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STRATEGIC AND CRITICAL MINERALS: A SWOT ASSESSMENT OF BRAZIL'S COMPETITIVENESS IN DOMESTIC AND INTERNATIONAL MARKETS

MINERAIS ESTRATÉGICOS E CRÍTICOS: ANÁLISE SWOT DA COMPETITIVIDADE DO BRASIL NO CENÁRIO NACIONAL E INTERNACIONAL

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ABSTRACT

This study examines the SWOT Matrix as a strategic management tool to support senior managers and decision-makers in assessing Brazil's use of Strategic and Critical Minerals, enabling them to evaluate the country's position within an increasingly competitive mineral geopolitics landscape. The study presents the concepts, definitions, and functionalities of the SWOT Matrix; characterizes the national context and the international outlook of these mineral resources; and assesses Brazil's competitiveness based on the strategies identified through SWOT Analysis. A qualitative research approach was adopted to evaluate Brazil's competitiveness regarding Strategic and Critical Minerals. The methodological procedures consisted of a literature and documentary review, involving the consultation of sources classified into three categories: (1) sources addressing the definitions, concepts, and functionalities of the SWOT Matrix; (2) sources characterizing the national context and the current international landscape of Strategic and Critical Minerals; and (3) sources assessing Brazil's competitiveness concerning these highly relevant mineral resources for the twenty-first century. The findings indicate that Brazil possesses significant potential to emerge as a major international player in the industrialization and value-added processing of its mineral resources, provided that appropriate strategies and timely action plans are developed based on the continuous monitoring of the four dimensions of the SWOT Matrix.

Keywords: Strategic Minerals; Critical Minerals; Brazil; SWOT Matrix; Competitiveness; National Context; International Landscape.

RESUMO

Este trabalho aborda a Matriz SWOT como ferramenta de gestão estratégica a ser utilizada por gestores e decisores de alto nível

quanto ao uso, pelo Brasil, dos Minerais Estratégicos e Críticos, permitindo-lhes avaliar o posicionamento do país ante uma geopolítica mineral competitiva. Apresenta os conceitos, definições e funcionalidades da Matriz SWOT; caracteriza a conjuntura nacional e o panorama internacional destes recursos minerais; e avalia a competitividade do Brasil em função das estratégias estabelecidas pela Análise SWOT. Esta pesquisa adotou uma abordagem qualitativa para mensurar a competitividade brasileira no tocante aos Minerais Estratégicos e Críticos. O procedimento utilizado foi a revisão da literatura e documental, que envolveu a consulta a fontes classificadas em três categorias: (1) fontes que apresentassem as definições, conceitos e funcionalidades da Matriz SWOT; (2) que caracterizassem a conjuntura nacional e o atual panorama internacional dos Minerais Estratégicos e Críticos; e (3) fontes que avaliassem a competitividade do Brasil no tocante a estes recursos minerais tão importantes neste século XXI. Os estudos apontaram o quanto o país teria a capacidade de despontar-se como um importante ator internacional na industrialização de seus recursos minerais, desde que estabelecesse adequadas estratégias e oportunos planos de ação decorrentes do monitoramento contínuo dos quatro quadrantes da Matrix SWOT.
Palavras-chave: Minerais Estratégicos; Críticos; Brasil; Matriz SWOT; Competitividade; Cenário nacional; Panorama internacional.

1. INTRODUCTION

The twenty-first century has been marked by profound economic and technological transformations occurring at a pace unimaginable only a few decades ago. The Fourth Industrial Revolution (Industry 4.0) has introduced numerous innovations that have benefited modern societies through a wide range of

equipment, materials, products, goods, and services derived from disruptive technologies.

In the contemporary era, humanity has gained access to transportation systems, telecommunications networks, and healthcare services capable of significantly improving quality of life. The speed at which these innovations are introduced into the market illustrates the extent to which scientific and technological progress has contributed to social and economic development worldwide.

Conversely, climate change, driven by global warming and the increasing concentration of greenhouse gases in the atmosphere, has prompted societies to reassess prevailing development models and implement measures that prioritize renewable energy sources over fossil fuels. Governments and industries across all continents have incorporated the energy transition into the global agenda. As a result, sustainable development emerged as a central priority within the international community, integrating economic growth, social inclusion, and environmental stewardship.

A common element underlying these industrial, economic, technological, and digital transformations is the set of mineral resources that make such advances possible. These resources are indispensable inputs in the production chains of goods and services. Numerous chemical elements of the Periodic Table have acquired extraordinary importance in the transformations characterizing contemporary society. Although mineral resources had already played a prominent role during the First Industrial Revolution in eighteenth-century England, their strategic relevance has become even more significant in the modern era.

However, the fundamental difference between the use of mineral resources today and in previous historical periods lies in the technological sophistication applied to their extraction, processing, and utilization, which substantially increases their added value. Achieving this technological frontier has required sustained investments in research and development, enabling certain countries to position themselves at the forefront of the scientific, technological, and industrial competition that defines the twenty-first century.

It is therefore not surprising that several countries have classified specific minerals as strategic and critical according to their national priorities and criteria. The growing importance of these resources has contributed to the consolidation of global supply chains, stimulated investments, strengthened international partnerships, and, in some cases, reshaped geopolitical dynamics.

As a consequence of shifts in the global balance of power associated with strategic and critical minerals, the formulation of strategic plans and action frameworks by governments, mining companies, and industrial sectors has become increasingly important. Such initiatives seek to secure supply chains, ensure export competitiveness, guarantee access to imports, and support industrial production processes involving manufactured and semi-manufactured goods.

In this context, an important question arises: how can strategic planning, risk management, market intelligence generation, and timely decision-making related to mineral industrialization be effectively assessed in such a dynamic and complex environment?

One management tool that has gained widespread recognition in the field of strategic management is the SWOT Matrix. Accordingly, this study employs SWOT analysis as a framework for examining Brazil's position regarding strategic and critical minerals, providing a comprehensive perspective on the country's current situation and supporting the identification of pathways for the effective management of its mineral wealth.

Regarding the methodological approach, this study adopts a qualitative perspective. The investigation was based on bibliographic and documentary research, encompassing national and international publications, scientific articles, reports from Brazilian governmental agencies, documents issued by international organizations and multinational institutions, as well as information obtained from authoritative online sources. The consultation and consolidation of these materials enabled the identification of the key issues addressed in this research.

The general objective of this study is to analyze Brazil's competitiveness in the national and international strategic and critical minerals sectors through the application of the SWOT Matrix. Based on this analysis, the study seeks to provide insights for political, economic, scientific, and technological institutions regarding how Brazil may strengthen its competitive advantages in the management of its mineral resources in response to the challenges and opportunities of the twenty-first century.

To achieve this objective, the specific objectives are: to present the concepts, definitions, and applications of the SWOT Matrix; to characterize Brazil's domestic landscape concerning strategic and critical minerals; to examine the current international scenario

involving these mineral resources; and to assess Brazil's competitiveness in the twenty-first century through the lens of SWOT analysis.

To accomplish these objectives, the article is organized into four sections that provide a comprehensive analysis of strategic and critical minerals and their implications for Brazil's competitiveness at both the national and international levels. The first section, Introduction, presents the central theme of the study. The second section, Methodology, describes the research approach and the procedures adopted for data collection and analysis. The third section, Theoretical Framework, discusses the concepts, definitions, and applications of the SWOT Matrix, characterizes the national and international contexts of strategic and critical minerals, and evaluates Brazil's competitiveness regarding these resources.

Finally, the Conclusions section synthesizes the principal findings of the research and offers insights for political, economic, scientific, and technological institutions on how Brazil may strengthen its competitive advantages in the management of its mineral resources amid the evolving scenarios of the twenty-first century.

2. THEORETICAL FRAMEWORK

This theoretical framework is organized into four subsections. The first presents the definitions, concepts, and applications of the SWOT Matrix. The second characterizes Brazil's domestic landscape regarding Strategic and Critical Minerals. The third examines the international context of these mineral resources. The fourth and final subsection evaluates Brazil's competitiveness based on its

opportunities, capabilities, and constraints in the management of Strategic and Critical Minerals in the twenty-first century.

2.1. Concepts, Definitions, And Applications Of The SWOT Matrix

The SWOT Matrix is a widely recognized strategic management tool developed by Albert Humphrey in the 1960s. It comprises four analytical dimensions: strengths and weaknesses, which are associated with the internal environment and are generally subject to organizational control, and opportunities and threats, which arise from the external environment and therefore remain beyond direct organizational control (Leite; Gasparotto, 2018).

The intrinsic characteristics of an organization, represented by strengths and weaknesses, together with the extrinsic factors, represented by opportunities and threats, constitute the foundation of the SWOT framework.

This analytical model reflects perceptions of the environments in which an organization operates, enabling the assessment of its strategic position within a given context and supporting more effective organizational diagnosis and decision-making processes (Fernandes, 2015).

Table 1. SWOT Matrix

Internal Environment	**Strengths**	**Weaknesses**
	Identify and Relate	Identify and Relate
External Environment	**Opportunities**	**Threats**
	Identify and Relate	Identify and Relate

Source: Baptista (2014).

Thus, the role of SWOT Analysis is to define strategies and action plans aimed at strengthening organizational strengths, eliminating or mitigating weaknesses, capitalizing on opportunities, and neutralizing potential threats. After completing the SWOT Matrix (Table 1), it becomes possible to consolidate the organization's key characteristics.

For this reason, SWOT Analysis is recognized as one of the most widely used and effective tools in strategic planning, as it establishes a connection between the organization's resources and its business environment (Ribeiro; Forte, 2020; Vieira; Morandi, 2021; Souza; Marinho; Sartori, 2022 apud Ribeiro, 2024).

As previously mentioned, the matrix is part of a set of management tools whose analytical approach integrates the organization's internal and external dimensions, identifying priorities for intervention and supporting the development of action plans by senior management (Araújo et al., 2015 apud Leite; Gasparotto, 2018).

When constructing the matrix, the variables are cross-analyzed, facilitating their interpretation and providing support for decision-making processes, which are essential for assessing competitive scenarios and developing strategic initiatives (Silveira, 2011).

This is why SWOT Analysis is considered a crucial instrument for quality management across different types of organizations, as it offers a simplified and comprehensive overview of the enterprise's current situation.

2.1.1. Internal Environment Analysis (Strengths And Weaknesses)

Strengths are internal characteristics of an organization that can generate competitive advantages over competitors or the market, as they represent distinctive capabilities that support the achievement of organizational objectives (Freitas, 2012 apud Leite; Gasparotto, 2018). They also encompass the resources, competencies, and attributes that enable an organization to face market challenges, competitors, and operational difficulties, while remaining as differentiated as possible from rival organizations. Strengths are understood as factors that remain under the direct control of the organization and can simultaneously be employed to influence the external environment (Fernandes, 2015).

Weaknesses, in turn, are internal characteristics that require control and improvement, as they may place the organization in a vulnerable position when compared to its competitors, thereby hindering the achievement of established objectives (Freitas, 2012 apud Leite; Gasparotto, 2018). They represent areas in which the organization perceives itself as fragile, regardless of the cause or nature of the limitation. Weaknesses may constitute obstacles that constrain business performance and market positioning; however, they are generally factors that can be reversed, minimized, or corrected, given that they remain within the organization's sphere of control (Fernandes, 2015).

In other words, weaknesses restrict or prevent the attainment of positive organizational outcomes due to bottlenecks, deficiencies, and operational limitations, thereby requiring corrective measures to ensure the accomplishment of strategic objectives.

2.1.2. External Environment Analysis (Opportunities And Threats)

The external environment of an organization comprises factors over which managers and entrepreneurs have little or no direct control, being represented by uncontrollable variables. Opportunities may create favorable conditions and stimulate business growth, whereas threats may negatively affect organizational activities and performance (Moura, 2014 apud Leite; Gasparotto, 2018).

Within this perspective, organizations are required to continuously monitor the external environment, identifying opportunities capable of contributing to long-term sustainability and organizational growth, while simultaneously detecting threats that may substantially harm business operations if they materialize and their negative effects cannot be adequately mitigated (Fernandes, 2015).

Threats exert negative impacts on business performance, directly affect organizations, and generally cannot be controlled. Consequently, they may result in losses in market positioning, competitiveness, and organizational performance (Lima, 2016 apud Leite; Gasparotto, 2018). Finally, the external environment encompasses the marketplace, which undergoes continuous transformation as a consequence of changing customer preferences and broader societal developments. It is important to note that both opportunities and threats affect organizations within the same competitive environment; however, their impacts vary according to the level of preparedness, adaptability, and strategic response capacity demonstrated by each organization in the face of market competition (Fernandes, 2015).

2.1.3. SWOT Matrix Functionalities

Strategic Planning has become firmly established within the business environment, emerging as a highly valuable managerial tool that enables decision-makers to project future scenarios with greater accuracy. Executives increasingly recognize that the business environment is influenced, to varying degrees, by numerous internal and external variables. Consequently, Strategic Planning has become an essential instrument for preparing organizations for future challenges, enabling them to address uncertainties while capitalizing on market opportunities (Fernandes, 2015).

Within the Strategic Planning process, the primary functionality of the SWOT Matrix is to integrate Strengths with Opportunities, Strengths with Threats, Weaknesses with Opportunities, and Weaknesses with Threats simultaneously (Kloc, 2012 apud Leite; Gasparotto, 2018). This integration is typically developed through three successive stages. The first stage consists of identifying and cataloging all relevant internal and external environmental characteristics (Table 1). The second stage involves cross-analyzing these factors, resulting in the construction of the SWOT Matrix itself. The third and final stage comprises the examination of the intersection points among the identified factors, generating strategic actions that are subsequently incorporated into an action plan and broader strategic planning framework (Campos, 2016).

Table 2. SWOT Matrix Analysis

		External Environment Analysis	
		Opportunity (Leverage)	**Threat (Neutralize)**
Internal Environment Analysis	**Strength (Enhance)**	Maximize Maximize	Minimize Maximize
	Weakness (Eliminate)	Maximize	Minimize
		Minimize	Minimize

Source: Silveira (2011) and Baptista (2014).

According to Silveira (2011), this simultaneous integration (Table 2) would provide the following strategic configurations: a. Strengths–Opportunities: maximizing the organization's strengths to fully capitalize on identified opportunities; b. Strengths–Threats: leveraging organizational strengths to minimize the effects of identified threats; c. Weaknesses–Opportunities: developing strategies that reduce the negative effects of weaknesses while taking advantage of emerging opportunities; d. Weaknesses–Threats: formulating strategies aimed at minimizing weaknesses as much as possible while effectively addressing existing threats.

Based on these relationships, it becomes possible to formulate strategies and action plans to be adopted by the organization. Not surprisingly, the results derived from these interactions may demonstrate the organization's level of preparedness to face its desired future scenarios (Fernandes, 2015). Understanding how to integrate the four quadrants of the matrix enables organizations to minimize risks and anticipate challenges arising from both internal and external environments. Therefore, it can be partially concluded that SWOT Matrix analysis provides a broader understanding of both the organization and its market environment, contributing to more informed, timely, and reliable decision-making. Consequently, the primary purpose of this study is to address the following research question: considering the functionalities, benefits, and advantages offered by the SWOT Matrix, what is the current level of Brazil's

competitiveness, both nationally and internationally, regarding Strategic and Critical Minerals?

2.2. National Context Of Strategic And Critical Minerals

The importance of metallic substances in the Brazilian mining industry dates back to the Colonial period. The expeditions of the *bandeirantes* in search of precious metals during the seventeenth and eighteenth centuries established new routes for the occupation of Brazil's interior and culminated in the exploitation of gold deposits, initially concentrated in the region of Minas Gerais. As territorial occupation expanded westward beyond the Tordesillas Meridian and geological knowledge advanced, new metallic mineral deposits were discovered and consolidated, increasing the relevance of substances such as manganese and iron. These discoveries had a significant impact on the national economy and played a fundamental role in fostering Brazil's industrialization process (ANM, 2024). In the twenty-first century, mining has become firmly established as an economic pillar, driven by the growing global demand for mineral commodities. Its contribution to the Gross Domestic Product (GDP) has remained significant, accounting for approximately 2.4% in 2023 (IBRAM, 2024 apud Santos, 2025).

As a result of the territorial foundation largely consolidated during the eighteenth century, the Brazilian mining sector represents an important source of foreign exchange earnings for the country's trade balance. In 2020, the sector generated a trade surplus of US$ 28 billion, corresponding to 54% of the overall positive trade balance of the Brazilian economy (Brasil, 2025). In 2024 alone, Brazil's trade balance for strategic mineral products reached US$ 31.93 billion, as the surplus generated by the Mineral Extractive Industry (US$ 34.14

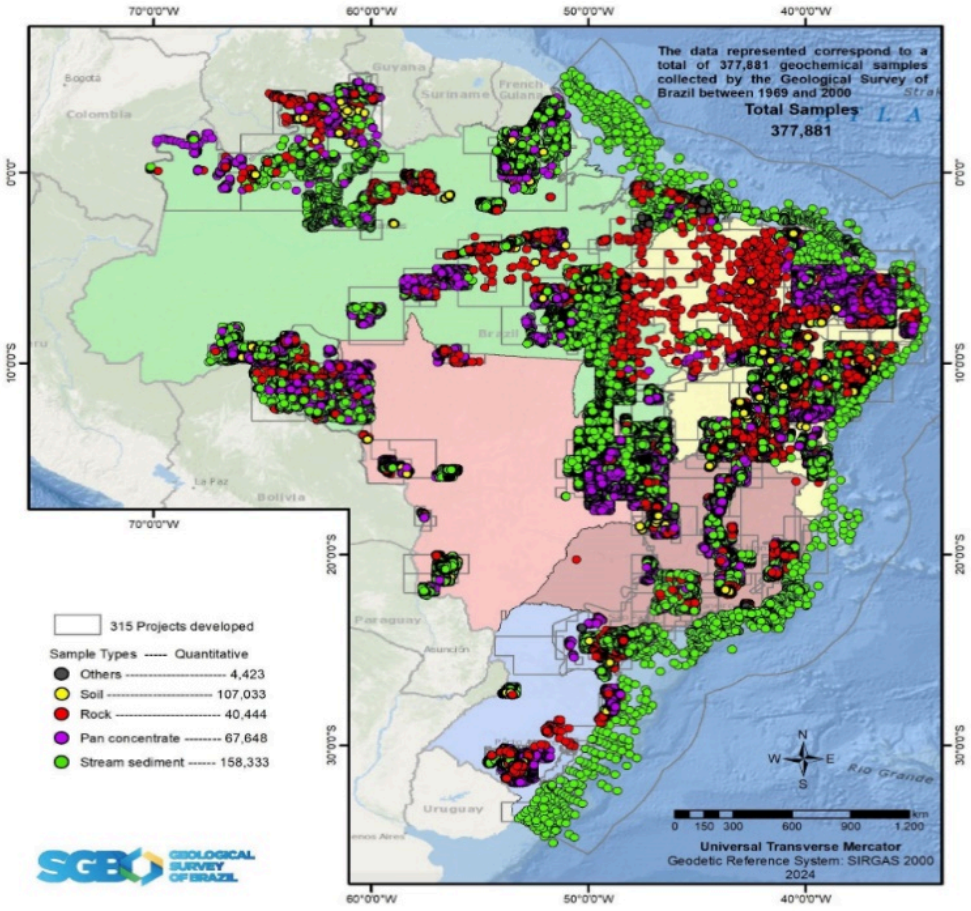
billion) offset the US$ 2.21 billion deficit recorded by the Mineral Processing Industry (Bezerra, 2025).

In addition to niobium, a sector in which the Brazilian Mining and Metallurgical Company maintains global leadership, the country possesses proven reserves of rare earth elements, vanadium, tantalum, bauxite, and graphite, among others. The development of these deposits would enable Brazil to integrate into high-value-added production chains capable of generating highly skilled and well-paid employment opportunities throughout the twenty-first century (Brasil, 2025). Brazil is widely recognized as one of the world's leading producers of mineral commodities, particularly metallic minerals, due to its extensive mineral diversity. The country has established strategic guidelines for the exploitation of its mineral resources and has recently advanced public policies based on two major strategic documents issued by the Federal Government: The National Mining Plan 2030 (*Plano Nacional de Mineração 2030*) and the National Strategy for Science and Technology 2016–2022 (*Estratégia Nacional de Ciência e Tecnologia 2016–2022*) (Brasil, 2011; 2016 apud Castro; Peiter; Góes, 2022).

Given its geological diversity and substantial reserves of strategic minerals, Brazil is favorably positioned to become a key player in the global mining sector. The country hosts significant deposits of lithium (Minas Gerais and Ceará), nickel (Bahia and Goiás), niobium (Minas Gerais and Amazonas), graphite (Minas Gerais and Bahia), and rare earth elements. Possessing extensive reserves of critical minerals and a longstanding tradition in the extraction of commodities such as iron ore, bauxite, and niobium, Brazil also demonstrates the technological and industrial capabilities required to play a central role in global supply chains (Karas, 2025).

With these extensive mineral reserves, Brazil has the opportunity to expand its participation in global value chains while promoting economic and sustainable development. Recognizing this potential, the Brazilian government has implemented several initiatives aimed at encouraging the production and processing of these minerals. Among the most significant is the Critical Minerals Fund (*Fundo de Minerais Críticos*), a partnership between the Brazilian Development Bank (BNDES) and the Ministry of Mines and Energy, which foresees investments of up to BRL 1 billion in projects dedicated to the research, development, and operation of strategic mining assets associated with the energy transition and food security (Brasil, 2024a apud Viana, 2025). It should be emphasized that, over the past decade, the Brazilian mining sector has navigated a landscape characterized by both substantial opportunities and persistent challenges. This potential is driven by the country's vast geological wealth, including strategic mineral reserves that remain underutilized (CPRM, 2024 apud Santos, 2025). An analysis of Figure 1 highlights Brazil's extensive mineral resource base, which possesses significant potential to support the global energy transition. The domestic supply of these minerals is expected to increase in the coming years through the development of new resources, reserves, and production inputs (CEBRI, 2025). Currently, the northern region of Minas Gerais is responsible for nearly all lithium production in Brazil, particularly in the municipalities of Araçuaí, Itinga, and Medina. The region is also an important producer of graphite, especially in Itapecerica, Pedra Azul, and Salto da Divisa, as well as gold, notably in Riacho dos Machados (Bezerra, 2025).

Figure 1. Location of the Main Metallic Mineral Reserves in Brazil.



Source: SGB (2025).

This wealth, combined with geopolitical stability and a strong export-oriented profile, positions Brazil as an attractive partner for major global powers seeking to diversify their mineral supply chains (Karas, 2025).

Particular attention should be given to Brazil's position in the global ranking of major mineral reserves, especially regarding niobium (first place), followed by tantalum, natural graphite, barite, nickel, rare earth elements, and iron. Concerning producing reserves, Brazil also stands out in niobium (first place), iron (second place), aluminum, vanadium, and ornamental and dimension stones (Castro; Peiter; Góes, 2022).

These conditions provide Brazil with the capacity to assume a leading role in the global mineral supply market, considering its vast and still underexplored geological reserves, including lithium in

Minas Gerais and Ceará, nickel in Goiás and Bahia, copper in the Carajás region of Pará, and promising rare earth deposits in Minas Gerais and Amazonas (ANM, 2024b).

In terms of scale, according to data from the National Mining Agency, Brazil produced more than 5,000 tons of lithium in 2021, supported by investments exceeding BRL 340 million, representing a sixty-four-fold increase compared to the previous decade (Karas, 2025). Currently, Brazil ranks among the world's leading producers of niobium (95% of global production), iron ore (the second-largest exporter), and bauxite, while also emerging as a strategic supplier of critical minerals required for the energy transition (Castro et al., 2022).

Brazil's mining infrastructure is well established from both logistical and operational perspectives, with major mining hubs located in Minas Gerais, Pará, Bahia, and Goiás, interconnected through efficient logistics corridors such as the Carajás Railway and the ports of Itaqui, in Maranhão, and Tubarão, in Espírito Santo (Karas, 2025).

Furthermore, several companies have distinguished themselves by pursuing a more advanced integration into global value chains. Sigma Lithium, for example, operates one of the largest lithium reserves in South America while adopting rigorous sustainability and traceability standards, exporting its products directly to automakers and battery manufacturers committed to ESG (*Environmental, Social and Governance*) principles. This strategy not only responds to the growing international demand for green minerals but also repositions the company within more sophisticated segments of the value chain. Similarly, AMG Brasil and Atlantic Nickel have strengthened their presence in the lithium, graphite, and nickel

markets through operations focused on supplying the global energy and mobility industries directly (Karas, 2025).

Therefore, it is evident that Brazil possesses substantial potential to play a significant role in the global minerals sector. With diversified reserves distributed across several states of the Federation (Figure 1), the country holds a remarkable geological heritage (Oliveira, 2025). Moreover, its extensive geological base and longstanding mining tradition provide favorable conditions for occupying a prominent position in both the energy transition and the production of advanced technologies (CEBRI, 2025).

Accordingly, it is crucial to transform this natural wealth into enduring technological, social, and economic capabilities, thereby overcoming the so-called resource curse that has affected many developing nations. Mastery of a value chain that is strategically important for high technology, defense, and energy sectors constitutes an imperative for Brazil's present and future security and autonomy (Santos, 2025).

On the other hand, despite Brazil's considerable competitive advantages in the mineral sector, as previously discussed, several bottlenecks, limitations, deficiencies, and unfavorable conditions currently require attention from multiple national stakeholders. Otherwise, the country may fail to achieve the sustainable competitive advantages required within the contemporary energy, technological, digital, and economic landscape of the twenty-first century.

First, investments in the Brazilian Geological Survey remain insufficient to meet the growing demand for geological information

throughout the national territory. The limited number of mining concessions is largely a consequence of these restricted investments, which have resulted in reduced geological knowledge and exploration activities (Tomi; Loredo; Santos, 2024).

Unfortunately, Brazil's commercial structure continues to rely heavily on the export of primary commodities, with more than 85% of critical minerals being exported either in raw form or with minimal processing. This extractivist pattern reflects the absence of an industrial policy effectively integrated with mineral policy, resulting in Brazil's peripheral position within global value chains (Santos, 2023). Consequently, adding value to mineral production remains a major challenge, requiring the country to prioritize the vertical integration of its productive chains through investments in domestic mineral processing capabilities (CNI, 2024).

Otherwise, Brazil will remain primarily a supplier of raw materials, frequently exporting concentrates and unprocessed ores to industrialized countries that control refining technologies, advanced manufacturing processes, and complete production chains. This situation limits the country's economic, technological, and strategic gains, reinforcing the urgency of policies aimed at promoting the verticalization of mineral production and strengthening national industrial development (Karas, 2025).

Additionally, technological bottlenecks persist, including the lack of specialized equipment for refining minerals such as rare earth elements. Institutional barriers, including regulatory and environmental issues, complicate the licensing process for mineral exploration and processing activities. Furthermore, insufficient

coordination with other productive sectors continues to constrain sectoral development (Karas, 2025).

Structural and institutional barriers also limit competitiveness and reduce the economic benefits derived from these resources. Among the most significant challenges are inadequate industrial infrastructure, high logistics costs, tax complexity, limited access to financing, shortages of qualified labor, and weak integration among science, technology, and industry. These constraints hinder mineral processing and production verticalization, thereby perpetuating Brazil's status as an exporter of low-value-added mineral commodities (CEBRI, 2025).

Recent studies indicate that insufficient financing mechanisms, limitations in logistics and technological infrastructure, and weak integration among research institutions, industry, and innovation ecosystems continue to restrict the development of new mining projects and the verticalization of production chains (CEBRI, 2025).

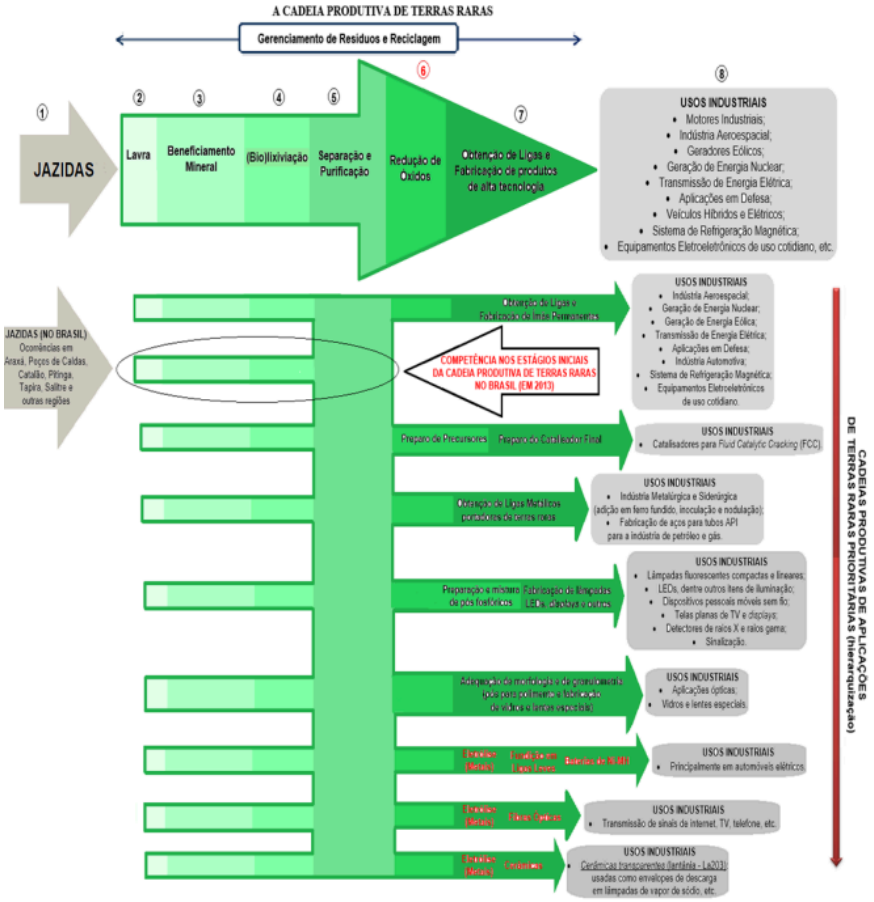
Particular attention should also be directed toward limited institutional coordination, insufficient investments in technological innovation, and inadequate incentives for the industrialization of mineral resources. As previously noted, the productive structure remains concentrated in primary extraction activities with low levels of value addition, a condition that compromises Brazil's competitiveness relative to economies that not only extract critical minerals but also dominate the industrial and technological stages of their value chains (Castro et al., 2022; IEA, 2022).

Environmental and social sustainability represents another major challenge, requiring the adoption of responsible practices, including

rigorous tailings management and biodiversity protection (ANA, 2022 apud Santos, 2025). The country also remains dependent on the consolidation of regulatory frameworks capable of meeting internationally required standards of sustainability and traceability (WEF, 2023 apud Karas, 2025).

Furthermore, the Brazilian mining sector still lacks a more favorable environment for the expansion of integrated projects, as companies' ability to benefit from public policies aimed at the mining industry has been constrained by both the fragmentation of government initiatives and the absence of robust mechanisms to promote innovation and value addition (Karas, 2025). Another relevant issue concerns legal certainty, as the complexity of the current legal framework creates investment uncertainties, highlighting the need for a clearer and more predictable regulatory environment (Santos, 2025).

Figure 2. Verticalization of the Rare Earth Value Chain.



Source: Silva (2025).

From an industrial perspective, the complete vertical integration of the rare earth value chain (Figure 2) requires technological mastery across multiple stages, including mining, mineral processing, bioleaching, separation and purification, oxide reduction, alloy production, high-technology manufacturing, and industrial application. However, since 2013, Brazil has mastered only the first five stages. This limitation represents the principal obstacle to the verticalization of the rare earth value chain in the country, making it imperative to develop the remaining stages through the support of universities, research institutes, public and private financing, and research and development initiatives (Silva, 2025).

Finally, the study identified another vulnerability within the national context: Brazil exhibits a high degree of dependence on four strategic minerals associated with the agro-industrial fertilizer sector and the chemical industry, namely phosphate, potash, sulfur, and

molybdenum. The sensitivity of this issue lies in the fact that domestic production is unable to meet national demand, resulting in an import dependency of approximately 81% of total domestic consumption (Brasil, 2020c apud Castro; Peiter; Góes, 2022).

Therefore, it may be partially concluded that Brazil possesses numerous advantages and competitive differentiators regarding mineral resources, particularly strategic and critical minerals. These advantages contribute to the country's capacity to act as a global leader in the supply of mineral commodities and semi-processed products that are essential to both domestic and international markets in the twenty-first century, thereby benefiting the national economy and supporting socioeconomic development. Nevertheless, several bottlenecks and vulnerabilities were also identified, imposing significant challenges that must be addressed if Brazil is to maintain its relevance within contemporary industrial, economic, scientific, and technological trends.

2.3. International Landscape Of Strategic And Critical Minerals

Demand for Strategic and Critical Minerals continued to grow throughout 2024. Lithium demand increased by nearly 30%, while nickel, cobalt, graphite, and rare earth elements recorded growth rates ranging from 6% to 8%. This expansion was primarily driven by energy-related applications, including electric vehicles, battery storage systems, renewable energy technologies, and electrical grids. In the case of copper, the expansion of investments in electrical transmission networks in China represented the principal driver of demand growth over the previous two years. Battery minerals, including lithium, nickel, cobalt, and graphite, destined for the energy sector, accounted for 85% of total demand growth during

the same period (IEA, 2025). The replacement of fossil fuel-based energy sources with green technologies, such as wind farms, solar power plants, and electric vehicles, has significantly increased demand for strategic and critical minerals. Electric vehicles, for example, require approximately six times more minerals than conventional vehicles, whereas onshore wind turbines consume up to nine times more materials than natural gas-fired power plants (IEA, 2021 apud IBRAM, 2025).

The relevance of rare earth elements within the global geopolitical and economic landscape is indisputable. These materials are considered the backbone of advanced technologies and are fundamental to the energy transition. In the electronics industry, they are indispensable components of smartphones, computers, televisions, and optical fibers. Their strategic importance derives from unique physicochemical properties that enable the production of materials for which viable substitutes are often unavailable (UNCTAD, 2023).

From a broader perspective, Strategic and Critical Minerals are not merely industrial inputs. They have increasingly become instruments of geopolitical power, as competition for their control reshapes international alliances, consolidates trade policies, and stimulates national development strategies. For countries such as Brazil, the challenge is evident: transforming geological potential into geopolitical influence through robust industrial policies, active diplomacy, and sustained investments in technology and sustainability (Bezerra, 2025).

The growing global demand for minerals essential to the energy and digital transitions positions Brazil as a strategic supplier within

international markets (IEA, 2023 apud Santos, 2025). Consequently, countries seeking to diversify their supply chains have intensified investments in mineral exploration and the development of new mining projects (IBRAM, 2024 apud Santos, 2025). This scenario represents a valuable opportunity for Brazil to strengthen its competitive advantages while mitigating existing weaknesses.

With the diversification of supply chains and the expansion of investments mentioned above, Brazil faces a historic opportunity to leverage its economy by establishing a leadership position in the production and refining of critical minerals required for energy-transition technologies. The implementation of an effective strategic planning framework and a coherent political-regulatory structure would facilitate the attraction of investments aimed at increasing value addition within mineral production chains, thereby supporting the expansion of Brazil's industrial infrastructure and advanced technological capabilities (IBRAM, 2025).

It is noteworthy that the European Union (EU) has established ambitious targets to secure the supply of essential minerals, including the requirement that at least 40% of refining activities and 15% of extraction activities be conducted within the bloc by 2030. To achieve these objectives, the EU has strengthened partnerships with countries in Latin America, Africa, and Asia, with particular emphasis on Brazil. These initiatives encompass not only mineral imports but also cooperation in research, technological development, environmental best practices, and technical capacity building, thereby creating significant opportunities for countries capable of aligning their mineral policies with the principles of the European green economy (Karas, 2025).

The international competition for critical minerals, driven by Western powers seeking technological autonomy in response to China's dominant position, provides another important opportunity for Brazil (Viana, 2025). Therefore, Brazil's position in international trade involving critical minerals should be understood not only in terms of export volumes but also in relation to the strategic role these minerals play within emerging global production and environmental systems (Karas, 2025).

For the 2025–2029 period, investments in the Brazilian mining sector are projected to reach US$ 68.4 billion (IBRAM, 2024). Of this total, 28.7% is expected to be allocated to iron ore projects, 16.6% to socio-environmental initiatives, 10.5% to copper projects, and 8.7% to fertilizers. Although investments in lithium (US$ 1.19 billion) and rare earth elements (US$ 1.45 billion) remain relatively modest in absolute terms, their participation has been growing rapidly, indicating increasing international interest in minerals associated with the energy transition (Karas, 2025). Furthermore, rapid technological development worldwide has generated substantial growth in the consumption of strategic and critical materials, particularly because of the importance of mineral elements in modern production systems (Pope; Smith, 2023; Castro; Peiter; Góes, 2022 apud Tomi; Loredo; Santos, 2024).

A prominent example of leadership within this sector is China. Traditionally recognized for its specialization in the production and supply of primary mineral products due to its extensive mineral reserves, China has increasingly specialized in the manufacture of mineral-based industrial products, including essential inputs for the energy, electronics, transportation, and healthcare equipment

sectors (Barteková; Kemp, 2016; Mancheri; Sundaresan; Chandrashekar, 2013 apud Castro; Peiter; Góes, 2022).

Not surprisingly, China's dominance of the rare earth supply chain, from mining operations to alloy production, has generated significant global concerns regarding supply security. In terms of scale, China accounts for approximately 69% of global rare earth production and more than 90% of permanent magnet production, granting the country considerable international influence (Couto; Reis, 2021 apud Santos, 2025). China is also the world's largest consumer of cobalt, with nearly 87% of its consumption directed toward the lithium-ion battery industry (Viana, 2025).

The geopolitics of strategic and critical minerals has intensified as a consequence of the trade dispute between the United States and China, the advancement of green industrial policies within the European Union, and increasing consumer market demands for traceability and environmental compliance based on ESG principles. Within this highly competitive environment, Brazil must position itself strategically and autonomously through participation in multilateral forums, the negotiation of technical agreements, and the attraction of investments associated with technological transfer and industrial development (Karas, 2025).

2.4. SWOT Analysis as a Tool For Assessing Brazil's Competitiveness

Initially, it is important to emphasize that the National Strategy for Science, Technology and Innovation (ENCTI 2024–2034), issued by the Ministry of Science, Technology and Innovation, states that Brazil should achieve mastery over integrated strategic and critical mineral

value chains through the development of technologies related to exploration, processing, and recycling activities, thereby reducing vulnerabilities and promoting sustainability. This guideline is considered a national priority due to its direct relevance to Brazilian sovereignty and national defense interests (Brasil, 2024b).

From this future-oriented perspective, the importance of Strategic Planning for senior decision-makers becomes evident, as it contributes to the development of more accurate scenario projections. In this context, the SWOT Matrix emerges as one of the tools capable of assessing Brazil's level of competitiveness in both national and international contexts regarding Strategic and Critical Minerals. Based on the considerations presented in the previous subsections, it was possible to synthesize the most relevant information concerning the Brazilian context and the international landscape of Strategic and Critical Minerals, as presented in Table 3.

Table 3. SWOT Analysis of the Brazilian Context and the International Scenario of Strategic and Critical Minerals.

Internal Environment	**Strengths**	**Weaknesses**
	• Holder of vast reserves of strategic and critical minerals; • Rich geological diversity; • Prominent position in the global mineral supply market (1st place in niobium); • Long-standing tradition in commodity mining; • Significant industrial and logistical potential; • Geopolitical stability; • Export-oriented profile; • Global leader in niobium production, iron, aluminum, and bauxite; • Potential strategic role in the energy transition; • Companies with strong market positioning in the sector (Sigma Lithium, AMG Brasil, and Atlantic Nickel).	• High external dependence on certain critical minerals; • Lack of equipment for mineral refining; • Export profile characterized by low value addition; • Limited institutional coordination; • Insufficient investments in technological innovation and incentives for mineral industrialization; • Productive structure concentrated in primary extraction; • Difficulties in coordination among regulatory and governmental entities; • Insufficient investments in the Brazilian Geological Survey; • Reduced investments in geological research; • Lack of technological mastery across the entire rare earth value chain; • High logistics costs; • Tax complexity; • Low availability of qualified labor; • Bottlenecks affecting integrated projects; • Limited institutional coordination; and • Insufficient industrial infrastructure.
External Environment	**Opportunities**	**Threats**
	• Growing global demand for critical minerals; • European Union supply requirements; • International cooperation in research and technological development; • Increased inflow of foreign investment; • Diversification of countries' supply chains.	• United States–China trade war; • China's leadership across the rare earth value chain, including mining, refining, and permanent magnet production; • Geopolitical tensions among major global powers; • Green industrial policies in the European Union; • Growing pressure from international markets regarding traceability and environmental compliance; • Countries that dominate the industrial and technological stages of critical mineral value chains.

Source: WEF (2023); ANM (2024); Karas (2025); IBRAM (2025); Bezerra (2025); Viana (2025).

Having assessed the Brazilian context (Strengths and Weaknesses) and the international landscape (Opportunities and Threats), the next step of this study was to integrate these findings with Table 2, combining the available evidence to support high-level decision-makers, including policymakers, investors, business leaders, industrial stakeholders, and researchers, in the development of action plans and strategic initiatives within their respective spheres of responsibility. Such initiatives are intended to enhance Brazil's competitiveness, facilitate more informed and timely decision-making, and anticipate risks associated with the country's mineral resources.

To facilitate the understanding of the integration among Tables 2, 3, and 4, a set of strategic proposals was identified and organized with the objective of contributing to Brazil's continuous development within the context of Strategic and Critical Minerals and, consequently, strengthening its competitive position.

Table 4. Strategic Proposals Derived from the SWOT Matrix Analysis.

Brazil's Strengths	Opportunities	Strategy
• Holder of vast reserves of strategic and critical minerals; and • Geological richness and diversity.	• Growing global demand for minerals; and • European Union supply requirements.	• Intensify multilateral agreements through the strengthening of foreign trade (exports of Brazilian minerals to Europe).
Brazil's Strengths	**Threats**	**Strategy**
• Geopolitical stability; and • Export-oriented profile.	• International market pressure for traceability and environmental compliance.	• Implement public policies and regulatory frameworks that facilitate mining companies' compliance with ESG standards.
Brazil's Weaknesses	**Opportunities**	**Strategy**
• Insufficient investment in the Brazilian Geological Survey.	• Increased international capital investment.	• Promote international partnerships that enable investments in technological research and mineral exploration activities within Brazilian territory.
Brazil's Weaknesses	**Threats**	**Strategy**
• Shortage of qualified labor.	• Countries that dominate the industrial and technological stages of critical mineral value chains.	• Strengthen academic programs for professional training and the development of specialized human resources dedicated to the value chain of strategic and critical minerals.

Source: Adapted by the Author.

Based on the additional strategies identified, action plans could be developed to enhance Brazil's competitiveness. Naturally, these initiatives would encompass a broad range of dimensions, given the diversity of stakeholders directly and indirectly involved in shaping the country's future across multiple areas related to mineral

resources. These areas include the energy transition, digital transformation, research and technological development, production chains, human capital development, economic policy, industrial development, science and technology, international relations, mineral diplomacy, foreign trade, among many others.

Finally, it may be partially concluded that, based on the evidence presented in Tables 3 and 4, Brazil possesses significant advantages, competitive differentiators, and capabilities within its domestic environment, while simultaneously facing limitations and challenges in the international arena concerning Strategic and Critical Minerals. Nevertheless, according to the SWOT Matrix framework, the country's competitiveness can be strengthened to the extent that decision-makers are able to leverage existing strengths, capitalize on emerging opportunities, and effectively mitigate both weaknesses and external threats.

3. METHODOLOGY

The methodological approach adopted in this study was qualitative in nature, as its primary objective was to analyze Brazil's competitiveness in both national and international contexts regarding Strategic and Critical Minerals through the application of the SWOT Matrix as a management tool. This approach is widely recognized within the scientific community for its ability to provide contextualized analyses and comprehensive interpretations of complex phenomena, enabling a broader understanding of how a strategic management tool such as the SWOT Matrix can support the assessment of a country's competitiveness concerning mineral resources that are essential in the twenty-first century. Furthermore, qualitative research emphasizes the interpretation and

understanding of complex realities, making it particularly suitable for investigating dynamic, multifaceted, and geopolitical scenarios, such as those involving mineral resources employed across a wide range of economic and technological activities.

Regarding the methodological procedures, the study was classified as bibliographic research. This type of investigation is based on the systematic analysis of previously published scientific literature and constitutes one of the fundamental pillars of scientific knowledge production. According to Severino (2017), bibliographic research represents an essential stage of scientific inquiry, as it enables the identification, analysis, and interpretation of theoretical contributions related to the object of study. This procedure contributes to the consolidation of the theoretical and methodological foundations of the research while strengthening the analytical basis of the discussions developed throughout the investigation.

For the purposes of this review, the research sources were selected and classified into three categories: (1) sources addressing the definitions, concepts, and functionalities of the SWOT Matrix; (2) sources characterizing the Brazilian context and the contemporary international landscape of Strategic and Critical Minerals; and (3) sources evaluating Brazil's competitiveness concerning these strategically important mineral resources in the twenty-first century.

The classification of these sources facilitated a more comprehensive understanding of the need to employ a strategic planning tool capable of identifying Brazil's competitive advantages and differentiating factors regarding mineral resources. Moreover, it enabled a systematic assessment of the country's strengths,

weaknesses, opportunities, and threats within the global minerals sector.

The literature review was conducted through the analysis of scientific publications from both domestic and international sources, including peer-reviewed journal articles, official documents issued by Brazilian governmental agencies, reports produced by international organizations, publications from multinational institutions, and relevant online resources. This broad range of sources ensured comprehensive coverage of the subject matter and reflected the various possibilities for strategically planning Brazil's future development based on its capabilities, opportunities, and constraints concerning Strategic and Critical Minerals.

The documentary research component was characterized by substantial analytical depth, encompassing technical documents, institutional reports, statistical yearbooks, and public policy documents produced by prominent national and international organizations associated with the mining, energy, scientific, and environmental sectors. Materials published by institutions such as the National Mining Agency (ANM), the Ministry of Mines and Energy (MME), the International Energy Agency (IEA), the World Economic Forum (WEF), the United Nations Conference on Trade and Development (UNCTAD), the Brazilian Mining Institute (IBRAM), and the Brazilian Center for International Relations (CEBRI), among other organizations of recognized scientific and strategic relevance, were examined.

This documentary corpus enabled the investigation of multiple dimensions of the research topic, integrating economic, geopolitical, environmental, and technological aspects related to Strategic and

Critical Minerals. As highlighted by Pereira and Oliveira (2024), observation and documentary analysis significantly contribute to scientific research by expanding the range of evidence available to researchers and strengthening both the theoretical and methodological foundations of the investigation.

4. FINAL CONSIDERATIONS

Strategic and Critical Minerals, including Rare Earth Elements, have assumed a central role in the twenty-first century. Their physicochemical properties enable their application across the mining industry and other sectors of strategic importance to contemporary society, including energy, digital technologies, pharmaceuticals, and advanced manufacturing.

Certain chemical elements of the Periodic Table have become so essential that countries possessing economically exploitable deposits can exert significant influence over global supply chains. This reality is particularly relevant to Brazil, which holds substantial mineral wealth and geological diversity due to the favorable geological formations present within its territory.

Brazil also possesses additional competitive advantages, including geopolitical stability and a strong export-oriented profile in mineral commodities, both of which constitute significant strengths within the domestic context. Nevertheless, important limitations and vulnerabilities remain within the mining sector, notably the inability to master the entire rare earth value chain, insufficient investments in geological research, and shortages of qualified human resources.

Regarding the international landscape, Brazil may benefit from several opportunities capable of strengthening its position within

the emerging geopolitics of minerals. Among these opportunities is the growing global demand for critical minerals required for technologies associated with the energy transition.

A clearer understanding of how to accurately assess these capabilities and limitations can be achieved through the application of the SWOT Matrix by policymakers and senior decision-makers. Such an approach contributes to more precise and timely decision-making, enabling the anticipation of risks and the formulation of strategies and action plans within a highly competitive global environment for mineral resources.

This study identified numerous factors that were incorporated into the four quadrants of the SWOT Matrix, thereby providing a comprehensive assessment of Brazil's current position regarding Strategic and Critical Minerals.

Accordingly, the objective of this article was to analyze Brazil's competitiveness in both national and international contexts concerning Strategic and Critical Minerals through the application of the SWOT Matrix as a management tool. Based on this analysis, the study sought to provide insights for political, economic, scientific, and technological institutions regarding how Brazil could consolidate competitive advantages in the management of its mineral resources in light of the challenges and opportunities emerging throughout the twenty-first century.

The findings indicate that the study achieved its proposed objectives by identifying a series of strategic pathways capable of enhancing Brazil's competitiveness as a global player in mineral industrialization. Moving beyond the role of a mere exporter of raw

or semi-processed minerals, the analysis demonstrated that Brazil possesses the conditions necessary to transform its mineral potential into economic, technological, and industrial capabilities. By strategically leveraging the SWOT Matrix framework, the country may further strengthen its position in the energy transition and in the production of high-technology, high-value-added goods and services.

An additional contribution of this study lies in demonstrating how a strategic management tool developed during the second half of the twentieth century remains highly relevant for understanding the complex environments surrounding Strategic and Critical Minerals in the twenty-first century.

Within this context, the research addressed the following question: *How can strategic planning, risk management, mineral market intelligence, and the anticipation of timely and appropriate decisions related to mineral industrialization be effectively assessed within a dynamic and complex environment?* The findings indicate that the SWOT Matrix constitutes a valuable analytical framework for addressing these challenges.

Thus, the qualitative approach adopted in this study, supported by a literature review and documentary analysis, proved fundamental in demonstrating the relevance of the SWOT Matrix for identifying future perspectives capable of contributing to Brazil's competitiveness in the management of its mineral resources, thereby supporting their use as instruments of economic, technological, and industrial development.

Finally, future research is encouraged to investigate the applicability of Porter's Five Forces Framework to the global context of Strategic and Critical Minerals, thereby expanding the analytical perspectives available for understanding competitiveness, market dynamics, and value-chain governance within this strategically important sector.

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