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Railway Infrastructure Development and Regional Economic Integration in Africa: Progress, Challenges and Future Prospects

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Abstract *Regional economic integration remains a critical priority for Africa as the continent seeks to expand intra-African trade, strengthen regional value chains, and achieve sustainable economic development. Despite significant progress in policy initiatives such as the African Continental Free Trade Area (AfCFTA) and the Programme for Infrastructure Development in Africa (PIDA), inadequate transport infrastructure continues to restrict economic cooperation and market integration. Among transport modes, railway infrastructure offers considerable potential to reduce trade costs, improve connectivity, and facilitate the movement of goods and people across borders. This review explores the evolution of railway infrastructure development in Africa and its contribution to regional economic integration. Inferring on evidence from historical analyses, empirical studies, policy reports, and corridor-based case studies, the review explores the transformation of African railways from colonial-era extraction networks to contemporary infrastructure investments aimed at supporting regional development. Findings indicate that railway connectivity contributes positively to trade expansion, foreign direct investment attraction, market access, and cross-border economic cooperation. Major railway corridors, including the Lobito, Maputo, and emerging transcontinental corridors, demonstrate the capacity of rail infrastructure to stimulate regional integration through improved logistics efficiency and value chain development. However, the realization of these benefits remains constrained by infrastructure deficits, inadequate financing, fragmented technical standards, governance challenges, and limited technology adoption. The review concludes that railway infrastructure development is an essential enabler of Africa's integration agenda and that coordinated regional planning, infrastructure modernization, policy harmonization, and sustained investment are necessary to maximize its economic and developmental impacts. Strengthening railway networks will be critical to unlocking the full potential of AfCFTA and fostering a more interconnected and competitive African economy.*

Keywords *Africa, Development, Infrastructure, Railway, Regional.*

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Introduction

Africa's quest for regional economic integration represents one of the most significant development challenges and opportunities of the 21st century [1]. Despite comprising 54 countries with abundant natural resources and a rapidly growing population, the continent remains characterized by fragmented markets and limited intra-regional trade. Intra-African trade consistently averages between 12-15% of total continental trade [2], substantially lower than comparable figures in other regions. This limited regional integration perpetuates economic vulnerabilities, constrains industrial development, and undermines the continent's potential to leverage collective bargaining power in global markets.

The persistence of low intra-African trade stems from multiple interconnected factors, including tariff and non-tariff barriers, weak institutional frameworks, limited financial integration, and most critically, inadequate physical infrastructure. Among infrastructure deficits, transportation networks – particularly railway systems – represent perhaps the most significant constraint to regional economic integration [3]. Railways offer unique advantages for continental integration, including cost-effective long-distance freight transport, reduced environmental impact compared to road transport, and the capacity to handle bulk commodities that form the backbone of many African economies [4].

Historically, Africa's railway development followed colonial patterns designed primarily to extract raw materials from interior regions to coastal ports for export to metropolitan countries, rather than to facilitate intra-African connectivity. This legacy has resulted in fragmented railway networks characterized by different gauge systems, limited cross-border connections, and inadequate maintenance that has left many systems operating well below capacity [5]. The colonial-era infrastructure was never designed to support the vision of an integrated African economy, creating path dependencies that continue to constrain regional trade and economic cooperation.

Contemporary efforts to address these infrastructure deficits have gained momentum through various continental and regional initiatives. The African Union's Agenda 2063 envisions a transformed continent with world-class infrastructure, while the Programme for Infrastructure Development in Africa (PIDA) has identified priority railway corridors for development. Most significantly, the African Continental Free Trade Area (AfCFTA), which became operational in 2021, represents the world's largest free trade area by country participation since the formation of the World Trade Organization [6]. However, the realization of AfCFTA's potential depends critically on complementary investments in transport infrastructure that can reduce trade costs and improve market access.

Recent developments in railway infrastructure, including Chinese Belt and Road Initiative investments, regional development bank financing, and public-private partnerships, have created new opportunities for transforming Africa's transport landscape [7, 8]. Projects such as the Standard Gauge Railway in East Africa, proposed transcontinental corridors, and railway rehabilitation programs across various regions signal renewed recognition of railways' strategic importance for economic integration.

Despite growing policy attention and investment commitments, significant knowledge gaps remain regarding the relationship between railway infrastructure development and regional economic integration in Africa. While substantial literature exists on infrastructure and economic growth generally [9], comprehensive analysis specifically examining railways' role in facilitating intra-African trade, promoting industrial development, and supporting regional value chain formation remains

limited. Furthermore, existing studies often focus on individual countries or projects rather than adopting a continental perspective that considers network effects and regional spillovers.

This narrative review addresses these knowledge gaps by providing a comprehensive examination of railway infrastructure development and its relationship with regional economic integration across Africa. The review synthesizes existing evidence on railway investments, trade facilitation mechanisms, and economic outcomes while identifying key challenges and opportunities for future development.

Evolution of Railway Infrastructure in Africa

The evolution of railway infrastructure in Africa represents a complex narrative spanning over 150 years, characterized by distinct phases of development, decline, and recent renaissance that reflects broader patterns of colonial exploitation, post-independence policy shifts, and contemporary globalization dynamics. African railway development began in 1862 with the Cape Town-Wellington Railway in South Africa, marking the continent's entry into the railway age [10]. The colonial period witnessed rapid expansion following the Berlin Conference and the scramble for Africa, with lines opening in Mozambique in 1890, Burkina Faso in 1892, and Senegal in 1894, such that by 1904, the median country in sub-Saharan Africa had established railway infrastructure [10].

The most comprehensive quantitative analysis of this development confirms that railroads were fundamentally a colonial transportation technology, with 74% of today's 66,000 km network built by 1929, 88% by 1960, and 96% by 1975 [10]. Colonial powers constructed railways primarily for military domination and trade facilitation, with rail transport being dramatically cheaper than alternatives – roughly 10 times cheaper than headloading in Ghana circa 1914 and 100 times cheaper in Kenya in 1902 [10]. The construction of railways was governed by multiple factors, including port access, natural resource exploitation, territorial control, and administrative requirements, as evidenced in West African development, where the first Dakar-St Louis line was constructed in 1885 [11].

The post-independence period marked a fundamental shift in transportation priorities, with paved roads emerging as the preferred post-colonial technology while railway investment declined significantly [10]. This transition reflected changing economic priorities and the perceived advantages of road transport for newly independent nations, leading to systematic underinvestment in railway infrastructure that persists today. Most sub-Saharan African networks outside South Africa continue to operate to standards established during their original construction, with limited rehabilitation over decades [12].

Contemporary railway infrastructure in Africa suffers from multiple interconnected challenges that have been systematically documented through comprehensive research. A systematic literature review of 49 peer-reviewed papers published between 2000 – 2022 identified low penetration of electric-powered trains, limited technology integration, and inadequate shuttle services as persistent challenges, while revealing significant knowledge gaps in passenger demand optimization, price optimization, route scheduling, and transport emission experimentation [13]. Most railway systems in southern Africa are not functioning optimally due to historic underinvestment, creating an infrastructure gap that hinders economic development and regional integration, with additional challenges posed by gauge interoperability issues between Standard Gauge and Cape Gauge systems [5].

The current state of West African railways exemplifies broader continental challenges,

with deteriorated infrastructure, obsolete technologies, and low-quality operations resulting in traffic density below 1 million traffic units per route-km in most countries except Guinea, where private mining companies utilize railway lines extensively [11]. The 1990s marked a significant institutional shift with railway concessioning and privatization initiatives designed to encourage commercialization and reduce government financial burden [12]. However, analysis of railway privatization results across thirteen African concessions reveals mixed outcomes, with some improvements in operational efficiency offset by continued struggles with inadequate investment in infrastructure rehabilitation and modernization [14].

The 21st century has witnessed a significant railway renaissance driven primarily by Chinese investment through the Belt and Road Initiative, building upon the foundation established by the landmark Tanzania-Zambia Railway Project constructed between 1968-1976 with a Yuan 988 million interest-free loan [15]. Contemporary Chinese involvement in African railway development has been comprehensively analyzed, revealing how infrastructure projects serve Chinese capital expansion while potentially perpetuating Africa's dependent integration into global capitalist systems [16]. The analysis of Kenya's Standard Gauge Railway project under the Belt and Road Initiative identifies potential economic benefits including socio-economic development, government revenue generation, and enhanced regional integration, while highlighting concerns about debt burden and the need for more transparent stakeholder engagement [8].

The examination of railway imperialisms in East Africa reveals China's transition from providing anti-imperial infrastructure through projects like the Tanzania-Zambia Railway Authority to becoming a neo-imperial investor through contemporary Belt and Road Initiative projects [17]. This transformation reflects broader patterns in which recent rail infrastructure projects are often driven by international suppliers' preferences rather than creating railways that match regional network requirements, suggesting a disconnect between project design and regional integration objectives [18].

Railway Infrastructure and Regional Economic Integration

Railway infrastructure development represents a critical catalyst for regional economic integration across Africa, serving as both a facilitator of trade expansion and a driver of sustainable economic growth that has gained increasing attention as the continent pursues deeper economic integration through initiatives such as the African Continental Free Trade Area (AfCFTA) and various regional economic communities. The relationship between transport infrastructure and trade facilitation in Africa is well-established in empirical literature, with research examining the ECOWAS region demonstrating that including a rail connection between trading partners results in an average trade increase of 3.5 percent [19]. This finding underscores the tangible benefits that railway connectivity can deliver to regional trade volumes, while analysis of Eastern African countries reveals that transport infrastructure, including railways, has significant and positive effects on trade, with infrastructure exerting "a strong effect on trade and growth" in the region [7].

The broader transport infrastructure landscape in Africa shows consistent positive impacts on economic performance, as studies of Kenya, Tanzania, and Uganda found that transport infrastructure positively drives long-term growth, with cross-border trade volumes significantly boosting economic development in Kenya and Uganda [20]. These findings align with broader African infrastructure research showing that infrastructure contributed 99 basis points to per capita

economic growth across the continent, with most of the contribution coming from increases in stocks rather than quality improvements [21]. The impact of railway infrastructure on economic integration varies significantly across African regions, reflecting different levels of development, policy frameworks, and existing infrastructure stocks, as evidenced in the Southern African Development Community (SADC) where empirical analysis reveals a positive and statistically significant relationship between infrastructure development and intra-regional trade, with infrastructure improvements increasing intra-SADC exports by 1.76 percent [2].

The growth effects of infrastructure investment are particularly pronounced in less developed African economies, with research indicating that infrastructure spending and increments in access to infrastructure influence economic growth more significantly in lesser developed economies than in relatively more developed ones [22]. This suggests that railway infrastructure investments may deliver higher returns in countries with existing infrastructure deficits, making strategic targeting of investments crucial for maximizing regional integration benefits. Railway infrastructure facilitates regional economic integration through multiple channels beyond direct trade cost reduction, as infrastructure development creates spillover effects across neighboring countries where improved connectivity in one nation raises the profitability of investment in neighboring countries by creating wider markets and improving export opportunities [23]. This interconnectedness suggests that railway projects designed with regional integration in mind can generate benefits that extend far beyond national borders, particularly evident in the interaction between infrastructure and other economic factors, where research shows that the interaction between trade openness and infrastructure leads to increased foreign direct investment inflows, which in turn have positive and significant effects on growth [24].

Major Railway Corridors Supporting Integration

Africa's railway corridors have emerged as critical infrastructure for fostering regional economic integration, with several major corridors demonstrating significant impacts on trade flows, investment patterns, and cross-border economic cooperation. The continental recognition of this potential is evident in the Program for Infrastructure Development in Africa (PIDA), which has identified 42 corridors as forming a core network for regional integration and global connectivity [25].

The Lobito Corridor represents one of the most promising examples of railway infrastructure driving regional integration in Southern Africa. Connecting Angola, the Democratic Republic of Congo, and Zambia, this corridor has demonstrated measurable impacts on economic integration through multiple channels. Research using structural gravity modeling has shown that the corridor's infrastructural capacity, ability to anchor critical value chains, and regional integration functions all positively impact export volumes moved through the corridor [26]. The corridor's development leverages Southern Africa's transport infrastructure to drive economic transformation through agriculture and mining value chains while facilitating stronger bilateral and multilateral relations among participating countries.

The integration effects of railway corridors extend beyond direct trade facilitation to encompass broader investment patterns across regions. Spatial econometric analysis covering 40 sub-Saharan African countries over the period 2000-2021 reveals that shared rail corridors create spillover effects, where the presence of railway infrastructure in one country increases inward foreign direct investment not only domestically but also in

neighboring countries [27]. This finding suggests that railway corridors function as regional integration catalysts, creating investment clusters that transcend national boundaries and foster economic interdependence among participating nations.

The Maputo Corridor provides valuable insights into the conditions necessary for successful railway corridor development and integration outcomes. This corridor's experience demonstrates that effective integration requires a combination of public and private investments to improve infrastructure, an institutional framework promoting coordination, focus on operational efficiency of logistics services, and proven economic potential [25]. The corridor's success in enabling trade and economic development illustrates how railway infrastructure can serve as a foundation for broader regional economic integration when supported by appropriate institutional arrangements.

Continental-scale railway initiatives further demonstrate the integration potential of rail infrastructure. The Tripoli-Windhoek corridor, incorporating road-rail bridge projects, has shown positive and significant effects on exports from participating countries over the 1980-2020 period [28]. This transcontinental approach to railway development represents an ambitious vision for African integration, connecting diverse economic regions and facilitating north-south trade flows that complement traditional coastal-inland corridor patterns.

The integration mechanisms through which railway corridors operate are multifaceted and interconnected. Railway infrastructure reduces transportation costs, which is particularly crucial for landlocked nations that constitute a significant portion of African countries [29]. By providing cost-effective solutions for least developed countries, railway corridors enable these nations to participate more effectively in regional and global value chains. The corridors also facilitate the development of special economic zones and support the establishment of regional trade agreements, creating institutional frameworks that reinforce the physical infrastructure investments [26].

Infrastructure Deficits and Technical Barriers

Africa's railway infrastructure faces primary deficits that severely constrain the benefits of economic integration. Parida (2013) identifies an infrastructure gap resulting from historical underinvestment, noting that most railway systems in southern Africa are not functioning as they should [5]. This underinvestment has created a continent-wide challenge where Mbekeani (2010) observes that inadequate infrastructure and poor transport organization make it difficult to guarantee the timely delivery of goods or ensure reliability or flexibility in the supply of goods [30].

Technical standardization presents another critical barrier to regional connectivity. Parida (2013) again highlights the gauge and interoperability issue, i.e., Standard Gauge vs Cape Gauge, as a strategic challenge, particularly regarding requirements for interconnections with other regional railways. This fragmentation prevents seamless cross-border rail operations, which are essential for economic integration [5].

The adoption of modern technology remains limited across African railway systems. Bouraima et al. (2023) documented low penetration of electric-powered trains, technology integration, and shuttle services in their systematic review of 49 railway studies. These technological gaps compound existing infrastructure deficits, limiting the efficiency gains necessary to compete with other transport modes and realize integration benefits [13].

Future Prospects for Railway Development and Regional Economic Integration in Africa

The future of railway development in Africa is increasingly being shaped by continental and regional frameworks that recognize transport infrastructure as a catalyst for economic transformation and regional integration. As African economies seek to deepen trade relationships, strengthen regional value chains, and facilitate the implementation of the African Continental Free Trade Area (AfCFTA), railway systems are emerging as strategic assets capable of addressing long-standing transportation bottlenecks. In recognition of this potential, the African Union (AU) has placed railway development at the centre of its Agenda 2063 vision through the African Integrated High-Speed Railway Network (AIHSRN), a flagship initiative designed to connect major African capitals, commercial centres, and industrial hubs through interoperable rail corridors [31]. The overarching objective is to facilitate seamless movement of people and goods across national boundaries, thereby enhancing continental competitiveness and fostering sustainable economic growth.

The continental railway agenda is reinforced by several regional infrastructure programmes, including the Programme for Infrastructure Development in Africa (PIDA) and the Southern African Development Community (SADC) Regional Infrastructure Development Master Plan. These initiatives emphasize the importance of coordinated transport investments capable of overcoming the fragmented nature of Africa's existing railway systems while promoting greater connectivity between countries and regions [5]. Similarly, regional economic blocs such as the Economic Community of West African States (ECOWAS) have developed strategies aimed at creating efficient and interoperable railway systems that can support trade expansion, regional mobility, and economic cooperation across West Africa [11]. Collectively, these frameworks reflect a growing consensus that railway infrastructure will play a fundamental role in achieving the continent's integration aspirations.

Evidence of this commitment is increasingly visible through major railway investments currently being undertaken across the continent. In West Africa, Ghana has embarked on an ambitious Railway Master Plan that seeks to rehabilitate, modernize, and expand existing railway infrastructure while extending connectivity to neighboring countries such as Côte d'Ivoire, Togo, and Burkina Faso. The programme is structured into six implementation phases and represents one of the most comprehensive railway development strategies in the region, encompassing both infrastructure upgrades and rolling stock acquisition [11]. Beyond improving domestic mobility, these cross-border connections are expected to strengthen regional trade networks and facilitate access to seaports for landlocked economies.

Nigeria has similarly emerged as a major player in Africa's railway renaissance. Significant investments have been directed towards modernizing the country's rail network by developing standard-gauge railway corridors. Notable projects include the Abuja–Kaduna railway, the Lagos–Ibadan railway, and the broader rehabilitation of the western railway corridor linking Lagos to Kano. Additionally, the proposed Lagos–Calabar Coastal Railway represents one of the largest railway infrastructure projects currently under development on the continent. Beyond their national significance, these projects are expected to enhance regional connectivity by linking major commercial centers and facilitating trade flows between Nigeria and neighboring countries. The Kano–Maradi railway extension to Niger Republic further demonstrates the growing emphasis on cross-border rail infrastructure as a mechanism for

strengthening regional integration and economic cooperation within the ECOWAS sub-region [11].

Similar trends can be observed elsewhere across Africa. East African countries continue to invest heavily in standard-gauge railway projects to improve regional connectivity, while Southern African nations prioritize railway corridor development to support mineral exports, industrialization, and trade facilitation. These developments indicate a broader continental shift towards recognizing rail transport as a strategic component of economic development planning rather than merely a transport service.

The importance of railway development for regional integration extends beyond physical connectivity. Modern railway networks have the potential to transform Africa's economic geography by reducing transportation costs, increasing market accessibility, and improving the efficiency of supply chains. The vision underpinning many regional railway initiatives is the creation of an integrated economic space characterized by the free movement of goods, services, capital, and people. Improved railway connectivity is expected to support industrial development by linking production centres with domestic and international markets while simultaneously enhancing access to employment opportunities and social services [11].

Railways are also particularly important for facilitating the exploitation and commercialization of Africa's abundant natural resources. Historically, railway systems across the continent have been developed primarily to connect ports with mining regions and major urban centres. This pattern remains relevant today, especially considering that approximately 90% of Africa's international trade by volume is transported by sea [18]. Efficient rail links between inland production zones and maritime gateways can therefore significantly enhance export competitiveness and reduce logistics costs. Furthermore, growing partnerships between African countries and international development partners, particularly China, have accelerated the implementation of railway projects across the continent. Building upon the legacy of the Tanzania-Zambia Railway (TAZARA), contemporary China-Africa cooperation has contributed substantially to the financing and construction of strategic railway infrastructure, creating opportunities for greater regional connectivity and economic integration [15]. These initiatives increasingly complement broader regional development programmes and may contribute to the realization of continental integration objectives when effectively coordinated [32].

The growing interest in railway transport is also supported by its comparative advantages over other transport modes. Although road transport currently dominates African transportation systems, accounting for approximately 90% of passenger movements and 80% of freight transport, railways offer several economic and environmental benefits that make them particularly attractive for long-distance and bulk transportation [18]. Studies indicate that rail freight can generate between 75% and 85% fewer greenhouse gas emissions per transport unit compared with heavy-duty road vehicles. Additionally, the external costs associated with rail transport – including environmental impacts, congestion, accidents, and infrastructure wear – are substantially lower than those associated with road transportation. Estimates suggest that rail transport can reduce external costs by approximately 47.5% per passenger-kilometre and 75.4% per tonne-kilometre relative to road-based alternatives [18]. These advantages are particularly relevant as African countries seek to balance economic growth with environmental sustainability and climate resilience objectives.

Despite these promising developments, several challenges continue to constrain the realization of Africa's railway ambitions. A

major concern is the deteriorated condition of much of the continent's railway infrastructure. Decades of underinvestment, inadequate maintenance, and limited technological modernization have resulted in extensive sections of railway networks becoming inefficient or non-operational. Many systems continue to rely on outdated technologies, fragmented information systems, and operational practices that fall below international standards for safety and performance [11, 18].

Interoperability remains another critical obstacle. African railway networks operate using multiple track gauges, ranging from narrow-gauge systems to standard-gauge infrastructure. This diversity limits seamless cross-border operations and increases operational complexity. Differences in signalling technologies, communication systems, and technical standards further complicate efforts to establish integrated regional railway networks. In some instances, locomotives operating across multiple jurisdictions require different train control systems, thereby increasing operational costs and reducing efficiency [31].

Institutional and governance challenges also persist. The implementation of regional railway projects is often complicated by competing national priorities, fragmented regulatory frameworks, and insufficient coordination among participating countries. Bilateral infrastructure agreements occasionally result in isolated railway projects that are poorly integrated into broader regional transport strategies. Consequently, policy inconsistencies and regulatory barriers continue to hinder the development of efficient cross-border railway systems [11, 33].

Addressing these challenges will require coordinated and sustained interventions at both national and continental levels. One of the most frequently proposed solutions is the harmonization of technical standards across Africa's railway sector. The African Union and regional economic communities have important roles to play in promoting the adoption of common railway specifications, including standard track gauges, signalling technologies, electrification systems, and operational protocols. Standardization would improve interoperability, reduce maintenance costs, and facilitate the creation of truly integrated continental railway networks [31].

Capacity development is equally important for ensuring the long-term sustainability of railway investments. Strengthening local expertise through specialized railway education programmes, regional training centres, and knowledge-sharing initiatives can help address existing skills gaps while reducing dependence on foreign technical expertise. The establishment of regional railway academies and research centres may further contribute to workforce development and innovation within the sector [11].

Looking ahead, the development of a comprehensive continental railway strategy that integrates infrastructure planning, interoperability standards, safety management, data governance, and investment priorities will be essential. Such a strategy should be complemented by proactive regional implementation mechanisms, including standard-gauge railway expansion programmes, railway technology transfer initiatives, and collaborative financing arrangements. Emerging digital technologies, predictive maintenance systems, intelligent signalling platforms, and data-driven railway management solutions also offer significant opportunities to improve operational efficiency and network reliability [18].

Ultimately, the success of Africa’s railway transformation agenda will depend on the ability of governments, regional organizations, development partners, and private investors to align their efforts around a shared vision of continental integration. If effectively implemented, future railway corridors have the potential to reshape trade patterns, strengthen

regional value chains, reduce transport costs, and support the broader objectives of sustainable economic development across Africa.

Conclusion

Railway infrastructure plays an essential role in alleviating regional economic integration in Africa by improving trade connectivity, reducing transport costs, attracting investment, and supporting regional value chains. Evidence from major railway corridors shows that enhanced rail networks can facilitate significant economic spillovers beyond national borders. Nevertheless, persistent infrastructure deficits, interoperability challenges, financing constraints, and institutional weaknesses continue to limit the full realization of integration benefits. To support the objectives of AfCFTA and broader continental development agendas, African countries must prioritize coordinated railway planning, modernization of existing networks, harmonization of technical standards, and sustainable investment strategies. A more connected railway system is indispensable for achieving deeper regional integration and long-term economic transformation across the continent.

Conflicts of Interest

The authors declare that they have no conflicts of interest

Ethical Approval

Ethical Approval does not apply to this paper.

Data Availability

Not Applicable

Author Contributions

Afolabi O. M. conceptualized this study, Zirra J.F. critically revised and corrected the manuscript for important intellectual content, and supervised the study. Afolabi O.M. conceived and drafted the review outline and contributed to manuscript writing. Afolabi O.M. and Zirra J.F. participated in the literature review and contributed significantly to the writing and revision of the manuscript. All authors read and approved the final version of the manuscript.

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