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# Critical Minerals and Industrial Transformation: Tanzania's Prospects in Electronics and Battery Global Value Chains

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## Abstract

This review examines Tanzania's prospects for moving beyond raw mineral exports and entering higher-value segments of electronics and battery-related global value chains. The analysis is motivated by the country's endowment of critical minerals, including nickel, cobalt, graphite, lithium, and rare earth elements, which are increasingly important in battery systems and advanced manufacturing. Using a narrative review and thematic synthesis of policy, industry, and institutional sources, the paper evaluates realistic entry points for industrial upgrading. The findings suggest that Tanzania is unlikely to enter final electronics assembly in the near term. More feasible opportunities exist in upstream and midstream activities such as battery material refining, graphite processing, and rare earth separation. However, progress is constrained by gaps in refining capacity, technical skills, supplier networks, certification systems, and long-term regulatory credibility. The paper argues that gradual, capability-based industrial upgrading offers a more credible path to industrial transformation than attempts to attract major electronics firms prematurely. It contributes to debates on global value chains and industrial policy by identifying how mineral-rich late-industrializing economies can pursue selective upgrading within technologically complex supply chains.

**Keywords:** Tanzania; Industrial Upgrading; Global Value Chains; Critical Minerals; Electronics Manufacturing; Battery Materials.

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## 1. Introduction

The question of how mineral-rich developing economies can convert natural resource endowments into industrial transformation remains central to development policy (Andreoni & Chang, 2019; Whitfield et al., 2020). For countries such as Tanzania, the issue is no longer simply whether minerals can generate export revenue. It is whether those minerals can become a basis for domestic upgrading, technological learning, and participation in higher-value production systems (Lee et al., 2018; Ponte & Sturgeon, 2014). This is especially important at a time when global demand for battery materials, electronic inputs, and traceable mineral supply is rising, while multinational firms are under growing pressure to diversify sourcing, strengthen supply-chain resilience, and meet more demanding Environmental, Social, and Governance standards (Apple, 2023, 2025a, 2025b; United States Geological Survey [USGS], 2025a).

Tanzania enters this discussion with several structural advantages. The country has a youthful population, a strategically located coastline on the Indian Ocean, and an increasingly visible role in regional transport and logistics networks. With a median age of around 18 years, Tanzania possesses a large potential labor force whose long-term significance extends beyond demography into questions of industrial employment, skills formation, and domestic demand (United Republic of Tanzania [URT] et al., 2022; United Nations, 2022). At the same time, infrastructure investments, including the Standard Gauge Railway and port modernization in Dar es Salaam, signal attempts to address one of the most persistent constraints to industrial development, namely the high cost and unreliability of internal and external logistics (Reuters, 2024; World Bank, 2022a, 2022b, 2023; Ecofin Agency, 2025).

Yet these advantages do not automatically translate into industrial competitiveness. Resource endowment alone does not secure entry into advanced manufacturing networks. Global value chains in electronics and battery systems are shaped by much more than access to minerals. They depend on processing capacity, supplier coordination, stable policy regimes, quality assurance systems, technical labor, certification credibility, and the presence of firms capable of anchoring production ecosystems (Andreoni & Tregenna, 2020). In practice, many late-industrializing economies remain trapped at the level of extraction while higher value activities, including refining, precursor production, component manufacture, and final assembly, remain concentrated elsewhere (Andreoni & Tregenna, 2020; Dinh, 2026).

This review, therefore, asks a narrower and more policy-relevant question: What realistic entry points exist for Tanzania to participate in electronics and battery-related global value chains, and what reforms would be required to support such participation? The study uses Apple Inc. as an illustrative reference point because its supply chain reflects high standards of traceability, recycled content, and third-party assurance (Apple, 2024, 2025b; Government of India, 2025; India Briefing, 2025). However, the core analytical interest is broader. The focus is not on Apple as a firm, but on what contemporary lead-firm requirements reveal about the conditions under which Tanzania might move from commodity extraction toward industrial upgrading. The paper proceeds from the argument that Tanzania's most plausible pathway lies not in an immediate transition to final electronics assembly, but in a sequenced strategy focused on selected upstream and midstream segments. These include battery-grade mineral refining, graphite upgrading, rare earth separation, and the gradual development of supplier-supporting industrial zones. Such a pathway aligns more closely with Tanzania's current capabilities and with the structure of global production systems. It also enables a more grounded assessment of what can be achieved in the medium term, as distinct from longer-term industrial ambitions.

## 2. Relevance to Literature and Contribution to Knowledge

The literature on Global Value Chains (GVCs) and industrial policy has made important progress in explaining how developing economies can integrate into fragmented production systems. Foundational work has shown that participation in GVCs is structured by governance, power asymmetries, and the strategic behavior of lead firms, which shape upgrading opportunities and constraints for latecomer economies (Gereffi et al., 2005; Ponte & Sturgeon, 2014). More recent contributions have gone further, emphasizing that successful industrialization requires not only insertion into value chains but also the development of domestic productive capabilities, local firm linkages, and coordinated industrial policy interventions (Whitfield et al., 2020; Andreoni & Chang, 2019). Yet despite these advances, significant gaps remain in how this literature explains resource-based industrialization pathways, particularly in the context of emerging battery and electronics supply chains.

First, much of the GVC literature has historically focused on manufacturing sectors such as apparel, automotive, and agro-processing, where entry barriers, upgrading trajectories, and firm relationships are relatively well documented. By contrast, the intersection between critical minerals and high-technology value chains remains underexplored. Existing studies acknowledge that natural resources alone do not guarantee industrial upgrading, but they often stop short of specifying how mineral-rich economies can strategically position themselves within technologically complex production systems (Lee et al., 2018). As a result, the literature tends to treat resource-rich countries either as upstream suppliers or as failed industrializers, without sufficiently unpacking the intermediate possibilities that lie between extraction and full-scale manufacturing.

Second, while industrial policy scholarship has increasingly recognized the importance of capability accumulation, coordination, and political economy constraints, it has not consistently translated these insights into sector-specific, value-chain-sensitive strategies. Recent work highlights that industrial policy must address structural interdependencies across sectors and manage competing interests among actors, yet there remains limited guidance on how such policies should be operationalized in emerging industries characterized by high technological thresholds and stringent global standards (Andreoni & Chang, 2019; Xu, 2024). In particular, the literature has not fully resolved how late-industrializing economies can sequence entry into value chains where the most profitable activities are already concentrated in a small number of technologically advanced locations.

This paper contributes to the literature by bridging these gaps in three ways. First, it explicitly connects the critical minerals agenda to the global value chain framework, showing how mineral endowment can be analytically linked to specific nodes of industrial participation rather than treated as a generic comparative advantage. Instead of assuming a linear transition from extraction to manufacturing, the paper identifies concrete upstream and midstream entry points, including battery material refining, graphite upgrading, and rare earth separation, and situates them within the broader architecture of electronics and battery production systems. In doing so, it advances a more granular understanding of how resource-rich economies might engage with technologically complex value chains.

Second, the paper shifts the focus from broad notions of upgrading to a sequenced capability-building approach. While the literature acknowledges that upgrading is not automatic, it often treats it as a general process rather than a staged strategy. This study argues that the feasibility of industrial transformation depends on identifying segments of the value chain that are both technologically accessible and economically viable given existing capabilities. The emphasis on sequencing, rather than immediate convergence with advanced manufacturing hubs, offers a more realistic framework for analyzing late industrialization in resource-rich contexts.

Third, the paper introduces a lead-firm benchmarking perspective as an analytical tool. Rather than treating multinational corporations as direct investment targets, it uses the requirements embedded in their supply chains, including traceability, certification, and sustainability standards, to infer the institutional and productive conditions necessary for participation. This approach extends existing GVC literature by operationalizing lead-firm requirements as measurable thresholds for industrial readiness. It also provides a way to translate abstract concepts such as governance and upgrading into concrete policy-relevant criteria.

Finally, the paper contributes empirically by grounding these arguments in the case of Tanzania, a country that has received relatively limited attention in the GVC and industrial policy literature compared to more frequently studied cases in Asia and parts of Africa. While previous studies have examined upgrading in sectors such as textiles and apparel within Tanzania, they also highlight that outcomes vary significantly depending on value chain structure, policy design, and the distribution of rents (Boys & Andreoni, 2020). Building on this insight, the present study extends the analysis into mineral-based and technology-linked value chains, thereby expanding the empirical scope of the literature.

Taken together, the paper does not challenge the core insights of GVC or industrial policy theory. Rather, it refines them. It shows that the key issue for resource-rich latecomers is not simply whether to participate in global value chains, but where and how to enter them in ways that are consistent with existing capabilities while allowing for gradual upgrading. In doing so, it moves the discussion from general principles to context-specific strategy. That shift, although modest in appearance, addresses a persistent gap between theory and practice in the study of industrial transformation.

## 3. Research Methods

### 3.1 Study Design and Rationale

This paper adopts a narrative review design to examine Tanzania's readiness for industrial upgrading within electronics and battery-related global value chains. A narrative review was selected because the research question spans several domains that do not fit neatly within a single empirical literature (Snyder, 2019). These include mineral endowment, industrial policy, transport infrastructure, mining regulation, workforce development, corporate sourcing standards, and supply-chain governance. The objective was therefore not to estimate a causal effect or to conduct a formal meta-analysis, but to synthesize heterogeneous evidence into an analytically coherent assessment of strategic entry points and policy requirements.

This design also reflects the current state of the evidence. The available literature on Tanzania's mineral sector, logistics improvements, and industrial prospects is fragmented across official reports, legal analyses, feasibility studies, multilateral publications, and corporate disclosures. Bringing these materials together is useful, but it also requires caution. The review is interpretive rather than exhaustive, and the conclusions should be understood as analytical judgments based on the available body of evidence rather than as definitive forecasts.

### 3.2 Scope and Analytical Focus

The review focuses on Tanzania's potential participation in electronics and battery value chains through selected upstream and midstream activities. It does not assume that Tanzania is currently positioned for large-scale final assembly of smartphones or other advanced consumer electronics. Instead, it examines whether the country can build capability in more realistic segments linked to its mineral resource base and its emerging logistics infrastructure. These segments include nickel and cobalt refining, graphite upgrading, rare earth separation, mineral traceability systems, industrial zone development, and workforce preparation for technically demanding processing activities (Geological Survey of Tanzania [GST], 2024; Ministry of Minerals, 2024; Lifezone Metals, 2025a, 2025b; Peak Rare Earths, 2022).

Apple is retained as an illustrative case because its public disclosures provide a visible benchmark for how lead firms structure sourcing requirements, supplier verification, and responsible mineral procurement (Apple, 2023, 2024, 2025a, 2025b). However, the purpose of using Apple is analytical, not predictive. The paper does not claim that Tanzania is on the threshold of hosting Apple's final manufacturing operations. Rather, Apple's sourcing model is used to illuminate the broader standards and ecosystem conditions that shape participation in high-technology supply chains.

### 3.3 Search Strategy

The review drew on three broad categories of material, with the search conducted from February 11 2024 to January 28, 2026. First, it consulted multilateral and institutional reports relevant to industrial development, supply chains, logistics, and mineral markets. Search terms in this category included "Tanzania industrial development," "critical minerals supply chains," "technology sector investment Africa," "high-tech manufacturing Tanzania," "mineral processing policy," "global supply chain standards," and "infrastructure readiness," with attention to documents from the World Bank, United States Geological Survey (USGS), the International Energy Agency, the Organization for Economic Co-operation and Development, the United Nations Economic Commission for Africa, and the African Development Bank.

Second, the review examined Government of Tanzania sources, including publications from the Ministry of Minerals, the Geological Survey of Tanzania, and legal and policy documents relating to mining regulation, industrial development, and labor capacity. Search terms included "Ministry of Minerals Tanzania reports," "Geological Survey Tanzania data," "industrial policy," "national mineral strategy," "regulatory reforms Tanzania," and "workforce development Tanzania."

Third, the review used selected corporate disclosures, feasibility materials, and secondary industry reporting to understand how current supply chains are organized and what kinds of standards are applied in practice. Search terms in this category included "Apple supply chain," "Bloomberg technology investment Tanzania," "Reuters mineral sector Tanzania," "Lifezone Metals feasibility," and "corporate filings Tanzania minerals." These searches yielded materials from Reuters, Bloomberg-oriented reporting, Apple disclosures, Lifezone Metals, and other sector-relevant sources (Apple, 2024, 2025b; Lifezone Metals, 2025a, 2025b; Reuters, 2024).

The strategy aimed to assemble a broad, policy-relevant evidence base. It was not fully systematic in the sense required by a formal scoping or systematic review. Accordingly, the paper does not claim exhaustiveness. Some relevant materials may have been missed, and the weight of evidence varies across source types.

### 3.4 Data Extraction and Thematic Synthesis

The selected materials were read and organized through thematic synthesis. The analysis focused on recurrent themes that bear directly on industrial upgrading. These included Tanzania's mineral and infrastructure base, the material requirements of electronics and battery production, the organizational features of contemporary supply chains, the gap between raw extraction and higher-value participation, binding constraints to upgrading, and feasible short- to medium-term entry points.

These themes were not treated as isolated topics. They were used to build an analytical narrative about capability formation. More specifically, the synthesis assessed where Tanzania currently has a relative advantage, where the main capability gaps lie, and which policy actions appear feasible within different time horizons. This process supports an argument about sequencing. It does not generate quantitative forecasts, nor does it establish causal certainty. What it provides is a structured interpretation of the evidence currently available.

### 3.5 Evidentiary Limits

Several limitations should be recognized from the outset. First, some of the most detailed materials on mining and processing prospects are produced by corporate actors with a commercial interest in project advancement, and such sources may present assets in optimistic terms (Lifezone Metals, 2025a, 2025b; Peak Rare Earths, 2022). Second, institutional and media sources differ in depth, purpose, and reliability, which means that findings must be interpreted comparatively rather than mechanically. Third, the industrial trajectory under discussion is shaped by evolving policy conditions, commodity prices, technology shifts, and geopolitical dynamics, all of which may change faster than the published literature captures. For these reasons, the conclusions offered here should be read as contingent and policy-oriented rather than predictive in a strict sense.

## 4. Analytical Discussion

### 4.1 Tanzania's Resource Position and the Logic of Upgrading

Tanzania possesses a mineral base that is relevant to several segments of electronics and battery value chains. Existing and prospective deposits include nickel, cobalt, copper, graphite, lithium, tin, rare earth elements, gold, and silver, all of which matter in different ways to batteries, conductors, magnets, circuitry, and specialized components (GST, 2024; Ministry of Minerals, 2024; Jenness, 2016; USGS, 2017, 2022, 2025a). This gives the country a potentially important starting point. But a starting point is not the same thing as a competitive position. The distinction matters. In contemporary global production systems, raw material availability is only one layer of industrial participation. Lead firms and their first-tier suppliers typically rely on dense ecosystems of refiners, processors, logistics providers, quality-control laboratories, certification bodies, and technically trained labor (Gereffi et al., 2005; Lee et al., 2018; Ponte et al., 2014). As a result, countries that export unrefined or minimally processed minerals often remain distant from the more profitable stages of the chain (Andreoni & Tregenna, 2020). Tanzania currently fits this pattern more than it escapes it.

**Table 1: Gap Analysis**

| Material / Capability | Apple Use | Principal Processing Locations in Apple's Supply Chain | Tanzania's Position Today | Critical Capability Gap |
|---|---|---|---|---|
| Nickel & Cobalt | Battery cathodes | China, Indonesia | Kabanga (Ni-Co) deposit advancing; Joint Venture with Lifezone Metals | No domestic refining to battery grade |
| Graphite | Battery anodes | China (purification, spheronization and anode production) | Large deposits in Lindi and Morogoro | No anode coating or spheronization facility |
| Rare Earths (REEs) | Magnets (speaker, camera, haptics) | China (separation and magnet manufacturing) | Ngualla Bankable Feasibility Study complete | No REE separation or magnet manufacturing |
| Copper, Tin, Gold | Conductors, soldering, circuitry | Global network of smelters and component manufacturers | Already mined locally | No advanced copper processing or electronics component manufacturing |

| | | | | |
|---|---|---|---|---|
| Lithium | Battery chemistry | China (processing); Australia, Chile and Argentina (major upstream supply) | Early-stage exploration (Morogoro basin) | No beneficiation or battery precursor production |
| Electronics Manufacturing (EMS) | Assembly of iPhone components | China, India and Vietnam | Nascent electronics ecosystem | No Tier-1 EMS anchor or supplier park |
| Workforce & Policy | Supply chain reliability | Mature industrial ecosystems | Expanding industrial workforce; evolving regulatory framework | Specialized technical labour and long-term policy stability framework |

**Sources:** Apple (2024); Ecofin Agency (2025); Lifezone Metals (2025a, 2025b); Ministry of Minerals (2024); Peak Rare Earths (2022); Reuters (2024).

Projects such as Kabanga and Ngualla are significant in this regard because they indicate that Tanzania is not devoid of strategic assets. Kabanga has been presented as a major nickel-cobalt project with increasing commercial visibility, while Ngualla has advanced through bankable feasibility work and remains central to discussions of rare earth processing potential (Lifezone Metals, 2025a, 2025b; Peak Rare Earths, 2022). Still, the presence of such projects does not in itself resolve the central development challenge. What matters is whether these assets can be linked to domestic processing, technological learning, and institutional arrangements that retain more value inside the country. Table 1 compares the materials Apple relies on for the iPhone with Tanzania's current production stage, highlighting the missing link between raw mineral extraction and supply-chain integration.

### 4.2 Infrastructure Improvements Matter, but They Do Not Eliminate Capability Gaps

Recent logistics developments improve Tanzania's position, particularly when viewed from the perspective of bulk mineral transport and export competitiveness. The inauguration of the 541-km Standard Gauge Railway section between Dar es Salaam and Dodoma, together with freight operations and port modernization efforts, reduces some of the transport disadvantages that have historically constrained industrial expansion (Reuters, 2024; World Bank, 2022a, 2022b; Ecofin Agency, 2025). For an economy seeking to build mineral-processing capacity, this is important. Refining and precursor production require reliable movement of inputs, outputs, machinery, and intermediate goods.

Even so, logistics upgrades should not be mistaken for full industrial readiness. Moving minerals more efficiently is not equivalent to producing battery-grade sulphates, spherical coated graphite, separated rare earth oxides, or precision electronics inputs. Those activities require processing technology, stable electricity, environmental compliance systems, specialized engineering skills, and a policy environment that reduces uncertainty over long investment horizons. Infrastructure is therefore enabling, but not sufficient.

### 4.3 Why Final Electronics Assembly Is an Unrealistic Immediate Goal

One of the conceptual weaknesses in many industrial policy discussions is the tendency to conflate very different stages of production (Andreoni & Chang, 2019). Mineral extraction, mineral refining, precursor preparation, component production, and final electronics assembly do not require the same capabilities (Gereffi et al., 2005; Baldwin, 2016). They also do not present the same barriers to entry (Humphrey & Schmitz, 2002; Lee et al., 2018). In Tanzania's case, the evidence suggests that immediate participation in final smartphone assembly is far less realistic than entry into selected upstream or midstream segments.

Public information on Apple's supply chain and broader electronics manufacturing patterns illustrates this point clearly. Midstream processing and final assembly remain concentrated in locations with mature supplier clusters, specialized labor pools, tested quality systems, and stable incentive regimes, particularly China and increasingly India (Apple, 2024; Government of India, 2025; India Briefing, 2025; Reuters, 2024). Firms do not typically relocate these activities simply because a mineral-producing country seeks industrialization. They relocate or expand when a broader ecosystem already exists or when state policy has made such an ecosystem credible over time.

This suggests that Tanzania's most realistic ambition is not to position itself as an immediate final assembly location for consumer electronics. It is to build competitive capability in those earlier stages where mineral endowment offers a genuine foothold and where the gap between current capacity and required capacity, though still substantial, is narrower.

### 4.4 Realistic Entry Points in the Electronics and Battery Ecosystem

Several entry points emerge from the evidence. The first is battery materials refining, particularly in nickel and cobalt. Tanzania's relevance here is tied above all to Kabanga and to the broader global demand for battery materials used in energy storage and electronics (Lifezone Metals, 2025a, 2025b). Yet the current gap remains stark. Deposits alone do not place a country in the cathode materials chain. What is missing is domestic refining to battery grade, together with the commercial, environmental, and technical systems needed to make such refining investable.

The second entry point is graphite upgrading. Tanzania has large graphite deposits, including in Lindi and Morogoro, but the absence of anode coating and spheronization capacity means that the country remains outside the more valuable stages of battery anode production. This is precisely the kind of gap that industrial policy could target, provided feasibility, energy cost, environmental safeguards, and demand linkages are assessed carefully.

A third, more technically demanding possibility is rare earth separation. Ngualla has long been cited as a major rare earth project, and its relevance to magnets used in electronics makes it strategically significant (Peak Rare Earths, 2022). However, rare earth separation is neither simple nor institutionally neutral. It is capital-intensive, environmentally sensitive, and dependent on exacting technical standards. This makes it a plausible but more cautious medium-term target, rather than an easy policy win.

Across all three areas, the main message is the same. Tanzania's opportunity lies in selective upgrading, not generic industrial ambition. The country cannot enter every part of the chain at once, and it should not pretend otherwise.

### 4.5 The Regulatory Question is Central

The regulatory framework plays a decisive role in whether industrial upgrading remains rhetorical or becomes credible. Tanzania's mining regime, including provisions relating to free carried interest, state participation, and local content, signals an effort to ensure that national interests are embedded in resource development (Clyde & Co., 2022, 2024; FB Attorneys, 2022; Tanzania Legal Information Institute, 2019/2025). The developmental rationale is understandable. Countries rich in strategic minerals have legitimate reasons to seek stronger domestic returns. The difficulty lies not in the existence of such provisions alone, but in how predictably and transparently they are administered. Large-scale processing investments require long planning horizons, often stretching well beyond a decade. Investors, therefore, assess not only tax rates and ownership rules, but also the stability of interpretation, the credibility of dispute resolution, and the likelihood of policy reversals. In this respect, the issue is less whether Tanzania's framework is too interventionist in the abstract, and more whether it can provide sufficient certainty to support capital-intensive industrial activity.

### 4.6 Apple as Benchmark, Not Forecast

The paper placed Apple at the center of the discussion. Apple's public commitments on recycled cobalt, recycled rare earths, smelter and refinery disclosure, and supply-chain auditing are useful precisely because they reveal how demanding high-end technology supply chains have become (Apple, 2023, 2025a, 2025b). They show that participation now depends not only on having minerals but on demonstrating traceability, responsible sourcing, and process discipline. That said, Tanzania should not build policy around the expectation that Apple itself will establish direct operations in the country in the near term. The more realistic interpretation is that firms like Apple define an upper-bound standard. If Tanzania can move closer to those standards through domestic capability building, it may gradually become more attractive not only to such firms but also to a wider range of processors, component manufacturers, and industrial intermediaries operating within related value chains.

## 5. Conclusion

This review has argued that Tanzania's industrial opportunity lies not in the immediate attraction of marquee electronics firms, but in the more demanding and more realistic task of building capability in selected upstream and midstream segments of electronics and battery value chains. The country possesses a meaningful mineral base and has made visible progress in logistics infrastructure. Those conditions matter. They create a platform from which industrial upgrading can be discussed seriously. Yet they do not, on their own, establish competitiveness.

The key challenge is that global value chains reward coordinated capability rather than raw resource availability. Refining capacity, traceability systems, technical labor, industrial utilities, certification credibility, and regulatory predictability are all part of the same equation. Tanzania's current position suggests potential, but also distance from the production nodes where the greatest value is captured. In that sense, the central development question is not whether the country has strategic minerals. It does. The more difficult question is whether it can transform those assets into a coherent industrial base. The evidence reviewed here suggests that such a transition is possible only if it is sequenced carefully. Battery material refining, graphite upgrading, and, in time, rare earth separation appears to be more plausible entry points than final consumer electronics assembly. This is a narrower vision than the one often implied in public-facing industrial rhetoric, but it is also a more credible one. A disciplined strategy focused on feasible nodes of participation is more likely to generate learning, attract serious investment, and deepen domestic value addition over time.

Beyond its country-specific findings, this review contributes to the industrial policy and global value chain literature by demonstrating the value of evaluating industrial opportunities through a sequenced, capability-based lens rather than through resource endowment alone. It argues that industrial transformation in resource-rich economies is better understood as a process of identifying feasible entry points that align existing capabilities with the technological and governance requirements of contemporary production networks. In doing so, the paper extends existing discussions on industrial upgrading by providing an analytical framework for assessing where late-industrializing economies can participate realistically within electronics and battery value chains, rather than assuming that resource abundance will naturally lead to higher-value manufacturing.

## 6. Recommendations

### 6.1 Strategic Orientation

A credible industrial strategy for Tanzania should begin by identifying contestable segments of the value chain rather than aspirational end-states. The priority should not be to announce an ambition to become an electronics assembly hub in the near term. It should be to build capability where mineral endowment, logistics improvements, and policy leverage overlap (Lifezone Metals, 2025a, 2025b; Peak Rare Earths, 2022; USGS, 2022, 2025a). In practical terms, this means prioritizing battery material refining, graphite upgrading, and selected mineral-processing activities that can serve wider industrial markets before attempting to target final branded electronics production.

### 6.2 Industrial Policy and Infrastructure Coordination

Industrial policy will need to be more selective than general. Establishing processing zones along rail-linked corridors may be useful, but only if such zones are backed by reliable electricity, water, customs efficiency, environmental permitting capacity, and investor confidence regarding long-term operating conditions. Tax incentives alone will not be enough. What matters is the alignment of infrastructure, regulation, and sector targeting. Without that coordination, industrial zones risk becoming symbolic rather than productive (World Bank, 2022a, 2022b, 2023; Reuters, 2024; Ecofin Agency, 2025).

### 6.3 Regulatory Credibility

The mining and industrial framework should be administered in ways that preserve national developmental objectives while reducing uncertainty for long-horizon investors. Provisions relating to free carried interest, state participation, and local content can coexist with investment if they are implemented transparently and predictably (Clyde & Co., 2022, 2024; FB Attorneys, 2022; Tanzania Legal Information Institute, 2019/2025). What investors in refining and processing require most is not necessarily deregulation, but clarity. A stable interpretation of rules, credible contractual enforcement, and consistent permitting practices are all central to whether Tanzania is viewed as a serious location for capital-intensive industrial activity.

### 6.4 Workforce and Institutional Capacity

No mineral-based industrial strategy can advance far without technical skills (UNIDO, 2024). Tanzania should therefore treat workforce development not as a social supplement to industrialization, but as one of its core productive foundations. Partnerships between government, higher learning institutions, technical colleges, and private investors will be necessary to build competence in metallurgy, chemical processing, industrial maintenance, metrology, environmental management, and supply-chain assurance (Clyde & Co., 2022, 2024; FB Attorneys, 2022; Government of India, 2025; Reuters, 2024; World Bank, 2022a). This is slow work. But without it, higher-value participation will remain dependent on imported expertise and externally managed operations.

### 6.5 Near-Term Priorities

In the near term, the most realistic policy gains are likely to come from actions that improve credibility and reduce uncertainty. These include strengthening geological and project information, clarifying rules governing mineral processing and state participation, improving energy and logistics planning for industrial users, and assessing the commercial feasibility of pilot-scale graphite or mineral-processing facilities linked to advanced domestic projects. Early progress in these areas would not by itself transform Tanzania's position in global value chains. It would, however, signal seriousness and create a more concrete basis for subsequent investment decisions (Ministry of Minerals, 2024; GST, 2024; Peak Rare Earths, 2022; World Bank, 2022a).

### 6.6 Risk Management

The transition from extraction to industrial upgrading is exposed to significant risks, including commodity price volatility, project delays, policy inconsistency, environmental disputes, and weak local linkages. These risks cannot be eliminated, but they can be managed more effectively through phased investment strategies, transparent review processes, stronger environmental and social governance systems, and early adoption of traceability and auditing mechanisms that anticipate the requirements of internationally exposed supply chains (Apple, 2025a, 2025b; Clyde & Co., 2022; Tanzania Legal Information Institute, 2019/2025). The relevant policy objective is therefore not to promise a frictionless industrial transition. It is to create conditions under which risk becomes governable rather than prohibitive.

## 7. Limitations of the Study

This study is limited by the nature of the evidence on which it relies. As a narrative review, it synthesizes published reports, legal materials, institutional publications, feasibility documents, corporate disclosures, and selected secondary reporting rather than primary field data or original quantitative analysis. The result is useful for strategic interpretation, but it cannot substitute for empirical investigation of investor behavior, cost structures, local firm capability, or plant-level feasibility. Based on this, the study recommends that future studies integrate stakeholder interviews with quantitative assessments to quantify investment costs, energy requirements, and expected economic returns, thereby validating the proposed industrial pathways.

The source base is also uneven. Some documents, particularly feasibility and project materials, are produced by firms with direct commercial interests in advancing investment narratives, while media and institutional sources vary in depth and emphasis. In addition, the global industries discussed here are changing rapidly. Shifts in battery chemistry, commodity prices, geopolitics, trade policy, and lead-firm sourcing practices may alter the relevance of specific opportunities over time. For these reasons, the conclusions should be read as analytically grounded but contingent. They identify plausible pathways, not guaranteed outcomes.

The study also acknowledges comparative analysis as an important direction for future research. A comparative analysis of mineral beneficiation strategies across countries would indeed provide additional insights into alternative industrialization pathways. However, the primary objective of this manuscript is to evaluate Tanzania's readiness and identify realistic entry points into electronics and battery-related global value chains, rather than to undertake a comparative cross-country analysis.

## 8. Competing interests

The authors declare that no competing interests exist.

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