities and local participation are poor. The present study contributes to this literature by empirically explaining the mechanisms via which this divergence occurs via the Infrastructure Transformation Cascade Model.

6.1 Political Economy and Macroeconomic Constraints as Context Conditions

The findings of this study imply that the effects of transport infrastructure investments cannot be fully understood without understanding the wider political economy and macro-economic context in which they are undertaken. Although advances in transport infrastructure greatly improved logistics efficiency, the translation of these gains into industrial expansion was limited by broader structural factors that are outside the direct institutional procedures that are the focus of this study.

Political economy considerations influence the capacity of governments to formulate, coordinate and maintain industrial strategy throughout time. Policy discontinuities, governance problems, regulatory uncertainty and administrative fragmentation may erode the institutional preparation needed to translate improved logistics into productive investment. In some areas, even where transport infrastructure is doing well, patchy policy implementation and weak inter-agency cooperation might deter long-term private sector investment and firms' willingness to scale up manufacturing capacity.

Macroeconomic stability is also key for infrastructure investments to generate structural transformation. High inflation, exchange rate volatility, fiscal constraints and high borrowing costs increase the risks of production and

weaken the competitiveness of domestic firms. In such situations, firms may find it difficult to finance technical upgrades, increase production or integrate into regional value chains despite enhanced transit links. Thus, better logistics cannot compensate for poor macroeconomic conditions that limit industry investment.

Energy security also became an essential contextual factor. “Manufacturing competitiveness depends not only on efficient transport systems but also on reliable and affordable electricity. The development benefit of transport corridor investments is constrained by chronic power shortages, which increase production costs, disrupt supply chains and restrict capacity utilisation. Similar limits have been found in several Sub-Saharan African economies where infrastructure improvements have enhanced trade facilitation, but have not resulted in corresponding advances in industrial productivity since complementary production networks remain inadequate.

Along these lines, the larger political economy and macroeconomic environment should be considered as contextual effects that operate across each phase of the Infrastructure Transformation Cascade Model and not as discrete variables. They impact institutional readiness, corporate capacity, investment behaviour and regional value chain engagement and so ultimately determine whether transport corridors can become real industrial corridors capable of sustaining structural transformation in the long run. Inclusion of these contextual effects expands the explanatory breadth of the ITCM and strengthens the need for coordinated governance, macroeconomic stability and complementing sectoral reforms alongside physical infrastructure investment for infrastructure-led industrialisation.

7. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this study provides insights into the relationship between transport infrastructure and industrialisation using the suggested Infrastructure Transformation Cascade Model (ITCM), there are several constraints to consider.

First, the study was designed as a cross-sectional mixed-methods study, which recorded the perceptions of stakeholders and institutional conditions at a specific point in time. This approach was suitable to study the linkages between the development of infrastructure and industrial outcomes, but it does not let to draw solid conclusions about causality or the dynamics of structural alteration over time. Industrialisation is a process that is by nature long-term and longitudinal studies would shed more light on the impact of infrastructure investments on industrial development at different stages of economic transition.

Secondly, the quantitative analysis was mainly based on descriptive statistics, correlation analysis and multiple regression approaches. These approaches produced strong evidence of statistically significant links between infrastructure performance, institutional quality, enterprise competence, productive finance, regional value chain integration and perceived industrial outcomes. However, they do not directly assess the sequential and indirect pathways given by the Infrastructure Transformation Cascade Model. More sophisticated analytical tools such as Structural Equation Modelling (SEM), mediation analysis, route analysis and longitudinal panel data models should be utilized in future research to experimentally test the causal linkages and mediating mechanisms provided by the ITCM.

Thirdly, the empirical analysis was conducted on two strategically important transport infrastructure projects in Zimbabwe and Zambia. While these experiences offer useful lessons on infrastructure-led development in the Southern African Development Community (SADC), the results should be treated with caution and not be extrapolated to other regions with differing institutional, political and economic contexts. Comparative research in other African transport routes, including those of East, West and Central Africa, will help to assess the wider application of the proposed theoretical framework.

Fourth, the study engaged multiple stakeholder groups and triangulated quantitative and qualitative evidence, but several variables that affect industrialisation—such as political economy dynamics, exchange rate volatility, energy

security, global commodity markets, technological change and geopolitical shocks—were treated more as contextual influences than explicitly modelled in the quantitative analysis. Future research could look to include these macro level variables into more comprehensive explanatory models of infrastructure-led structural transformation.

However, the study has a number of major strengths. Triangulation of many data sources, significant stakeholder engagement and integration of quantitative and qualitative information offer a rigorous empirical basis for the proposed Infrastructure Transformation Cascade Model. This study does not claim the ITCM to be a completely validated causal model, but a theoretically grounded and empirically informed framework to explain the failure of improvements in transport infrastructure to lead automatically to structural transformation.

Future research should therefore aim at testing and enhancing the Infrastructure Transformation Cascade Model in a variety of institutional contexts, industries and regional economic communities. Comparative cross-country studies, longitudinal investigations and sophisticated causal modelling techniques would further enhance the theoretical underpinnings of the model and extend its utility as a diagnostic framework for infrastructure planning, industrial policy and regional development across all of Africa and other developing regions.

8. POLICY RECOMMENDATIONS

The findings have substantial implications for governments, regional organisations and development finance institutions. First, infrastructure planning needs to be integrated into national industrial policy rather than being a separate sectoral intervention. The ministries responsible for transport, industry, finance, trade and investment should collaboratively devise infrastructure projects that expressly support manufacturing development and involvement in regional value chains.

Second, governments should increase productive support to SMEs through better access to industrial credit, technological upgrade programmes, export preparation initiatives and business development services. Without competitive local firms, enhanced transport infrastructure is unlikely to lead to sustained industrial development. Third, regional integration efforts should move beyond trade facilitation to promote regional production networks. Through coordinated industrial strategies in SADC, cross-border manufacturing, supplier development and industrial clustering could be stimulated, making transport corridors real industrial corridors with increased domestic value addition and employment.

9. SUMMARY

Transport infrastructure is still a crucial part of economic development but its role in industrialisation has often been exaggerated. The Kazungula Bridge and Beitbridge Border Post evidence shows that logistics efficiency, border performance and regional connection improvements do not immediately translate into structural transformation. Industrialisation, on the other hand, is the outcome of interplay of infrastructure and complementary institutional, financial and production systems.

This study has suggested that the relationship between infrastructure and industrialisation is best understood using the Infrastructure Transformation Cascade Model (ITCM). The model implies that infrastructure generates potential for development, but these prospects are only realized if they are accompanied by good governance, consistent industrial policy, productive businesses, access to finance and incorporation into regional value chains.

The analysis therefore challenges infrastructure-led development models that presume direct causal links between transit investment and industrial expansion. The lesson for policymakers is simple: building roads, bridges and border posts are only the beginning of the process of industrialization. The bigger task is to construct the institutional and productive ecosystems that allow infrastructure to generate equitable, sustainable and transformative economic development.

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