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Harnessing Nigeria's mineral resources for sustainable infrastructure development: challenges and prospects

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Abstract
Nigeria is endowed with vast solid mineral resources that remain largely underexploited, despite their potential to catalyse national infrastructure development and drive inclusive economic growth. This study examines the challenges and prospects of linking Nigeria's mineral wealth with infrastructure development, within the broader context of sustainable development and regional integration. Drawing from empirical data, national reports, and comparative global case studies, the research identifies institutional fragmentation, policy and regulatory bottlenecks, weak governance, and limited financing mechanisms as key barriers to integrated mineral-infrastructure planning. It also explores successful models from countries such as Mozambique, Guinea, Botswana, Chile, and South Africa, providing strategic insights applicable to Nigeria's context. The study proposes a framework for developing mineral corridors, embedding infrastructure obligations in mining licenses, leveraging resource-for-infrastructure partnerships, and enhancing inter-agency coordination. By implementing these reforms, Nigeria can unlock the transformative potential of its mining sector, bridge its infrastructure gap and foster long-term economic diversification. The findings contribute to policy discourse on resource-based development and offer actionable recommendations for stakeholders across government, industry, and development finance institutions.

Keywords Nigeria · Mineral wealth · Resource-based development · Mineral corridors · Information technology · Sustainable development · Policy reform

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Introduction

Nigeria is endowed with an abundance of mineral resources, ranging from solid minerals such as limestone, gold, coal, bitumen, barite, and iron ore to energy minerals like oil and gas. Lithium deposits have also been recently discovered across the country, adding to the mineral wealth of Nigeria and enlisting the country as one of the lithium-rich destinations in the world (KPMG, 2023). Despite its enormous wealth in mineral resources, the country continues to grapple with underdeveloped infrastructure, particularly in transport, energy, water, and telecommunications (Aluko et al. 2024). There is a disconnection between Nigeria's mineral wealth and the level of its infrastructural advancement. Researchers refer to this phenomenon, where nations that are rich in natural resources experience relatively slower economic growth and infrastructural development, as the "resource curse". Countries experiencing "resource curse" are characterised by fragile governance, corruption, and volatility (Sachs and Warner 2001). However, in recent

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years, successive governments in Nigeria have shown growing interest in leveraging the country's mineral resources to stimulate economic growth, especially as the nation seeks to drive diversification of its economy from oil dependency (Omodero and Ehikioya 2020; Oladotun et al. 2023).

A growing body of literature underscores the significance of mineral resources as catalysts for broad-based economic development, particularly when linked with infrastructure investments. Mehlum et al. (2006) and Auty (2002) argue that appropriate institutions and policies can convert resource wealth into a development advantage. In the African context, scholars such as Hilson (2012) and Campbell (2009) have examined the relationship between mining and development, emphasising the importance of infrastructure as a key enabler for unlocking the economic potential of mineral resources. Studies in countries like South Africa and Ghana have demonstrated how mining-led infrastructure, such as roads, railways, power, and water systems, can deliver both direct and spillover benefits to host communities and national economies (Jourdan 2013; Aryee 2001). Recent studies are also exploring how nations can leverage mineral wealth in attaining green innovation and other infrastructure targets linked to the SDGs. Abbas et al. (2024) assert that understanding the role of taxation, green innovation, and minerals trade is integral and essential to achieving SDGs. The recent body of knowledge centred on Nigeria often focuses on mineral resource mapping, policy reform, and sectoral challenges (such as Obaje 2009). However, these studies rarely explore integrated strategies that link mining with sustainable infrastructure development. The Nigerian Minerals and Mining Act (2007) provide a framework for reform, yet implementation has been weak. There remains limited empirical work evaluating how Nigeria's mineral potential can directly or indirectly contribute to infrastructure growth across the regions of the country. Although the Nigerian government has recognised the strategic importance of the mining sector for economic diversification, there remains a notable research gap in understanding how mineral extraction can be systematically leveraged to develop regional and national infrastructure. Existing studies tend to treat mining and infrastructure as separate policy arenas, overlooking the synergistic potential of mineral-led infrastructure development. Moreover, insufficient attention has been given to the institutional, regulatory, and socio-economic challenges that constrain this linkage in the Nigerian context.

This study explores the interface between Nigeria's mineral endowment and infrastructure development. It examines both the challenges and prospects of using mineral wealth as a lever for infrastructural transformation with emphasis on (a) review of Nigeria's key mineral deposits and their spatial distribution; (b) analysis of existing infrastructure in mining regions; (c) Institutional, financial, and governance barriers hindering mineral-linked infrastructure development; (d) Case studies of successful mining-infrastructure linkages from other African or global contexts that could inform Nigeria's strategy; and (e) SWOT Analysis: Linking Mineral Wealth with Infrastructure Development in Nigeria. Rather than reiterating the existence of the infrastructure gap, this manuscript critically interrogates why the mineral–infrastructure linkage has repeatedly failed to materialise in Nigeria, despite sustained policy recognition. This is achieved by examining the nuances in mineral-infrastructure linkages and highlighting governance, institutional incentives, and political economy constraints.

From a deeper analytical perspective, mineral–infrastructure linkages can be assessed through an explicit feasibility framework that separates strategic desirability from implementability under the current institutional and fiscal conditions of Nigeria. A practical approach is to test proposed interventions against four delivery gates: (1) technical feasibility (engineering suitability, geotechnical and environmental constraints, right-of-way complexity, and long-term operations and maintenance requirements); (2) financial feasibility (bankability, currency and tariff risks, and availability of tenor-matched capital); (3) institutional feasibility (clarity of mandates across the Ministry of Solid Minerals Development, Works/Transport/Power agencies, and state authorities, together with procurement and contract-management capacity); and (4) socio-political feasibility (security, land tenure, compensation, and durable social licence). Applying this lens clarifies why mineral-rich states can remain infrastructure-poor despite policy attention: critical constraints often sit outside geology and economics, such as disputed surface rights, weak enforcement of Community Development Agreements (CDA), or insecurity that raises insurance, delays mobilisation, and escalates project costs.

The framework also forces explicit assumptions into the narrative. Corridor proposals, as an example, implicitly assume that demand is great and durable enough to sustain rail or power investments; yet commodity price volatility and policy instability can reduce utilisation rates and revenue certainty, weakening the case for large, irreversible assets. In the same vein, resource-for-infrastructure concepts implicitly assume credible revenue capture and low leakages; high levels of informal production and smuggling can, however, undermine repayment capacity, while weak contract enforcement can raise required returns or deter credible investors (Konijn 2014). Feasibility framing, therefore, supports prioritisation and sequencing rather than blanket advocacy. Early phases can focus on interventions with strong 'no-regret' properties (digital cadastre

reliability, transparent licensing timelines, baseline geodata improvement, and enforceable community-benefit governance) because these reduce transaction costs for both mining and infrastructure finance. Later phases can scale into capital-intensive rail, ports, and transmission upgrades only where the four gates are satisfied and where a defined implementation owner exists.

Feasibility can be operationalised with trackable indicators embedded in the framework of the study: share of mining titles under dispute, average licensing turnaround time, percentage of medium-to-large operators with audited CDA delivery plans, proportion of mining areas within a defined distance to all-weather roads and stable power, and proportion of proposed public-private partnerships (PPPs) reaching financial close. These gates and metrics help to provide an implementation analysis rather than a normative call to action. Concrete illustrations covered in this paper align with this feasibility logic. The Ajaokuta–Itakpe–Warri corridor shows that a rail link alone cannot deliver integration when ownership disputes, weak project governance, and missing feeder roads and power persist, so institutional deliverability can dominate engineering adequacy. Reported limits in sector-specific credit and the modest scale of existing support vehicles, such as the Solid Minerals Development Fund, show that technically sound corridors can stall without guarantees, blended finance, and staged investment packages (World Bank 2017). Persistent leakages in gold exports and weak state-level oversight bodies (including inactive committees in many states) reduce fiscal space and weaken enforcement credibility. Acknowledgement of these constraints by this study grounds the study in implementation reality rather than aspiration. This also clarifies realistic sequencing priorities.

Review of Nigeria's major mineral deposits and their spatial distribution

Nigeria is richly endowed with over 44 commercially viable solid mineral types spread across more than 500 locations in the country's 36 states and the Federal Capital Territory (FCT). These mineral resources present a strategic opportunity for economic diversification beyond oil and gas. The spatial distribution of these resources varies by geology, tectonics, and sedimentary processes, influencing regional economic activities and development potential. The major mineral resources in Nigeria can be broadly categorised into metallic minerals, industrial minerals, energy minerals, and construction materials. Each category features prominently in specific geological belts and regions, as shown in Figs. 1, 2 and 3.

Metallic minerals

The extraction of metallic minerals in Nigeria dates back to the pre-colonial era. As far back as 1884, tin ore was being produced by the natives of the Bauchi Plateau in the northern part of Nigeria (FELL 1939). By 1937, the output for tin concentrate production in northern Nigeria, which was about 408 tons in 1908, had increased to 15,035 tons with a value of over £2,500,000, while the total global output for tin was then 145, 000 tons (FELL 1939). However, due to several factors such as a fall in global metal prices (including Tin) in the 1980s, the Nigerian civil war (1966–1970), the crude oil boom in 1970s and subsequent overdependence on the oil sector, the depletion of alluvial reserves, and ineffective state control, the bulk of mining operations by the private sector fell on small-scale indigenous miners' shoulders, leading to production decline (Azubuike et al. 2023; Owolabi et al. 2024). In recent times, exploration and exploitation of metallic ores in Nigeria have focused on gold, iron ore, lead-zinc, tin and columbite. The major locations of these metallic minerals, as well as their estimated reserves, are shown in Fig. 1; Table 1, respectively. It must be noted, however, that the documented resource estimates are derived against a backdrop of inadequate geological mapping and underfunded exploration. A recent study by Oluwatola (2025) observed that despite its potential, Nigeria's critical minerals sector is constrained by insufficient geological mapping and low exploration funding (only $2.5 M vs. $147 M in Côte d'Ivoire).

Industrial minerals

In Nigeria, industrial minerals' production constitutes the largest unit of production in the solid minerals industry, with limestone, granite, laterite, sand, shale and clay making up over 95% of production by tonnage and 90% by value (Olade 2019). As shown in Table 1, limestone, which is the backbone of Nigeria's vibrant cement industry, is found extensively in Edo, Ogun, Cross River, Benue, Sokoto, Gombe, and Kogi States. Gypsum, another important mineral used in the production of cement, is also an important industrial mineral found extensively in Nigeria. Gypsum deposits occur in numerous locations within northeastern Nigeria in three varieties: Balatino laminated, Alabaster and Satin Spar, and are interlayered within shale and mudstone (Mohammed et al. 2018). Barite is another important industrial mineral in Nigeria. Barite deposits in Nigeria are found in veins and cavity fillings hosted by a variety of rocks. It is largely used by the oil and gas industry during drilling operations as a drilling mud weighting agent to

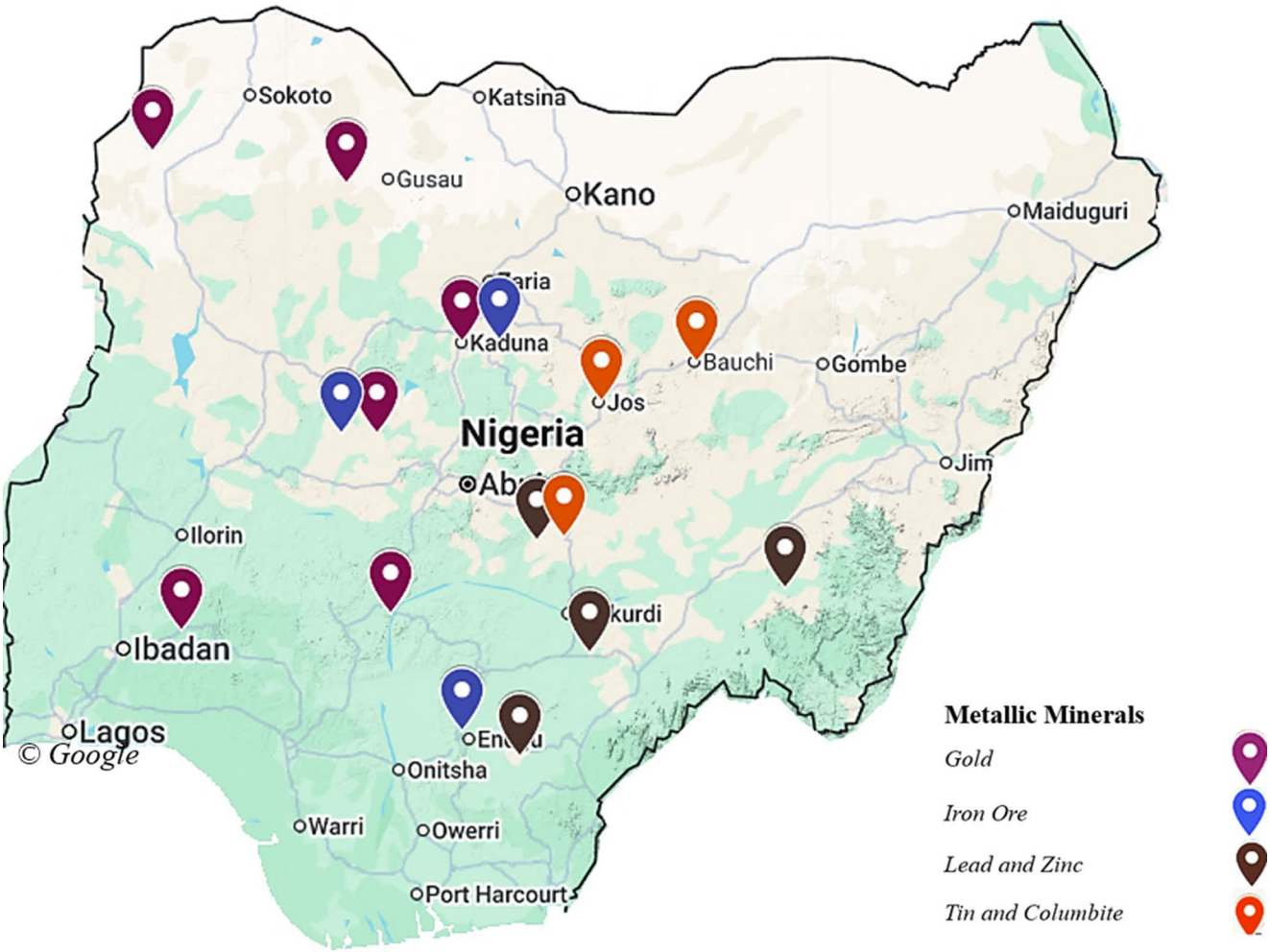

Fig. 1 Map showing of metallic minerals in Nigeria

balance the reservoir pressure and prevent blowouts (Ebunu et al. 2021). The major locations of these industrial minerals, as well as their estimated reserves, are shown in Fig. 2; Table 1, respectively.

Energy minerals

Nigeria is home to an array of critical energy minerals, including lithium, rare earth elements, and manganese, which are vital for the production of renewable energy technologies such as batteries and electric vehicles. These are increasingly important for the global green energy transition (batteries, electronics). Olade (2019) found that the lithium ore deposits—spodumene and lepidolite—across several states in Nigeria are relatively high grade, ranging from <0.5% Li_2O to up to 13% Li_2O, whereas the globally accepted cut-off grade for lithium is 0.4% Li2O. Thus, the exploration, exploitation and processing of Lithium ores in Nigeria have attracted growing international investment since 2022. The country also has an extensive reserve of coal to support traditional power sources, as shown in Fig. 3; Table 1. Coal is located predominantly in the Anambra Basin and Benue Trough, especially in Enugu, Kogi, Gombe, Benue, and Delta States. The proven reserves are over 639 million tonnes; inferred reserves of approximately 2.75 billion tonnes (MMSD 2020). Nigeria also has Bitumen (Tar Sands) reserves, concentrated in the Ondo, Ogun, Edo, and Lagos corridors. Nigeria is estimated to have the sixth-largest bitumen reserves globally (MMSD, 2020; Falufosi and Osinowo 2021).

Spatial distribution and regional patterns of Nigeria's mineral resources

Nigeria's mineral wealth is intricately linked to its diverse geological formations, which determine the concentration, accessibility, and economic potential of various mineral deposits across the country. The spatial distribution of these resources follows five principal geological zones: the Basement Complex, the Benue Trough, the Schist Belt, the

Fig. 2 Map showing of industrial minerals in Nigeria

Anambra Basin, and the Sedimentary Basins. Each zone exhibits a unique mineralogical profile shaped by its tectonic history, structural framework, and rock composition. This geologically informed distribution provides a foundation for targeted exploration and region-specific development strategies. The spatial distribution of Nigeria's mineral resources aligns with its geological zones, as shown in Table 2; Fig. 4.

The Basement Complex, predominantly found in states like Osun, Ekiti, Nasarawa, Kogi, and Niger, is a prime source of metallic and industrial minerals such as gold, tantalum, lithium, and granite. These crystalline rocks are often associated with artisanal and small-scale mining (ASM) activities, particularly in gold-rich areas like Osun and Kogi (Olade 2019). The economic potential in this zone is high, yet its development is hindered by limited mechanisation, environmental degradation, and the dominance of informal mining actors. Meanwhile, the Benue Trough, which spans Benue, Taraba, Ebonyi, and Nasarawa states, hosts critical base metals such as lead, zinc, and barite. These resources are essential for the oil and gas, construction, and paint industries, and their availability in this region highlights Nigeria's potential to reduce import dependency.

The Schist Belt, which includes Zamfara, Kebbi, Kaduna, and parts of Osun, is renowned for its rich gold deposits and gemstone occurrences, such as tourmaline, Topaz, and Beryl. The gem resources have attracted the attention of artisanal miners who usually seek near-surface minerals requiring minimal processing. These operations are mostly predominant in Zamfara, where a lack of regulation has led to severe environmental and public health crises (Environmental Law Institute 2014). The Anambra Basin is the coal core of Nigeria and a long-standing hub for energy production, which spans across Enugu, Kogi, Delta, and Benue. Despite the global concern over carbon emissions and the consequent impact on environmental sustainability, this zone presents prospects for the revival of coal-based power generation due to its significant coal and lignite reserves.

The Sedimentary Basins, which cover the coastal and southwestern states of Ondo, Edo, Lagos, and Ogun, contain strategic industrial minerals. These include bitumen, limestone, phosphate, Clay, Kaolin and gypsum. Thus, the

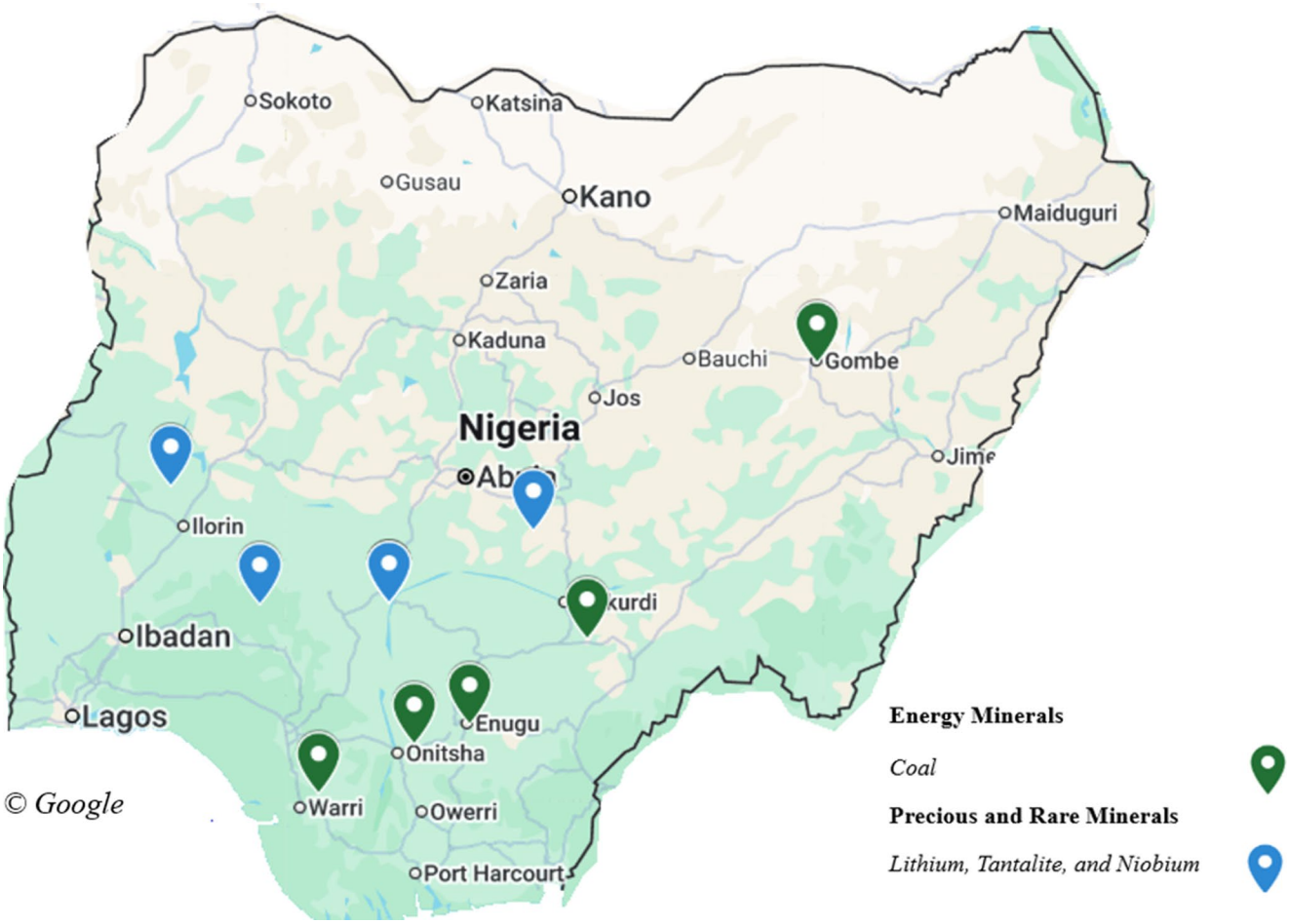

Fig. 3 Map showing energy, precious and rare minerals in Nigeria

zone is particularly important for infrastructure and construction development. For example, Nigeria has the world's sixth-largest deposit of bitumen, predominantly found in Ondo and Ogun (Milos 2015). However, Nigeria's bitumen resource remains underexplored due to technical constraints and weak investor confidence. Limestone and gypsum, on the other hand, are more actively exploited, used in cement and construction, with several cement plants operating in this zone, contributing to domestic cement sufficiency.

Regionally, the mineral distribution reveals distinct development prospects and policy imperatives. Northern Nigeria is rich in high-value minerals such as gold, tin, columbite, and uranium, but remains underdeveloped due to insecurity and weak infrastructure. The southwest is better positioned for industrial mineral exploitation, given its proximity to ports and existing processing facilities. The Middle Belt, as a mineral convergence zone, presents the greatest potential for multi-mineral development if access roads, processing hubs, and regulatory clarity are improved. Lastly, the southeast and south-south regions, though historically known for coal and heavy industrial minerals, are strategically positioned for integration into downstream value chains, especially in cement, ceramics, and metallurgy. A spatially differentiated approach to mining policy, grounded in geological realities and infrastructure planning, will be critical for unlocking Nigeria's mineral economy.

Strategic implications for the development of Nigeria's mineral sector

The spatial diversity of Nigeria's mineral resources presents a significant opportunity for decentralised industrial development across the country. There is a huge potential for Nigeria to adopt a regional development approach whereby states use their distinctive mineral endowments to spur local economic transformation rather than

Table 1 Distribution and estimated reserves of major solid minerals in Nigeria

Mineral Type	Mineral	Major Locations (States/Regions)	Estimated Reserves / Production	Notes / Economic Significance	Key References
Metallic Minerals	Gold	Zamfara, Kebbi, Kaduna, Niger, Osun, Kogi	~20 million ounces (proven)	Dominated by artisanal and small-scale mining; commercial exploration is expanding	NBS (2021)
	Iron Ore	Kogi (Itakpe, Agbaja), Enugu, Niger, Kaduna	>3 billion tonnes	Itakpe is the most developed deposit; it supports Ajaokuta Steel and NIOMCO	Olade (2019)
	Lead–Zinc	Ebonyi, Benue, Taraba, Nasarawa	~10 million tonnes	Significant base-metal resource with export potential	MMSD (2020)
	Tin & Columbite	Plateau (Jos Plateau), Nasarawa, Bauchi	Not fully quantified	Historically significant; strong potential for revival	(FELL 1939)
Industrial Minerals	Limestone	Edo, Ogun, Cross River, Benue, Sokoto, Gombe, Kogi	>2.3 billion tonnes	Backbone of Nigeria's cement industry	(Olade 2019)
	Gypsum	Gombe, Sokoto, Adamawa, Yobe, Borno	>1 billion tonnes	Key input for cement and fertilizer industries	(Mohammed et al. 2018)
	Barite	Benue, Cross River, Taraba, Nasarawa	10,000–14,000 t/yr; demand>31,000 t/yr	Critical for oil and gas drilling; supply deficit persists	Ebunu et al. 2021)
Energy Minerals	Coal	Enugu, Kogi, Gombe, Benue, Delta	639 Mt (proven); ~2.75 Bt (inferred)	Potential for power generation and industrial use	MMSD (2020)
	Bitumen (Tar Sands)	Ondo, Ogun, Edo, Lagos corridors	>42 billion barrels	Sixth-largest global reserves; underdeveloped	MMSD (2020); Falufosi and Osinowo (2021)
Precious & Rare Minerals	Lithium, Tantalite & Niobium	Nasarawa, Kogi, Kwara, Ekiti	Ongoing exploration	Strategic minerals for energy transition; rising investor interest since 2022	Bankole et al. (2026)

Table 2 Spatial distribution of Nigeria's mineral resources aligns with its geological zones

Geological Zone	States	Dominant Minerals
Basement Complex	Osun, Ekiti, Nasarawa, Kogi, Niger	Gold, Tantalite, Granite, Lithium
Benue Trough	Benue, Taraba, Ebonyi, Nasarawa	Lead, Zinc, Barite, Coal
Schist Belt	Zamfara, Kebbi, Kaduna, Osun	Gold, Quartz, Tourmaline
Anambra Basin	Enugu, Kogi, Delta, Benue	Coal, Iron Ore, Lignite
Sedimentary Basins	Ondo, Edo, Lagos, Ogun	Bitumen, Limestone, Gypsum

concentrating industrial activity in a small number of urban areas. As an illustration, barite-rich states such as Nasarawa may focus on building oilfield services connected to Nigeria's upstream petroleum sector, while gold-rich states like Zamfara and Osun could serve as anchors for the transition from artisanal and informal to established small-scale and large-scale mining operations. This drive could be supported by local jewellery-making and refining businesses. Holistically, spatially diversified development promotes inclusive growth, job creation, and regional equity (Eniowo 2024).

The development of mineral corridors would be strategic for value addition, job creation, economic diversification, and spatial development in the Nigerian mining industry (Cook and Mitchell 2014; Eniowo et al. 2026). Mineral resource corridors are designated routes that facilitate the extraction, processing, and transportation of mineral resources, and they link resource-rich areas to markets and

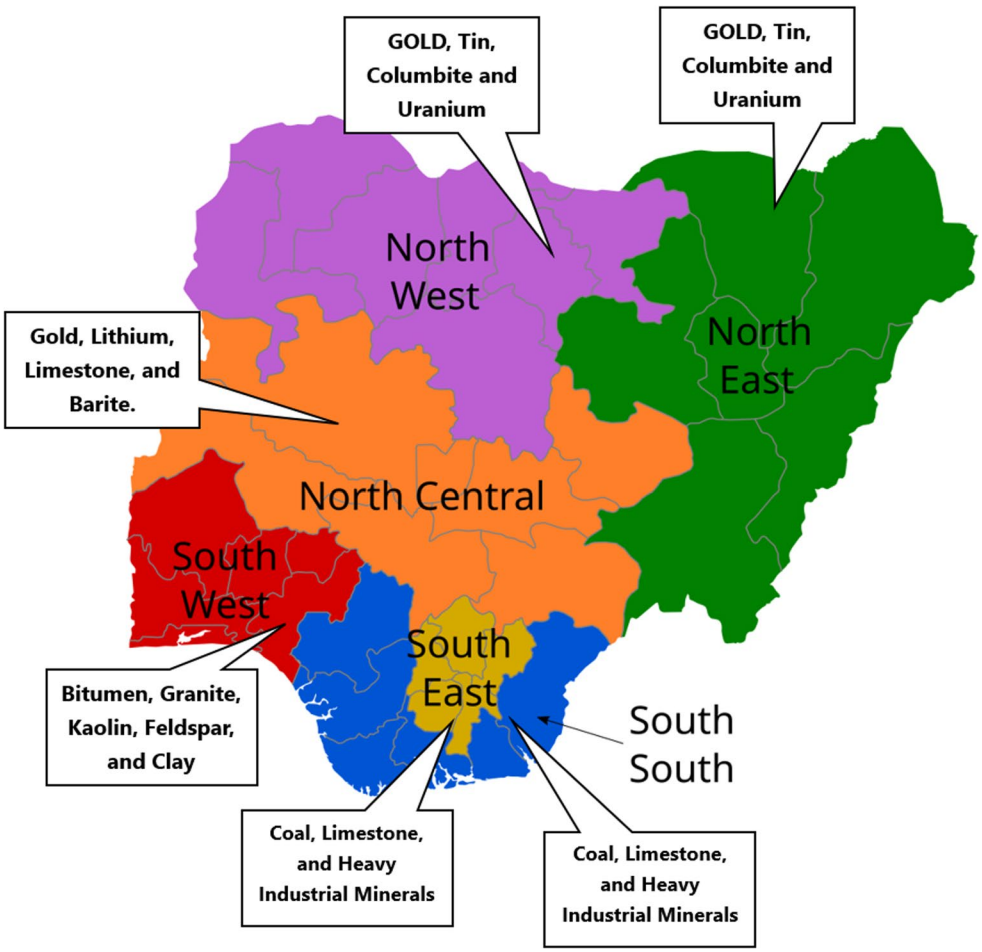

Fig. 4 A cross-mapping of mineral resources and their respective geopolitical zones in Nigeria

industrial centres. Development of a mineral resource corridor involves channelling large investment in infrastructure, goods and services, in the extractive industry and can help achieve viable economic development and diversification (Azubuike et al. 2023). Specifically, mineral corridors can improve market accessibility, lower logistics costs, and draw investment to remote and isolated areas. A typical example of a mineral corridor was the Ajaokuta–Itakpe–Warri corridor. In the design, there was a steel complex and a downstream industry. The corridor was designed as an important link between coastal ports and inland iron ore reserves. Although the project stalled due to governance-related challenges that have hindered the development of the corridor. Still, the model is workable for similar projects, such as the South-West Bitumen Belt or the projected North-Central Barite Corridor (Azubuike 2023). Nigeria has the potential to unleash the economic prospects of its hinterlands by combining investments in power, rail, and roads with mineral development.

Industrialisation can be further advanced through regional specialisation, in which nations and geopolitical zones focus on processing and enhancing the value of their dominant minerals. This strategy not only enhances competitiveness but also reduces import dependency and improves trade balances. For instance Nigeria spends millions of dollars importing barite to meet the consumption gap, despite holding the fourth-largest barite reserves in the world (over 21 million metric tons) across states like Cross River, Taraba, and Nasarawa. (Afolayan et al. 2021) Similarly, lithium and other battery minerals in states like Kogi and Nasarawa can serve as anchors for future green-tech value chains if properly harnessed through beneficiation and industrial clustering. This approach supports both economic diversification and global climate goals.

However, these strategic opportunities are undermined by deep-seated challenges. Spatial inequality in infrastructure development means that many mineral-rich regions, especially in the North and Middle Belt, lack the roads, power supply, and water access needed for sustainable industrial activity (FMWR et al. 2022). Insecurity, particularly in Zamfara, Kaduna, and Niger States, discourages investment and disrupts operations (Woyengitari and Titus 2025). Furthermore, policy inconsistencies, weak inter-agency coordination, and limited enforcement of mining regulations continue to create an unpredictable investment climate (Eniowo et al. 2026). Without addressing these foundational

issues, the full developmental potential of Nigeria's mineral sector will remain unrealised. Furthermore, the resource-curse literature cautions that mineral-driven growth, if poorly governed, can exacerbate regional inequalities, reinforce enclave development, and intensify local grievances. Debonheur (2025) argue that resource abundance usually leads to corruption and weak institutions due to a lack of state accountability, reducing the government's ability to maximise the benefits of mineral wealth to address spatial inequality. This risk is particularly pronounced in Nigeria's Middle Belt and Northern regions, where mineral endowments coincide with fragile institutions, land-use tensions, and existing security challenges.

To move forward, a place-based strategy anchored in spatial planning, security stabilisation, and institutional reform is essential. Establishing regional mining commissions, incentivising private infrastructure investment, and enhancing sub-national capacity for resource governance can provide the enabling environment required for regionally balanced mineral-led development. When combined with community engagement, environmental safeguards, and alignment with national development goals (e.g., Nigeria's Mining Roadmap and Vision 2030), these interventions can transform the mineral sector from a source of untapped wealth into a lever for sustainable national transformation.

Analysis of existing infrastructure in mining regions in Nigeria

Infrastructure forms the backbone of any thriving mining industry. Efficient transport, energy, water, and communication systems are crucial to facilitate mineral extraction, processing, and export. In Nigeria, despite significant mineral potential, the low state of infrastructure in many mining regions severely constrains sectoral development and regional economic integration. This section presents a critical analysis of existing infrastructure in Nigeria's mining regions, supported by available statistics and recent reports.

Overview of infrastructure categories - regional analysis of mining-linked infrastructure in Nigeria

Nigeria's mining sector infrastructure can be broadly categorised into: Transport Infrastructure (roads, rail, ports, airstrips); Energy Infrastructure (electricity generation, transmission, distribution); Water Supply and Sanitation; Information and Communication Technology (ICT) and Social Infrastructure (health, education, housing). These infrastructure elements are essential enablers for exploration, mineral extraction, beneficiation, and market access. However, their availability and quality vary significantly across Nigeria's geopolitical zones, affecting the economic viability of mining operations and the potential for mineral-led regional development. For instance, while the South-West and parts of the North Central regions benefit from relatively better transport and grid connectivity, mining-intensive zones in the North-West, North-East, and South-East face severe deficits in road access, electricity, and industrial processing capacity.

A regional analysis reveals distinct spatial disparities. The North Central zone, including states like Kogi and Nasarawa, hosts abundant deposits of iron ore, coal, and barite, and is intersected by critical infrastructure such as the Itakpe–Warri railway and the Ajaokuta steel complex. Yet, feeder roads and last-mile electricity distribution remain inadequate. In the North-West, states like Zamfara and Kaduna are rich in gold and gemstones but face insecurity, limited road access, and no processing zones, forcing miners to rely on artisanal methods. The South-East, particularly Ebonyi State, has long-standing lead-zinc and limestone mining activity but suffers from aging transport and power networks. In contrast, the South-West, especially Ogun and Ondo States, enjoys proximity to ports, dual-carriage highways, and industrial clusters, enabling better mineral-to-market logistics. This uneven infrastructure landscape underscores the urgent need for a regionally differentiated infrastructure development strategy that aligns with Nigeria's mineral endowment zones and economic corridors.

A regional inventory of transport, power, water, ICT, and social infrastructure is most useful when paired with an explicit discussion of implementation constraints that determine whether physical assets translate into reliable mining and community services. In the mineral belts of Nigeria, last-mile access is often the binding constraint: trunk assets such as a rail corridor or highway can exist, yet feeder roads to pitheads and processing sites remain mostly impassable during rains, and distribution networks fail to deliver stable electricity even where transmission passes nearby. This explains why mineral-rich states identified as corridor anchors can still experience high logistics costs and low beneficiation, despite proximity to national projects. Feasibility also depends on the maintenance institutions. Road deterioration is not only an engineering problem but a governance one: weak axle-load enforcement, fragmented maintenance responsibilities, and budget volatility shorten asset life and shift costs back to operators through vehicle damage, downtime, and higher haulage tariffs.

For rail, utilisation depends on reliable interfaces: sidings, loading facilities, signalling, and port turnaround times, so corridor planning should explicitly map bottlenecks at terminals and customs rather than assuming that new track

automatically reduces evacuation constraints. Energy access exhibits similar 'infrastructure stack' dependencies. Grid-connected supply is limited by distribution reliability, transformer capacity, and losses, prompting widespread reliance on diesel generation that raises operating costs and emissions; therefore, analysis of mining-linked power should distinguish between grid reinforcement, embedded generation, and hybrid microgrids, and should discuss ownership and long-term service obligations after construction. Water availability is another contextual constraint. Processing and dust suppression can compete with agricultural and domestic demand, especially in semi-arid zones and where rural WASH coverage is weak; cumulative abstraction from multiple mines can trigger conflict unless integrated watershed planning and monitoring are implemented. Security conditions operate as soft infrastructure and can nullify hard-asset benefits. In areas affected by banditry, kidnapping, or communal violence, contractors face restricted mobility and higher security costs; supply chains avoid night transport; and insurers raise premiums, reducing the effective capacity of roads and power lines. This implies that corridor selection and phasing should incorporate security diagnostics and credible stabilisation plans rather than treating security as an external variable.

ICT gaps also have direct operational consequences: weak broadband coverage limits digital cadastre use, traceability tools, and remote monitoring, and increases transaction costs for compliance reporting, tendering, and market access. Climate and hydrological risks should be treated as design constraints, not afterthoughts. Flooding, erosion, and extreme heat can damage roads, bridges, and power assets; therefore, resilience standards and lifecycle costing should be incorporated into the regional infrastructure assessment. Embedding these constraints into the regional analysis transforms the section from a descriptive deficit list into a grounded explanation of why infrastructure gaps persist and which interlocking failures must be solved for mineral-led development strategies to be implementable. Land acquisition and right-of-way management remain schedule risks, since corridors cross customary land, farms, and grazing routes; weak compensation and grievance systems can delay projects and intensify opposition where ESIAs are incomplete. Pre-feasibility dossiers can quantify these risks alongside cost and demand.

Transport infrastructure

Road networks Nigeria has an estimated 195,000 km of road networks, but only about 60,000 km are paved. Mining-rich states like Kogi, Nasarawa, Zamfara, and Taraba suffer from poor rural road connectivity. For example, in Zamfara, several gold mining communities are accessible only by dirt roads, impeding equipment transport and ore evacuation. In Benue and Cross River, barite mines are often located over 30 km from the nearest paved road, increasing logistics costs by 40–60% (Ebunu et al. 2021). Bakari (2019) argue that inadequate infrastructure and lack of investment in road networks create a serious setback to the sector, as most mines are left out of paved road coverage since they are predominantly in rural areas, and road coverage largely favours urban areas.

Rail infrastructure The Itakpe–Warri rail line, completed in 2020, links the Itakpe iron ore mine to the Ajaokuta Steel Plant and Warri Port, improving ore transport in Kogi State. However, most other mining regions, including the Jos Plateau, Nasarawa, and Taraba, remain unlinked to rail infrastructure, limiting bulk mineral movement. Nigeria's total functional rail network is under 4,000 km, with less than 25% serving mineral-producing areas. Bakari (2019) notes that historically, the mining sector, particularly coal production, played a critical role in driving the development of railway infrastructure during periods when coal mining was a vibrant industry. However, Bakari (2019) argues that deficiencies in modern rail connectivity continue to deter foreign investment in the mining sector.

Port Access Major seaports (Apapa, Tin Can Island, Onne) are congested and distant from inland mining zones. Exporters of industrial minerals (e.g., barite, feldspar) often face delays and high demurrage charges due to inadequate port linkages. Studies have identified the lack of good roads linking the minefield with major international outlets (sea and air ports) and poor electricity as major impediments to foreign investments (Bakari 2019).

Energy infrastructure

National electricity generation averages 4,000–5,000 MW, far below the 30,000 MW estimated national demand. Many mining operations in North-Central and Northwest Nigeria rely on diesel-powered generators, increasing production costs by 20–35% (MMSD 2020). Kogi and Osun States, despite hosting gold and iron ore projects, lack reliable grid electricity. The Ajaokuta Steel Complex, for instance, is underpowered despite its strategic importance. Renewable energy penetration in mining communities remains minimal, with only pilot solar installations in areas such as Gombe and Ekiti.

Water supply and sanitation

Water is critical for mineral processing and dust suppression, yet access remains limited in rural mining zones. According

to the National Bureau of Statistics (NBS), less than 35% of rural communities in Benue, Nasarawa, and Bauchi States have access to safe water sources. In artisanal mining zones (e.g., Zamfara, Kebbi), the lack of water infrastructure contributes to the use of contaminated surface water, increasing health risks and environmental degradation (Zvarivadza, 2018a; Zvarivadza and Nhleko 2018).

Social infrastructure

Mining communities in Zamfara, Niger, Plateau, and Taraba face severe deficits in social infrastructure such as schools, hospitals, and housing. The Zamfara lead poisoning crisis (2010) revealed the absence of basic health services in artisanal mining communities, resulting in over 400 child fatalities. In regions like Barkin Ladi (Plateau), mining-induced land degradation has worsened access to education and health infrastructure due to displacement and erosion.

The ability of Nigeria to effectively link mineral exploitation with national development is heavily constrained by the state of infrastructure in its mining regions. Most of the country's mineral-rich states are in areas with limited access to essential infrastructure such as roads, power, water supply, and processing facilities. These deficiencies limit investment attraction, hinder mineral value addition, increase production costs, and ultimately reduce the contribution of mining to GDP. Table 3 of this study present a comparative overview of these infrastructure gaps in selected mining-intensive states.

Security as 'Soft' infrastructure

Alumona and Onwuanabile (2019) noted the increasing level of insecurity and deepening violence in the Northern region of Nigeria and the impacts on the development of the Nigerian extractive industry. Security and law enforcement capacity are often categorised as "soft infrastructure" alongside governance and legal systems. In addition to physical infrastructure, security constitutes a critical but often underemphasised form of enabling infrastructure for mining development. In several mineral-rich regions of Northern Nigeria and the Middle Belt, the prevalence of banditry, kidnapping, and communal conflict significantly raises operational risks, deters investment, and increases project costs. In such contexts, even well-developed transport and energy infrastructure may remain underutilised if security conditions undermine workforce safety and asset protection. A recent study by Shim (2025) asserts that conflicts and resource-driven violence significantly deter investment and disrupt mining development in resource-rich regions, underscoring the significance of security as a form of infrastructure that supports mining development.

Barriers to mineral-linked infrastructure development in Nigeria

Despite Nigeria's abundant mineral resources and urgent need for infrastructure, efforts to integrate mining activities with infrastructural development have been undermined by a series of institutional, regulatory, financial, and governance challenges. These collections of overlapping barriers weaken the ability of the mining industry to act as a catalyst for broader economic transformation. This section of the paper provides a detailed analysis of the constraints that impede mineral-linked infrastructure development, with illustrative case studies.

Institutional barriers

Institutional barriers in Nigeria's mining sector primarily stem from fragmented responsibilities, lesser coordination among agencies, and limited institutional capacity, which collectively hinder the integration of mining with infrastructure development. The mining sector in Nigeria falls under the purview of the Nigerian Ministry of Solid Minerals. Infrastructure development to support the sector falls under separate entities such as the federal ministries of works, power, and transport. However, there is a lack of cooperation and coordination among the ministries, which could help them deliver on development imperatives. The implication is that each of these ministries pursues projects that fail to align with local development. One good example is that of the Itakpe–Warri railway, which was conceived to ease the transportation of iron ore from Itakpe to Ajaokuta and Aladja Steel Rolling Mills in the Delta. However, this project suffered from a lack of oversight from the ministries

Table 3 Summary of Infrastructure Gaps in Key Mining States

State	Minerals	Key Infrastructure Gaps
Kogi	Iron Ore, Coal, Limestone	Defective rural roads, unreliable power, and water scarcity
Zamfara	Gold	Inadequate roads, a lack of health facilities, and limited grid power
Nasarawa	Barite, Lead-Zinc, Lithium	Weak ICT coverage, limited processing facilities
Benue	Barite, Coal	Remote mine sites, limited road network, weak social services
Ekiti/Osun	Gold, Tantalite	Power shortages, ICT gaps, and inadequate water access

of works, power, and transport. This culminated in the lack of investments in access roads, power supply, or local beneficiation hubs (MMSD 2020).

Mineral-linked infrastructure has also been hampered by the weakness of local institutions charged with monitoring compliance of mining companies with local development mandates. Mining companies are required by the Nigeria Mining and Mineral Act of 2007 to enter into an agreement with their host communities on infrastructure projects such as road construction, borehole sinking and construction of schools, that they will provide in support of the development of their host community. These projects are usually documented in the Community Development Agreement (CDA) report and endorsed by the representatives of the community and the company. To facilitate compliance of the firms with the contents of the CDA, the Act established the Mineral Resources and Environmental Management Committees (MIREMCOs), which, together with the Department of Mines Inspectorate of the Ministry of Solid Mineral Development, are to monitor compliance (Eniowo et al. 2017). The MIREMCOs were established across the country to facilitate grassroots involvement, decentralisation of oversight and the alignment of mining operations with local development. However, the low effectiveness of MIREMCOs and the consequent lack of monitoring of compliance with CDAs across the states constitute a critical institutional barrier that has caused conflicts between host communities and mining companies. A typical example is in Nasarawa state, where there were conflicts between host communities and mining firms based on the latter's reluctance to deliver the promised infrastructure projects, such as roads and boreholes. Such institutional barriers arising from the lack of an effective, well-funded institutional framework for planning, oversight, and stakeholder coordination hamper Nigeria's attempts to harness its mineral endowment for sustainable infrastructure development.

Policy and regulatory barriers

Policy and regulatory challenges stem primarily from regulatory delays and weak implementation of mining laws, underutilisation of proven policy tools like mineral development corridors and resource-backed infrastructure models, and the weak operationalisation of community-based governance structures such as the MIREMCOs. The cumulative effect is a disjointed and underperforming mining sector, with lost opportunities for regional development, foreign direct investment, and industrial growth.

(i) *Regulatory Delays and Weak Implementation of Mining Laws*

The first critical challenge is the drawn-out licensing timeline as well as the confusing licensing procedure, which deters investment and postpones project completion. Implementation of existing regulations is another barrier. For example, despite having a thorough framework, the Nigerian Minerals and Mining Act (2007) is not well implemented and does not include procedures for transparent land acquisition, effective dispute settlement, or real-time permit tracking. According to the Nigerian Extractive Industries Transparency Initiative (NEITI 2021), over 30% of mineral titles issued between 2010 and 2020 were either dormant or under dispute due to regulatory delays, lack of clarity on overlapping surface rights, or conflicts with state and community authorities.

A clear case study is the prolonged delay in the operationalisation of the Ajaokuta Steel Complex, which has faced multiple legal and bureaucratic hurdles since privatisation attempts began in the early 2000s. Conflicts between concessionaires and the Federal Government, largely due to inconsistencies in contract enforcement and failure to adhere to arbitration outcomes, have stalled infrastructure upgrades and discouraged credible investors (MMSD 2020). Similarly, in Zamfara State, regulatory weakness contributed to the proliferation of illegal gold mining operations, which operate outside of the legal framework and avoid tax or infrastructure contributions. This undermines state revenues that could fund infrastructure development. Without clear, enforceable, and investor-friendly regulatory mechanisms backed by digitised systems and inter-agency coordination, Nigeria's ability to link mining with long-term infrastructure growth will remain constrained (Eniowo et al. 2026).

(ii) *Limited Use of Mineral Development Corridors and Resource-Backed Infrastructure Frameworks*

Unlike many African countries that have adopted Mineral Development Corridors (MDCs) or Resource-for-Infrastructure (RFI) frameworks to unlock investment and create integrated logistics, Nigeria has yet to formally institutionalise either model. MDCs are geographic zones where transport, power, water, and ICT infrastructure are co-located with mining value chains to stimulate regional growth.

In contrast, countries like Mozambique and Guinea have effectively employed such models. The Nacala Corridor in Mozambique- anchored by Vale's coal mines - features over 900 km of railway, port facilities, and local electrification projects. Similarly, Guinea's Simandou iron ore project includes a $15 billion integrated rail-port plan funded via a resource-backed infrastructure deal (Samb 2022). Nigeria, by comparison, lacks a legal or policy framework to pursue such structured corridor

development, limiting its ability to attract large-scale mining infrastructure investment.

Furthermore, the absence of resource-backed mechanisms (e.g., using future mineral revenues or production to finance infrastructure) is a missed opportunity. The SMDF remains undercapitalised (with under ₦15 billion disbursed between 2016 and 2023) and does not engage in strategic co-financing with infrastructure partners.

(iii) *Inadequate Implementation of MIREMCOs*

The MIREMCOs were established under the Nigerian Minerals and Mining Act (2007) to serve as a bridge between the federal government, state authorities, host communities, and mining companies. Their mandate includes resolving conflicts, ensuring environmental compliance, and promoting community development projects through mechanisms like Community Development Agreements (CDAs). However, MIREMCOs have remained largely inactive in over 60% of states due to inadequate funding, limited autonomy, lesser capacity, and political interference (MMSD 2020). A 2021 audit by NEITI showed that less than 30% of medium- to large-scale mining operations had an active MIREMCO presence to monitor community engagement or infrastructure commitments.

Implementation barriers in practice: enforceability, coordination, and informality

Institutional and regulatory barriers merit additional interrogation of why well-designed instruments repeatedly underperform in practice, since implementation failure is central to the mineral–infrastructure disconnect. The Nigerian Minerals and Mining Act (2007) establishes licensing, Community Development Agreements (CDAs), and Mineral Resources and Environmental Management Committees (MIREMCOs), yet empirical evidence covered in this study shows gaps between legal intent and practice: over 30% of mineral titles issued over the last decade became dormant or disputed due to delays, overlapping surface rights, and unresolved conflicts; state-level monitoring bodies remain inactive in many jurisdictions; and fewer than 25% of CDAs contain tangible, measurable infrastructure targets. These patterns suggest that the binding constraint is not policy absence but enforceability and coordination across three tiers of government. Surface rights disputes illustrate the coordination problem. Federal mineral titles can overlap with customary land control and state land administration, creating legal ambiguity that discourages private infrastructure finance and lengthens project timelines, especially for assets requiring right-of-way across multiple communities. Digitised title systems can reduce uncertainty, but only when linked to georeferenced surface-rights registers and when dispute-resolution channels are credible.

CDA obligations can be expanded from social amenities to infrastructure co-development, but feasibility depends on specifying deliverables (technical standards, completion dates, maintenance responsibilities, and cost-sharing rules) and on creating verification mechanisms that do not rely solely on local political patronage. An option is to require annual CDA implementation statements with independent audits, linking verified performance to licence renewal conditions and to access to incentives such as expedited approvals or tax allowances. MIREMCO revitalisation, despite reported inactivity in over 60% of states, also requires more than statutory reaffirmation. A minimum operational package is needed: protected funding, technical staffing, inspection logistics, and clear reporting lines that limit political interference. Where capacity is weak, regional inspectorate teams can be piloted, supported by standardised monitoring templates and digital submission portals, reducing discretion and improving comparability across states.

Bureaucratic delays and policy instability further undermine bankability because infrastructure investors price regulatory risk. Addressing this requires a commitment device, such as published service standards for licensing timelines, transparent fee schedules, and real-time permit tracking, combined with inter-agency memoranda that clarify approvals for roads, power, and water crossings. Enforcement must confront informality. Illicit extraction and smuggling reduce fiscal revenues that could fund shared infrastructure and erode trust in formal operators; therefore, formalisation strategies should be integrated with infrastructure planning by linking access to processing hubs, market platforms, and finance to verified legal status. It is of great significance when reform proposals are paired with concrete enforcement architecture, capacity requirements, and the political economy risks that can block implementation even when legal frameworks exist nationwide. Implementation sequencing can reduce risk. Early pilots in a small set of states can test whether audited CDA templates, grievance redress, and MIREMCO funding reduce disputes reported in Nasarawa, and whether coordinated enforcement reduces incentives driving illegal gold mining in Zamfara. Lessons from pilots can then inform national roll-out and statutory amendments with clear targets and published performance dashboards.

Financial barriers

One of the foremost financial barriers to integrating mineral wealth with infrastructure development in Nigeria is the limited availability of long-term, affordable financing tailored to the needs of the mining sector. Commercial

banks, which dominate Nigeria's financial landscape, often avoid lending to mining ventures due to the sector's high perceived risk, long gestation periods, and lack of collateral (Eniowo et al. 2018, 2025). According to the Central Bank of Nigeria, less than 0.5% of total domestic credit was allocated to the solid minerals sector between 2016 and 2020 (CBN 2021). To fully actualise the economic potential of mineral resources, adequate investment is needed to meet the extensive mining infrastructure deficit. This includes upstream mining infrastructure to support the extraction and processing of ores, such as power and processing facilities, as well as downstream infrastructure, including motorable roads, for the distribution of extracted ores. One example of the effect of financial barriers is the Ajaokuta Steel Complex in Kogi State, which has remained mostly non-operational due to insufficient funding for necessary support infrastructure, including rail and power expansions, despite having a projected iron ore input capacity of over 5 million tonnes annually (Oyeyinka and Adeloye 1988). Other technical, institutional, and policy-related challenges discussed in this section are also relevant, but their specific role in the Ajaokuta Steel Complex is not examined here.

Similar to this, Nigeria imports more than 80% of its barite for oil drilling despite having substantial reserves because local miners lack the funds to invest in haulage roads and processing facilities, causing production in the barite mining cluster in Nasarawa State to stall (Ebunu 2021). Efforts to address this through the Solid Minerals Development Fund (SMDF) have been limited, with the Fund disbursing under ₦15 billion between 2017 and 2023 - far below the sector's infrastructure needs. In contrast, Guinea's Simandou iron ore project mobilised over $15 billion in investment through a resource-backed infrastructure deal that included 650 km of rail and a deep-water port (Samb 2022). The absence of similar financing innovations in Nigeria underscores the urgency for reforming the country's approach to mining infrastructure funding, particularly by leveraging public-private partnerships (PPPs), sovereign mining bonds, and resource-for-infrastructure frameworks.

Governance barriers

The attempts to use Nigeria's mineral wealth for infrastructural development are severely hampered by governance obstacles. Some of the major barriers include weak accountability, corruption, conflicting mandates, and inadequate enforcement of mining-related agreements (Omoijuanfo et al. 2024). Due to these governance barriers, there is less motivation for mining companies to fulfil their obligations in relation to local infrastructural development as enshrined in the community development agreement (CDA), which is usually signed between mining companies and their host communities (Omoijuanfo et al. 2024). This also has implications for the mining industry's contribution to the economic growth of the country. As an illustration, despite Nigeria's enormous mineral endowment, the solid minerals sector only contributed ₦128 billion (about USD 85 million) to government revenues in 2020, or less than 1% of GDP, according to the Nigerian Extractive Industries Transparency Initiative (Eniowo and Meyer 2020; NEITI 2021). Although the solid minerals sector is still nascent, the persistently low revenue contribution highlights governance challenges that constrain sectoral development, formalisation, and effective revenue mobilisation (Eniowo et al. 2026).

One notable example of the impact of governance barriers on mineral-linked infrastructural development is the absence of CDA enforcement in the states of Nasarawa and Zamfara, where mining corporations are required by law to fund local infrastructure, but regulators like the MIREMCOs are either nonexistent or underfunded. Kogi State's ongoing disputes over the Ajaokuta Steel Complex, which range from stalled concession agreements to unsuccessful privatisations, expose the lack of open governance and political stability required to draw in infrastructure investment and reestablish mining-industrial ties (MMSD 2020). In addition to undermining investor trust, these governance shortcomings limit the potential of mining activities from spurring the development of processing zones, power networks, and roads that are necessary for the country's economic transition.

Case studies on governance and infrastructure barriers in Nigeria's mining industry A complex interaction of governance flaws, institutional framework weaknesses, infrastructure limitations, and security-related interruptions has long limited the growth of Nigeria's mineral sector. Even though the nation has enormous amounts of strategic minerals, from gold to barite and iron ore, its incapacity to efficiently utilise these resources has impeded foreign investment, industrialisation, and job development. Three representative case studies are presented in this section (see Fig. 5) that illustrate the many obstacles to Nigeria's mineral resource development and use. Every story highlights the deeper institutional and policy-related issues that worsen inefficiency and vulnerability throughout the mining value chain, in addition to the technological and logistical flaws that obstruct progress.

The selected case studies: gold mining in Zamfara, Ajaokuta-Itakpe-Warri rail route, and the barite development in Nasarawa, provide unique insights into how institutional barriers, governance challenges, and infrastructure gaps all

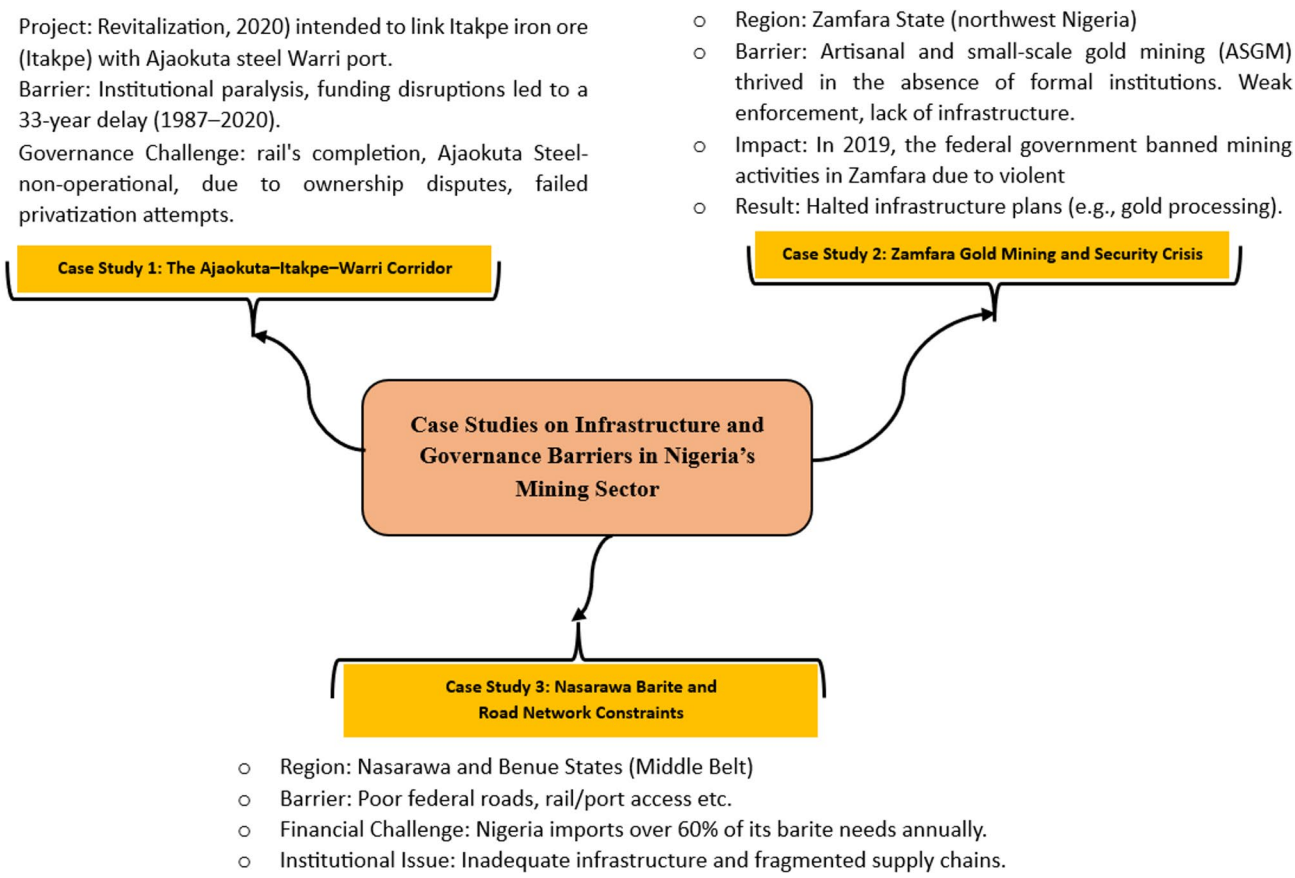

Fig. 5 Case Studies on infrastructure and governance barriers in Nigeria's mining sector

work together to hamper strategic initiatives, especially in the mining sector. One instance that illustrates this existing challenge is the prolonged delay of a crucial rail line, which was intended to drive integrated industrial development. Another instance is the plunging of artisanal mining activities into violence in Zamfara state. The third is the country's existing reliance on imports for vital mineral resources that can be sourced locally. These challenges, in addition to providing insight into the need for intervention in the industry, also offer insightful guidance for planning and policy in Nigeria's efforts to turn its mining industry into a catalyst for long-term, sustainable economic growth. This section of the paper offers empirical insight into how systemic barriers continue to undermine Nigeria's mineral potential. The section explores real-world examples, such as the bottlenecks facing barite production in Nasarawa, the lesser protection-driven collapse of artisanal mining in Zamfara, and the Ajaokuta–Itakpe–Warri rail corridor.

In terms of administration and infrastructure, the Ajaokuta–Itakpe–Warri Corridor is one good example. The 327-kilometre rail route was first planned in 1987 as a means of linking the Itakpe iron ore mine to the Ajaokuta Steel Plant and the port of Warri. However, the project was delayed for more than thirty years. It was not completed until 2020 due to institutional challenges, inadequate project management, dishonesty, and numerous shifts in government objectives (Akomodi 2025). Due to unresolved ownership conflicts, unsuccessful privatisation attempts, and a lack of a cohesive industrial policy, the Ajaokuta Steel Plant is still mostly non-operational even after the rail line was eventually revived. Even in the face of abundant resources, industrial integration is undermined by inadequate infrastructure, as this case demonstrates.

Even though the situation in Zamfara State is different, it still offers some insight. In this case, the governance let-down is more related to security and regulatory supervision than it is to physical infrastructure. Artisanal and small-scale gold mining (ASGM), which is sometimes run by informal networks with little consideration for safety or environmental regulations, became widespread due to the lack of official governance systems. When wrong elements started involving themselves in mining site activities, the situation worsened and contributed to a frightening security

situation. As a result, both legal and illegal mining operations were stopped in 2019 when the federal government outlawed mining in the state (Okwelum 2022). Although this move was required for security, it also caused investor confidence to decline and the planned infrastructure investments, including road renovations and clusters for gold processing, to be put on hold.

All three cases point to the critical need for coherent policy planning that integrates mining with transport, power, and industrial development. The absence of integrated development planning, whether in the form of stalled mega-projects or fragmented oversight, results in a mining sector that is spatially isolated, economically inefficient, and institutionally fragile. Furthermore, these governance and infrastructure failures contribute to environmental degradation, community displacement, and socio-economic inequality in mining zones, deepening local discontent and reducing the social license to operate (Hilson and McQuilken 2014).

Coherent policy planning that aligns mining with transportation, power, and industrial expansion is vital, as demonstrated by all three cases. A mining industry that lacks integrated development planning is institutionally unstable, economically inefficient, and geographically separated. This can be seen in the form of stalled mega-projects or disjointed oversight. Additionally, in mining zones, these governance and infrastructural shortcomings exacerbate local dissatisfaction and diminish the social license to operate by causing environmental damage, community dislocation, and socioeconomic disparity (Hilson and McQuilken 2014).

Lessons for Nigeria from successful mining-infrastructure linkages: examples from Africa and other regions

Governments in several developing nations have used their mineral wealth as a catalyst for the construction of extensive infrastructure, frequently through integrated planning, transparent governance frameworks, and strategic alliances. In addition to facilitating mineral exports, these mining-related infrastructure corridors have had a wider economic and social impact by facilitating regional trade, job creation, and the provision of public services. Nigeria, whose mining industry requires government and infrastructure attention, can learn practical lessons from these global experiences. Five case studies, Mozambique, Guinea, South Africa, Chile, and Botswana, are covered in this section to demonstrate successful mining-infrastructure integration approaches, as seen in Fig. 6.

Mozambique: the Nacala Logistics Corridor

The Nacala Logistics Corridor in Mozambique is a compelling illustration of how mining may propel the development of regional infrastructure. The corridor, which spans 912 km of rail through Malawi and Mozambique, links inland coal

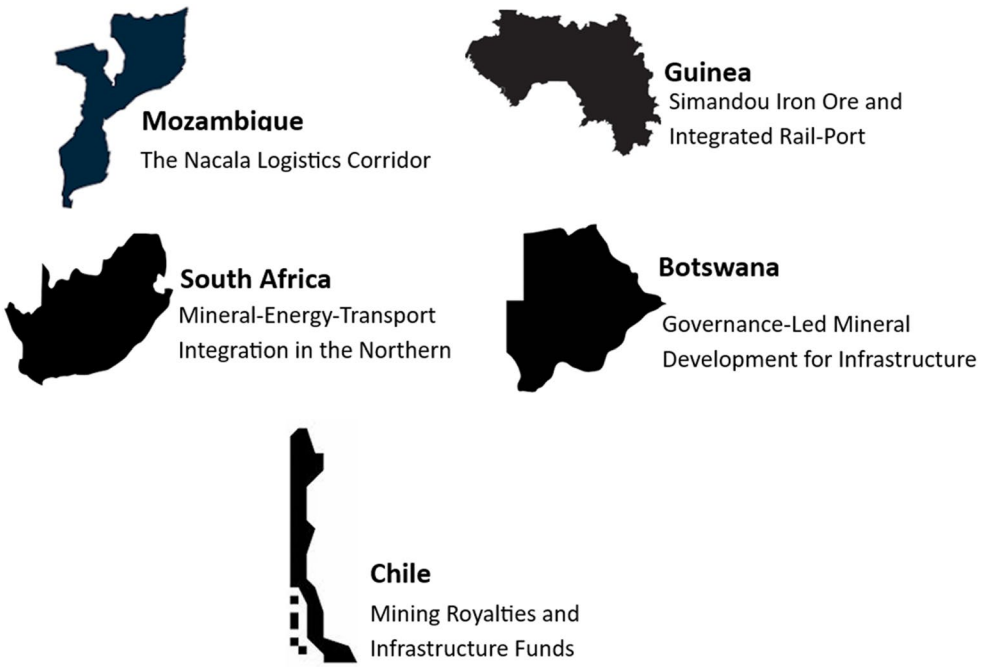

Fig. 6 Successful mining-infrastructure linkages: case studies from Africa and beyond

deposits to the deepwater Port of Nacala and is anchored by the enormous coal reserves in Tete Province. The corridor was designed to alleviate the major interior transportation bottleneck and was created through a public-private collaboration that included Vale (Brazil), Mozambique Ports and Railways (CFM), and regional stakeholders (World Bank, 2015). The Nacala Corridor has significant main effects. Mozambique's export competitiveness was greatly increased when coal transportation prices decreased by more than 30%. During construction, the project generated over 3,000 jobs, and it has since maintained several hundred more. Crucially, the infrastructure promoted regional cooperation by facilitating trade between Malawi and Zambia, linking previously landlocked economies. Foreign direct investment, government backing, and an open legal system that made risk-sharing obligations clear were all factors in the corridor's success.

For Nigeria, the Nacala case shows the potential of multi-country mineral corridors in unlocking inland mineral wealth. Nigeria's iron ore-rich states, such as Kogi and Kaduna, could benefit from similar cross-regional infrastructure plans, particularly if tied to active port access and supported by a mix of public and private capital. Legal clarity, intergovernmental cooperation, and FDI attraction mechanisms are critical for such projects.

Guinea: Simandou iron ore and integrated rail-port development

Guinea's Simandou project represents one of the most ambitious mining-infrastructure developments in sub-Saharan Africa. Home to one of the largest untapped high-grade iron ore reserves globally, the Guinean government partnered with the Simfer consortium, including Rio Tinto and Chinalco, to construct a 650-kilometers railway and deepwater port at Matakong. Valued at approximately $15 billion, the project reflects Guinea's strategic use of its resource leverage to negotiate long-term, multipurpose infrastructure (Samb 2022). The project's legal design includes robust local content provisions, community development funds, and compensation policies for displaced populations. Notably, the government ensured the rail and port facilities would be open for commercial and passenger use beyond mining, addressing broader national development goals. It is projected that once operational, the Simandou project will raise Guinea's GDP by 7–10% annually.

Nigeria can draw key lessons from Guinea's negotiation tactics. First, retaining control over infrastructure use rights ensures national benefits beyond mineral exports. Second, embedding social responsibility mechanisms into infrastructure agreements strengthens community buy-in. These features should be standard components of Nigeria's future mining license agreements.

South Africa: mineral-energy-transport integration in the Northern Cape

South Africa's Northern Cape Province has demonstrated successful alignment of mining, energy, and transport policies through the Sishen–Saldanha rail line. This 861 km bulk rail corridor, developed and managed by the state logistics company Transnet, transports over 60 million tonnes of iron ore and manganese annually to the port of Saldanha Bay. The project's strategic approach includes ring-fenced tariffs, whereby mining royalties are partially reinvested into infrastructure (Transnet, 2021). Collaboration between mining firms like Kumba Iron Ore and Transnet Freight Rail has helped reduce transport costs by up to 40%, while expanding South Africa's market share in global manganese exports. The corridor has become a backbone of mining logistics in the regions it serves, demonstrating the effectiveness of state-owned enterprises in de-risking large-scale transport infrastructure investments.

For Nigeria, this case illustrates the value of mineral-specific bulk corridors and state-led coordination. Nigeria's underutilised rail systems and fragmented logistics networks could benefit from a centralised entity tasked with freight coordination, possibly under the Nigeria Railway Corporation or a reformed Transport Ministry. This would ensure synergy between mining licenses and infrastructure delivery schedules.

Chile: mining royalties and infrastructure funds

Chile, as the world's top copper exporter, has successfully channelled mining rents into infrastructure and development through fiscal reforms and long-term planning. Since the early 2000s, the Chilean government has earmarked a portion of royalties - mainly from CODELCO, its state-owned copper company -into a national infrastructure and development fund. These revenues have financed highways, ports, water systems, and rural electrification (OECD 2018). Between 2005 and 2020, over $5.3 billion in mining revenues were allocated to infrastructure development. As a result, mining towns saw notable improvements in basic services and a 25% rise in rural electricity. Transparent resource revenue management and the strategic function of a state mining company that acts as both a producer and a public investor are the main components of Chile's model's success.

By creating a sovereign mining infrastructure fund funded by designated royalties, Nigeria can improve by taking a cue from Chile when it comes to the allocation of mining revenue. Enhancing openness and making sure money is spent on infrastructure in host communities will boost

public confidence and aid in resolving the problems with social legitimacy that many mining projects face.

Botswana: Governance-led mineral development for infrastructure

A governance-first approach to managing mineral resources is provided by Botswana. Botswana continuously reinvests diamond profits into its own infrastructure through a 50/50 joint venture with De Beers (Debswana). The distribution of mining profits to water projects, schools, hospitals, and highways is governed by the nation's Public Investment Programme (PIP) and National Development Plans (NDPs) (World Bank, 2020). Consequently, the road network in Botswana grew from 6,000 km in 1980 to over 31,000 km by 2020, with more than 70% of that distance being paved. More than 90% of rural areas now have access to safe drinking water. Low levels of corruption, robust institutional control, and participatory budgeting procedures serve as the foundation for these accomplishments. The experience of Botswana emphasises the value of strategic planning, national ownership, and the efficient use of joint ventures to match private investment with public infrastructure objectives.

Through effective governance, Botswana's experience offers Nigeria a path forward for coordinating mining with national development. To handle mineral earnings and infrastructure planning, transparent organisations like Nigeria's Sovereign Investment Authority (NSIA) might be reorganised. Furthermore, implementing inclusive development plans with community involvement tools could lessen the mistrust that frequently impedes Nigerian extractive industry initiatives.

Cross-cutting lessons and relevance to Nigeria

When taken as a whole, these five case studies demonstrate that effective mining-infrastructure integration is dependent upon three fundamental elements: creative funding, robust governance, and strategic planning. Each case shows that mineral wealth alone is insufficient without cogent policy and institutional frameworks, whether through public-private partnerships (as in Mozambique), legal negotiation leverage (as in Guinea), coordinated logistics (as in South Africa), fiscal transparency (as in Chile), or governance-led reinvestment (as in Botswana).

Nigeria, with its substantial reserves of gold, iron ore, barite, bitumen, and other strategic minerals, has the potential to replicate and even surpass these successes. However, this will require comprehensive structural reforms - including operationalising MIREMCOs, developing legal frameworks for resource-for-infrastructure agreements, and establishing integrated planning units that bridge mining, infrastructure, and national development goals.

By drawing from these international experiences, Nigeria can reposition its mining sector as not only a revenue source but a driver of inclusive and sustainable national transformation as presented in Table 4.

While international experiences from countries such as Botswana, Chile, and South Africa offer valuable insights into effective mining–infrastructure linkages, their direct transposition to the Nigerian context is neither straightforward nor guaranteed. These models emerged within governance environments characterised by relatively strong institutional coherence, stable regulatory frameworks, and clear alignment between national and sub-national authorities. Recent literature asserts that the Nigerian mining industry has struggled with a complex regulatory framework characterised by overlapping responsibilities between federal and state governments (Eniowo et al. 2026). Therefore, Nigeria's federal structure, marked by uneven institutional capacity, intense sub-national competition for resource control, and persistent corruption risks, fundamentally alters the conditions under which such linkages can be implemented. This underscores the importance of treating international case studies as heuristic guides rather than prescriptive templates (Guercini and Freeman 2021).

SWOT analysis: linking mineral wealth with infrastructure development in Nigeria

Nigeria's vast endowment of over 44 solid minerals, spread across the country, positions it as a potential mining powerhouse on the African continent. With increasing demand

Table 4 Comparative table - key features of case studies

Country	Mineral	Key Infrastructure	Model	Lessons for Nigeria
Mozambique	Coal	Rail & Port (Nacala)	Public-private partnerships (PPPs)	Regional integration, multi-sector use
Guinea	Iron Ore	Rail & Deep-water Port	Resource-for-Infrastructure	Shared use, local content, negotiation capacity
South Africa	Manganese	Rail (Sishen–Saldanha)	State-backed + private miners	Bulk corridors, tariff ring-fencing
Chile	Copper	Roads, Power, Water	Royalties + Infrastructure Fund	Fiscal discipline, sovereign infrastructure savings
Botswana	Diamonds	Roads, Water, Health	JV + Public Planning	Fiscal discipline, sovereign infrastructure savings

for strategic minerals such as lithium, barite, and gold, the Nigerian mineral sector could become a catalyst for large-scale infrastructure development. However, the realisation of this vision depends on Nigeria's ability to navigate a complex mix of internal strengths and weaknesses, as well as external opportunities and threats. To help guide investment and policy choices, this SWOT analysis provides a methodical evaluation of major factors.

Strengths

Abundant mineral endowment

Nigeria possesses commercially viable deposits of iron ore (estimated at 3 billion tonnes), coal (over 639 million tonnes proven), barite, lithium, gold, and more, according to MMSD (2020). The minerals are geographically distributed across all geopolitical zones, enabling balanced regional development if appropriately linked to infrastructure. For instance, gold deposits in Zamfara and Osun, barite in Nasarawa and Cross River, and lithium in Kogi and Nasarawa offer localised entry points for mineral-based development corridors.

Strategic geographic location

Situated along the Atlantic coast with access to West African trade routes, Nigeria is ideally placed to develop mineral corridors for both domestic processing and regional exports. The proximity to landlocked nations such as Niger and Chad offers opportunities to serve as a mining logistics hub, especially through trans-border infrastructure such as railways and deep-sea ports.

Reform momentum and policy frameworks

Recent government initiatives, such as the Solid Minerals Development Roadmap (2016) and the NIIMP, show a commitment to aligning mining activities with infrastructure expansion. Additionally, the SMDF provides a platform to finance infrastructure in mining areas.

Private sector and FDI interest

A number of private and foreign entities, including Thor Explorations, African Natural Resources and Mines Ltd., and new Chinese investors in the lithium sector, have indicated their willingness to co-invest in mine-to-market infrastructure. According to the Nigerian Investment Promotion Commission (2023), the country attracted $2 billion in mining-related investment pledges between 2021 and 2023, including proposed investments in mine development and processing infrastructure, particularly in gold, steel, and lithium.

Weaknesses

Limited infrastructure in mining regions

Over 70% of Nigeria's mining zones lack paved road access or proximity to grid electricity, hindering the viability of mining operations (FMWR et al. 2022). The case of barite mining in Nasarawa is illustrative - despite high reserves, the absence of feeder roads and processing infrastructure keeps production uneconomical and limits local beneficiation.

Insecurity in mineral-rich areas

Common communal conflicts, among other security concerns, are rampant in several mining regions, including Zamfara, Kaduna, and Taraba. These threats deter both foreign and local investment, disrupt infrastructure projects, and increase operational risks (Eniowo 2024). Infrastructure developers may avoid these zones altogether without strong security guarantees.

Fragmented Institutional Coordination

Multiple ministries - Ministry of Solid Mineral Development, Works and Housing, Power, and Transport - often work in silos with overlapping mandates. State-level structures like the MIREMCOs are underfunded and inactive in many states, weakening the coordination of mining-related infrastructure development (MMSD 2020).

Limited financing mechanisms

Nigeria can improve by establishing innovative financial instruments such as mineral-backed bonds or resource-for-infrastructure (RFI) frameworks that have worked in countries like Angola and Guinea. Domestic banks often perceive mining infrastructure as high-risk. Due to long payback periods and political uncertainties, private financing is scarce (CBN 2021). Similarly, existing supporting financing currently lacks scale, which limits its impact.

Weak governance and regulation

Governance issues such as licensing bottlenecks, informal and unauthorised mining, and dishonesty persist. NEITI (2021) reports that Nigeria loses over $2 billion annually in illicit gold exports. Weak enforcement of environmental and licensing regulations erodes public trust and undermines formal investment.

Environmental and social backlash

Management of mining and infrastructure projects could be improved to avoid land degradation, pollution, and displacement of communities, especially in ecologically sensitive regions. The absence of comprehensive Environmental and Social Impact Assessments (ESIAs) has led to community resistance and legal challenges in several states. Social license to operate is increasingly becoming a critical factor in project viability.

Policy instability and bureaucratic delays

Frequent changes in mining taxation, export policies, and government positions can dissuade long-term infrastructure investment. Historical reversals in Nigeria's steel and power sector reforms are cautionary tales that highlight the cost of policy inconsistency. Investor confidence is impacted by the absence of a strong legal framework for infrastructure finance tools like RFI agreements.

Opportunities

Global demand for critical minerals

The global shift towards clean energy technologies has accelerated demand for minerals like lithium, cobalt, and rare earth elements. Nigeria's lithium reserves in Kogi and Nasarawa provide a critical opportunity to position the country as a supplier of strategic energy transition minerals (International Energy Agency - IEA, 2021). This rising demand can be leveraged to attract infrastructure-oriented investments such as processing facilities and rail links.

Regional integration initiatives

The African Continental Free Trade Area (AfCFTA) and ECOWAS protocols present opportunities to develop cross-border mineral corridors and integrate Nigeria into continental value chains. Infrastructure investments that align with regional integration goals-such as the Nigeria-Niger rail project-could improve competitiveness and expand market access for mining products.

Technological advancements

Modern technologies like GIS mapping, drone-based exploration, and digital cadastral systems can reduce exploration costs, improve data transparency, and support more targeted infrastructure planning. The National Geodata Repository (NGR), under development with World Bank support, will provide real-time geological data to investors and policymakers, enhancing project efficiency (World Bank 2017).

Public-private partnerships and esg alignment

The global rise of Environmental, Social, and Governance (ESG) standards is creating new financing models for infrastructure. Investors are increasingly drawn to projects with strong community engagement, renewable energy components, and environmental safeguards. Nigeria can tap into blended finance opportunities by aligning its mining infrastructure with ESG principles and transparent governance.

Threats

Global commodity price volatility

Nigeria's mineral sector remains susceptible to international commodity cycles. For instance, the global slump in coal prices in 2020 sharply reduced investor interest in Nigeria's coal reserves. Overreliance on mineral exports for infrastructure finance, without diversification, could create revenue instability during downturns (World Bank Commodity Outlook 2021).

Policy framework for mining-linked infrastructure development in Nigeria: strategic suggestions

Nigeria's mineral sector has yet to realise its full potential due to policy inconsistencies, governance challenges, and infrastructure limitations. However, any policy framework aimed at strengthening mineral–infrastructure linkages in Nigeria must contend with entrenched governance constraints that have historically undermined reform efforts. Akper (2024) documented how the Nigerian Mining Corporation (NMC), established in 1972 to drive the development of the mining industry and fill the void created by the exit of expatriates and foreign mining companies, recorded an abysmally poor performance due to poor funding, mismanagement, and corruption. The NMC eventually became comatose due to systemic corruption, coupled with the overwhelming power and tax competition of the oil and gas sector, weak institutional capacity at the federal and state mining agencies, and a lack of political will to depoliticise resource allocation (Akper 2024; Mallo 2011). Without confronting these realities, even well-designed policy instruments risk remaining aspirational rather than implementable.

Nevertheless, strategic interventions that link mineral exploitation with infrastructure investment, industrialisation, and regional development are desperately needed if

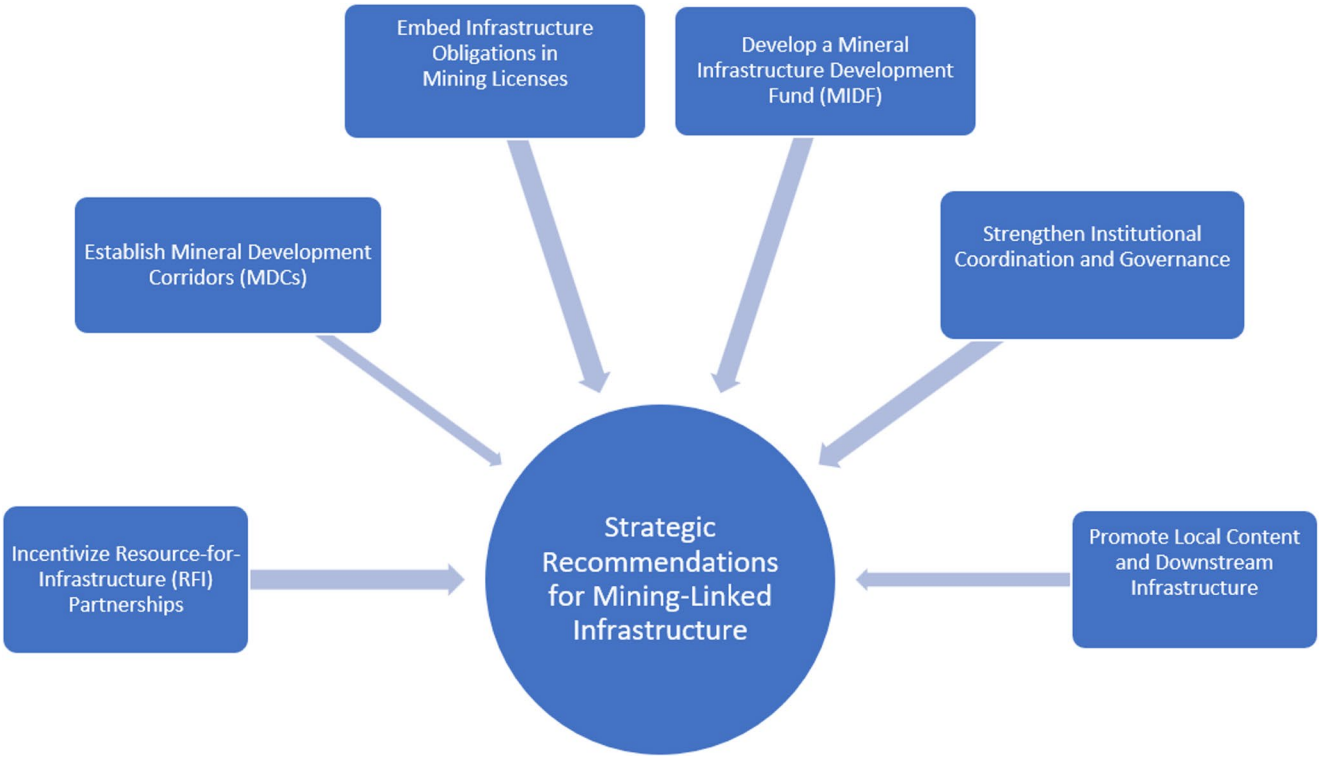

Fig. 7 Strategic Recommendations for Mining-Linked Infrastructure Development in Nigeria

mining is to become a catalyst for sustainable economic growth (Zvarivadza, 2018b, c). As seen in Fig. 7, this section presents six interconnected strategic suggestions that, when taken as a whole, provide a road map for maximising the mining industry's potential for development in Nigeria. These recommendations are based on lessons learned from international best practices.

MDCs offer a compelling organising concept, but corridor feasibility hinges on rigorous project preparation, credible governance, and careful sequencing rather than broad spatial designation. Corridor selection should begin with criteria that combine geological potential with 'infrastructure leverage': projected mine life and throughput sufficient to anchor demand; proximity to existing trunk assets that can be rehabilitated faster than greenfield builds; security conditions that allow contractor mobilisation; and environmental and social constraints that do not make right-of-way acquisition prohibitively contentious. This study notes that over 70% of mining areas lie far from paved roads or power, implying that corridors must be designed as multi-node systems rather than single lines on a map. A staged implementation pathway can reduce risk. Stage 1 can prioritise enabling packages in one or two belts (feeder roads, bridge repairs, weighbridge and axle-load enforcement, embedded power solutions for processing clusters, and digital connectivity upgrades) because these components are modular, deliver quick productivity gains, and build institutional learning. Stage 2 can progress to heavier assets (rail rehabilitation, bulk handling terminals, transmission reinforcement) only after demand commitments, tariff principles, and maintenance funding are secured. Stage 3 can scale to new rail-to-port construction where bankability is demonstrated under stress tests for commodity prices, exchange rates, and security costs.

Governance design is decisive throughout. A corridor authority or special-purpose vehicle requires clear mandates over land access coordination, multi-user access rules, and performance monitoring; otherwise, the historical problem of siloed ministries and stalled projects reappears. Public–private partnerships can mobilise capital, but evidence of over 40% PPP attrition before financial close shows that transaction design must be strengthened: risk allocation should follow control, revenue models should be transparent, and dispute-resolution mechanisms should be credible to lenders. Shared-use principles also require enforceable access and tariff rules to prevent corridor capture by a single operator and to ensure spillover benefits for agriculture and manufacturing. Maintenance must be financed and governed ex ante through ring-fenced O&M accounts, performance-based contracts, and public reporting of asset condition, since poor maintenance has repeatedly undermined transport reliability in comparable projects.

Environmental and social safeguards must be integrated early: corridor ESIAs should address cumulative impacts across multiple mines, water demand, and resettlement, and

should build grievance redress systems capable of resolving disputes before they become litigation risks. Embedding these implementation details within the MDC recommendation would shift the section from advocacy toward an operational plan, clarifying which institutions carry which responsibilities, what sequencing reduces failure probability, and what measurable thresholds determine when a corridor is ready to advance from concept to bankable project. A minimal evidence base is also required: georeferenced mineral occurrence and production data, baseline traffic and power-demand forecasts, and a pipeline of 'shovel-ready' subprojects with cost ranges and implementation timelines. Establishing a corridor project-preparation facility within existing funds can finance feasibility studies, transaction advisory, and ESIA baselines, reducing dependence on ad hoc donor support. Publishing corridor dashboards, procurement milestones, costs, and delivered outputs would improve accountability and reduce perception of politicisation and would help investors verify progress before committing capital.

Establish Mineral Development Corridors (MDCs)

Mineral Development Corridors (MDCs) are spatial strategies that integrate mining clusters with transportation, energy, and processing infrastructure to facilitate both mineral exports and regional development. Nigeria's mineral-rich belts, such as Kogi–Benue–Enugu (coal and iron ore), Nasarawa–Taraba–Plateau (barite, lithium), and Zamfara–Kaduna (gold, gemstones), currently lack coherent infrastructure connectivity. According to the Nigerian National Integrated Infrastructure Master Plan (NIMP 2020), more than 70% of mining areas are located over 50 km from a paved road or power grid. This severely limits the viability of large-scale investment.

Global success stories like Mozambique's Nacala Corridor, developed by Vale and Mozambique Ports and Railways, demonstrate how targeted infrastructure investment can transform remote mining areas into export-oriented economic hubs (World Bank, 2015). Nigeria should identify 3–5 MDCs based on geological potential and economic clustering. These corridors must co-locate road, rail, ICT, and energy infrastructure to support multi-sectoral growth. The inclusion of MDCs in the NIIMP and leveraging PPP frameworks will be crucial to attracting both public and private capital for their development.

It must be stated, however, that due to Nigeria's fiscal, institutional, and political constraints, there is a need for strategic prioritisation in the formulation of an integrated mineral-infrastructure master plan. As an illustration, Nigeria could prioritise one or two strategic minerals and corridors initially (such as the iron ore and steel corridor and gold precincts) rather than taking a broad-based approach. This is crucial since a sequenced approach that concentrates resources on a limited number of high-impact mineral corridors is more realistic and potentially more transformative. A recent study by Azubuike et al. (2023) underscored the need for the Nigerian state to adopt pragmatic steps in developing an economic plan that integrates the mineral resource corridor to actualise Nigeria's economic objectives.

Embed infrastructure obligations in mining licenses

Despite existing regulations mandating Community Development Agreements (CDAs) for mining licensees, only a minority include meaningful infrastructure components beyond social amenities. The Ministry of Mines and Steel Development (MMSD 2020) reports that fewer than 25% of CDAs incorporate tangible infrastructure targets, leading to community dissatisfaction, project delays, and investor risk. Nigeria should amend the 2007 Minerals and Mining Act to mandate that medium- and large-scale operators co-develop local infrastructure, including power connections, health centres, and access roads, as part of their license requirements to close this gap.

The allocation of royalties to legally binding municipal infrastructure agreements by Chile's state-owned corporation CODELCO provides a compelling precedent (OECD 2018). By establishing performance metrics linked to license renewal and providing explicit guidance via the Minerals Cadastral Office (MCO), Nigeria can follow a similar strategy. In addition to fostering local trust, licensing requirements for infrastructure would lessen the financial strain on the state in underprivileged areas.

Develop a Mineral Infrastructure Development Fund (MIDF)

The establishment of a ring-fenced Mineral Infrastructure Development Fund (MIDF) is critical to financing long-term, strategic infrastructure in mining regions. While Nigeria has a Solid Minerals Development Fund (SMDF), it remains undercapitalised and administratively limited. NEITI (2021) notes that less than 3% of total mining revenues are reinvested in mining communities, reflecting systemic neglect and missed opportunities.

Drawing inspiration from Chile's Copper Stabilisation Fund, which invested over $5.3 billion in regional infrastructure, and Botswana's Public Investment Programme (World Bank, 2020), Nigeria should establish the MIDF with legal backing, independent governance, and transparent reporting mechanisms. Revenue sources may include mining royalties, export levies, concessional loans, and windfall taxes. Crucially, disbursement should be aligned

with SDGs, regional development plans, and performance metrics to avoid politicisation.

Financing feasibility and risk allocation for mining-linked infrastructure

Financing instruments proposed for mining-linked infrastructure, such as a ring-fenced Mineral Infrastructure Development Fund, ESG-aligned blended finance, and Resource-for-Infrastructure partnerships, require deeper interrogation of fiscal realism and risk allocation to avoid repeating past experiences where ambitious programmes remained unfunded or contested. The infrastructure financing gap noted in this study underscores scale, yet the study also notes that existing support has been small relative to need, and that less than 3% of mining revenues is reinvested in mining communities, indicating that new vehicles must be designed for durability, not only created by proclamation. Revenue stability is a binding constraint. Commodity price volatility can cause boom-bust fiscal cycles, so a MIDF should embed counter-cyclical rules: conservative reference prices, stabilisation buffers, and transparent triggers for saving versus spending. Currency mismatch is also material. Many infrastructure inputs are imported and priced in foreign currency, while royalties, taxes, and tariffs are largely naira-denominated; without hedging, indexation, or blended concessional tranches, depreciation can undermine debt service and force politically difficult tariff increases.

It is also important to note that governance risk directly translates into financing cost. Lenders and institutional investors require credible procurement, contract enforcement, and audit trails; opaque allocation can create contingent liabilities and erode trust, especially in a federal setting where revenue sharing and land control are politically sensitive. A MIDF, therefore, needs legal backing, independent board composition, published investment criteria, and annual audited accounts, with disbursements tied to verified outputs (kilometres of all-weather road delivered, megawatts connected, processing capacity commissioned) rather than input budgets. RFI models merit even tighter safeguards. While large deals elsewhere demonstrate the possibility of leveraging future mineral revenues for upfront rail and port assets, RFI can lock in unfavourable terms when valuation is opaque, when mineral flows are pledged without competitive tendering, or when repayment depends on optimistic production profiles. Feasibility analysis should therefore specify: competitive selection of contractors and financiers; transparent valuation of collateral; debt sustainability assessment under downside scenarios; escrow and ring-fenced revenue collection; step-in rights and performance penalties; and disclosure of beneficial ownership to reduce corruption risk.

Blended finance and ESG alignment can reduce the cost of capital if projects credibly deliver community benefits and environmental safeguards, but 'ESG-washing' risk exists when monitoring is weak. Independent verification of social and environmental performance, including CDA delivery and ESIA compliance, should be treated as a bankability requirement, not a reputational add-on. Financing strategy, ultimately, should be matched to asset type. Modular investments (feeder roads, power microgrids, shared processing hubs) can deliver faster returns and learning, whereas megaprojects require stronger governance and demand certainty. Embedding these constraints and safeguards within the finance recommendations would reposition the section as a critical feasibility assessment of which financing tools fit the political economy of Nigeria, and under what conditions they can reliably translate mineral wealth into durable infrastructure. Given reports of under ₦15 billion SMDF disbursement and the high share of PPP proposals failing to reach financial close, resources for project preparation: feasibility studies, ESIA baselines, transaction advisory, and permitting coordination should be budgeted, since weak preparation often drives renegotiation, delay, and cost escalation.

Incentivise Resource-for-Infrastructure (RFI) partnerships

Nigeria's $100 billion infrastructure financing gap (African Development Bank AfDB 2025) calls for innovative financing strategies, especially resource-backed models. Resource-for-Infrastructure (RFI) agreements allow countries to exchange future mineral revenues or production for upfront infrastructure development. Guinea's $15 billion Simandou deal and Angola's oil-backed RFI arrangements with China have successfully financed large-scale infrastructure through mineral leverage (Samb 2022).

For Nigeria, RFI models can be particularly useful in unlocking investments in underdeveloped mineral regions like Kogi (iron ore), Nasarawa (lithium, barite), and Zamfara (gold). However, such deals require strong legal frameworks and risk management protocols. The Debt Management Office (DMO), in partnership with MMSD, should lead the drafting of legislation to guide RFI agreements, ensuring transparency, environmental safeguards, and fiscal sustainability. Pilot projects should focus on non-oil minerals to diversify the national resource portfolio and avoid the pitfalls of oil dependency.

Strengthen institutional coordination and governance

One of the most pervasive barriers to mining-linked infrastructure in Nigeria is institutional fragmentation. Ministries

such as Mines and Steel Development, Works and Housing, Finance, and Trade and Investment often operate in silos, leading to duplication, delays, and stalled projects. According to the ICRC (2023), over 40% of mining-related PPPs approved between 2010 and 2023 failed to reach financial close due to less inter-agency coordination.

To overcome this challenge, Nigeria should establish a Mining Infrastructure Coordination Unit (MICU) under the Presidency or the National Planning Commission. The unit would integrate planning between federal ministries, state governments, and private actors, while fast-tracking project approvals and resolving jurisdictional conflicts. South Africa's Presidential Infrastructure Coordinating Commission (PICC) provides a replicable model for aligning transport, energy, and mining infrastructure strategies (Transnet, 2021). MIREMCOs must also be revitalised to ensure state-level participation and environmental oversight.

Promote local content and downstream infrastructure

For mining to serve as an engine of industrialisation, Nigeria must go beyond raw mineral exports and invest in local beneficiation and manufacturing capacity. Currently, Nigeria imports over 60% of its barite for oil drilling due to limited local processing and logistics (Ebunu et al. 2021). Similarly, lithium and other critical minerals needed for the energy transition are being exported in unprocessed forms, missing significant value addition opportunities (Bankole et al. 2026). Nigeria could adopt policies that link infrastructure provision to local content development. Rwanda's success in mandating in-country tantalum processing has led to the establishment of multiple smelters and jobs (Cook and Mitchell 2014). Nigeria can replicate this by offering tax incentives, power subsidies, and concessional land for investors who establish processing plants in mining industrial parks or Special Economic Zones (SEZs). By building power, water, and transport links within these zones, Nigeria can nurture competitive mineral-based industries and reduce dependence on imports.

Concluding remarks and recommendations

From a deep critical analysis perspective, the study explicitly covers uncertainties, boundary conditions, and an evaluation agenda that allows the proposed mineral–infrastructure framework to be tested rather than assumed. Mineral endowment estimates and corridor prioritisation rely on the quality of geological and production data. While national exploration programmes and the planned geodata repository can improve transparency, current coverage remains uneven, and informal production is substantial, implying that corridor demand forecasts can be biased if based only on formal output. National infrastructure statistics mask local variability in road condition, grid reliability, and water availability, so feasibility should be anchored to site-specific diagnostics and updated as new audits and geospatial layers become available. Political economy constraints introduce non-technical failure modes. Intergovernmental competition over revenues and land control can delay right-of-way approvals and create conflicting levies that disrupt cash flows; policy instability can raise the discount rate applied by investors; and vested interests may resist formalisation because smuggling and informality generate rents.

Security conditions are also not exogenous: intensified extraction can attract armed actors and magnify grievances if benefits are uneven, so stabilisation and community benefit governance should be treated as integral parts of corridor design, not parallel activities. Environmental and social trade-offs must be acknowledged as determinants of implementability. Corridors and processing hubs can accelerate land conversion, affect watersheds, and displace livelihoods; without credible ESIAs, cumulative impact management, and grievance redress, projects can become legally stalled or socially contested even when economically attractive. Given these uncertainties, a staged pathway is the most defensible conclusion. Early reforms that reduce transaction costs, like digitised and time-bound licensing, improved dispute resolution for overlapping rights, strengthened inspectorate capacity, and audited CDA delivery, can be framed as prerequisites for scaling capital-intensive investments.

A monitoring and evaluation (M&E) dashboard aligned to the study recommendations, with indicators that capture both outputs and outcomes, is proposed. The indicators include time to process titles; share of titles under dispute; percentage of operators with verified CDA implementation; proportion of mining communities with all-weather access and reliable power; value of minerals processed domestically; and incidence of mining-related conflicts and environmental violations. Where quantitative baselines exist, these can be used to set realistic annual targets and to identify early warning signs of implementation failure. Scenario planning can further operationalise feasibility by stress-testing corridor economics under alternative commodity prices, exchange rates, and security costs, identifying no-regret investments that remain valuable across scenarios. Future research directions can be framed around empirically validating the causal links assumed in the framework: spatial econometric studies that relate infrastructure accessibility to investment and beneficiation; case-comparison of corridor-type projects to identify governance determinants of delivery; and evaluation of formalisation interventions that tie

market access and finance to verified legal status. Recognising this limitations-and-testing agenda can directly answer concerns about advocacy by showing which claims are conditional, what constraints are most binding, and how progress can be measured and falsified over time. This approach converts recommendations into hypotheses that can be iteratively refined.

As can be observed from the study, Nigeria possesses an impressive array of mineral resources distributed across its regions, offering substantial opportunities for economic transformation if effectively integrated with infrastructure development. However, a persistent lack of infrastructure in key mining regions hampers value addition, deters investment, and marginalises rural communities. A strategic understanding of resource distribution is essential to guide regional industrial policy and attract sustainable investment. Addressing infrastructure gaps through public investment, public-private partnerships, and the development of mineral corridors is critical for unlocking the full value of Nigeria's mineral endowment. Furthermore, modern technologies, including robust information systems, centralised database management systems and the like, could also be used to strengthen inter-Ministerial Coordination as well as become instrumental to bridging institutional and policy gaps which tend to undermine mining-linked infrastructural development in Nigeria (Onifade et al. 2024; Zvarivadza et al. 2024).

Nonetheless, the mining sector requires improved institutional coherence, financing, and strong governance frameworks. These systemic barriers have led to limited outcomes in states like Ajaokuta, Zamfara, and Nasarawa, where mining and infrastructure planning are disconnected. Realising the sector's developmental promise requires deep institutional reforms, coordinated policy implementation, innovative financing models, and inclusive governance that integrates the needs and rights of host communities. Without these changes, the vision of mining-driven development will remain unrealised.

To transform mining into a catalyst for inclusive growth and national development, Nigeria must adopt a holistic and strategic approach. This includes enforcing infrastructure commitments in mining licenses, establishing Mineral Development Corridors (MDCs), creating dedicated infrastructure funds, and leveraging regional integration and ESG-aligned finance opportunities. International case studies demonstrate that with strong political will, transparency, and coordinated planning, resource-rich countries can successfully align mining with national development objectives. Nigeria stands at a pivotal moment to transition from being merely mineral-rich to becoming a mining-powered economy. Addressing these governance failures will require institutional reforms that go beyond incremental policy adjustments. To face the governance challenge, the establishment of an independent, technocratic Mineral Infrastructure Development Authority with protected funding and cross-sectoral powers is recommended.

Author contributions Olushola Daniel Eniowo contributed to the conceptualisation of the study, data collection, analysis, and manuscript writing. Moshood Onifade contributed to the study's conceptualisation, supervision, methodology, and revisions of the manuscript. John Adebisi was responsible for reviewing relevant literature and providing valuable insights on infrastructure development. Tawanda Zvarivadza contributed to the integration of comparative case studies and provided expertise in regional integration strategies. Abiodun Ismail Lawal provided critical input in the mining sector's policy context and contributed to the analysis of institutional frameworks. Manoj Khandelwal contributed to the methodological framework, data analysis, and revisions of the manuscript.

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Declarations

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