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Article

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Triple helix and its implications in the Brazilian context

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Abstract

Purpose – This study aims to analyze the triple helix model and its implications in the Brazilian context.

Design/methodology/approach – A content analysis was conducted using the methodology developed by Bardin (2011), with support from the Iramuteq software, to examine the theoretical foundations of articles related to the topic.

Findings – The research identified several obstacles hindering the efficiency of Brazil's innovation process. These include insufficient integration among stakeholders within the helix, the need to adapt the triple helix model to regional specificities and challenges in effectively incorporating civil society and environmental concerns into the framework.

Social implications – Including civil society and environmental dimensions as additional elements in the helix structure presents an opportunity to enhance the innovation process. This highlights the need for cultural shifts to enable effective collaboration among the helices.

Originality/value – The findings contribute to the formulation of policies, strategies and initiatives aimed at promoting sustainable development and innovation in Brazil.

Keywords Innovation, Triple helix, Sustainable development, Civil society, Environment, Content analysis

Paper type Literature review

1. Introduction

In the contemporary context, the interaction among the academic, business, and government sectors play a key role in driving innovation and sustainable development across nations (Etzkowitz & Leydesdorff, 2000; Etzkowitz & Zhou, 2017). The Triple Helix represents a model of collaboration among universities, industries, and governments, aimed at fostering technological advancement, enhancing business competitiveness, and formulating effective public policies.

Each helix fulfills a specific role within this model: the government provides a regulatory and political environment for innovation; industry contributes practical experience and financial resources; and academia offers research and technical knowledge. Collaboration among these three spheres can lead to more effective solutions to complex societal problems, contributing to the emergence of a knowledge-based economy (Leydesdorff & Etzkowitz, 1996).

In the Brazilian context, the adoption and adaptation of the Triple Helix model have become topics of increasing interest and debate, particularly given the country's unique characteristics in terms of its innovation system, economic structure, and social challenges. As a developing country, Brazil faces several barriers, ranging from improving education and research capabilities to enhancing industrial competitiveness and strengthening innovation policies (Tisatto & Bento, 2021).



Understanding the academic literature on the Triple Helix model in Brazil is essential for comprehending how interactions among universities, industry, and government have addressed challenges associated with the middle-income trap. This trap refers to the economic stagnation that occurs when countries, after reaching a certain income level, struggle to transition to high-income status due to structural barriers such as low productivity, limited innovation capacity, and dependency on traditional industries (Felipe, Kumar, & Galope, 2017). Silva, Andrade, Silva, and Abreu (2019) argue that although Brazil garners attention for its size and potential, it has lost global competitiveness in recent years. The country's difficulty in transitioning to a knowledge-based economy underscores the critical role of innovation in promoting sustainable socioeconomic development.

To address the challenges of fostering innovation and sustainable development in Brazil, it is important to examine the dynamics among universities, the business sector, and government institutions. Public policies are particularly influential in this process, especially those aimed at improving access to quality education (Mello & Moll, 2020) and creating a supportive business environment (Martins, Rocha, & Barra Neto, 2023).

Within this context, the Triple Helix model emerges as a promising framework for cross-sector collaboration. However, exploring the extent to which this model has been effectively implemented – and identifying the barriers that hinder its full realization – are crucial steps toward maximizing its potential in the Brazilian setting.

This study seeks to answer the following research question: How has the academic literature addressed the Triple Helix theory and its development as a model for implementing innovation in Brazil, and what are the main challenges to its societal application? Through a content analysis of academic texts, this study offers an in-depth examination of how the Triple Helix model has been applied in Brazil, contributing to the broader understanding of the interactions among universities, businesses, and the government in fostering innovation.

2. Theoretical background

The Triple Helix model explains knowledge-based economic development (Etzkowitz & Leydesdorff, 1995). Over time, this innovation model has evolved, giving rise to new frameworks – namely, the Quadruple and Quintuple Helix models – which integrate the academic, business, government, social, and environmental sectors to promote innovation and economic development (Etzkowitz & Zhou, 2017). These expanded models reflect the growing complexity of relationships among these sectors and aim to optimize collaboration for the creation and transfer of knowledge and the generation of societal value.

In today's world, the Triple Helix emphasizes interactions among universities, industry, and governments. Within this model, universities contribute through basic research and the training of highly qualified professionals; industry applies this knowledge to create innovative products and services; and government facilitates the process by implementing policies that support research and innovation (Figueiredo, Fernandes, & Abrantes, 2023).

The Triple Helix model has undergone refinements over time. In Model I, the government takes the lead, guiding interactions between universities and industry. In Model II, the three actors operate within distinct and clearly defined boundaries, engaging with one another sporadically. Model III, in contrast, features overlapping roles, where institutions form hybrid entities through their collaborative interfaces (Etzkowitz & Leydesdorff, 2000).

In Model I, the government is the central body that defines strategies and activities for the other segments involved in innovation. Model II offers greater stability in the roles of each actor but presents a low level of interaction, with each sector functioning in isolation except for occasional meetings. In contrast, Model III promotes a shared vision, where actors intersect to build an environment conducive to scientific and technological innovation. This collaborative effort occurs through trilateral participation, focusing on knowledge-based economic development and strategic linkages among companies, research institutions, and academia.

In Brazil, the Triple Helix model has gained relevance as the country seeks to strengthen its innovation capacity. Universities such as the University of São Paulo (USP) and the State University of Campinas (UNICAMP) have played pivotal roles in producing knowledge and fostering partnerships with both industry and government (Etzkowitz & Zhou, 2017). Development agency initiatives have also helped shape this landscape. One example is the Bahia Innovation Program, launched in 2003 by the Bahia State Research Support Foundation (FAPESB), which promotes innovation and entrepreneurship through collaboration among businesses, higher education institutions, research centers, and government entities (Silva *et al.*, 2019).

Investments in technology centers and creation of numerous science parks have also contributed to Brazil's innovation ecosystem, fostering cross-sectoral interaction to advance the knowledge-based economy (Mineiro & Castro, 2020).

Government regulations and initiatives – such as the Innovation Law (2004), the Good Law (2005), and especially Law 13.243 (2016), known as the New Legal Framework for Science, Technology and Innovation – have further encouraged innovation by reducing bureaucracy hurdles. These policies allow university faculty to engage in private-sector research with compensation, authorize the use of university laboratories by companies, and promote shared intellectual property rights between academia and industry. Such measures foster partnerships and strengthen Brazil's innovation environment, facilitating scientific and technological progress (Silva *et al.*, 2019).

The Triple Helix theory, first introduced by Etzkowitz and Leydesdorff, revolutionized the understanding of innovation by emphasizing the interaction among universities, industry, and government. However, this model has since evolved into more inclusive frameworks – namely, the Quadruple and Quintuple Helix models – proposed by Carayannis and Campbell, which introduce additional actors and dimensions into the innovation process (Gandia *et al.*, 2020).

The Quadruple Helix incorporates civil society as a fourth component. This expanded model acknowledges the role of citizens, non-governmental organizations, and civil society groups in innovation. Broader engagement fosters social responsibility and sustainability, ensuring that technological advancements align with societal needs and values. By including civil society, the theory highlights the importance of public participation in setting research priorities, evaluating the impact of innovation, and collaboratively co-creating solutions to social challenges. Civil society, with its diverse interest groups, contributes perspectives and demands that can shape the innovation agenda (Gandia *et al.*, 2020).

In the Brazilian context, the adoption of the Quadruple Helix is progressing as civil society and non-governmental organizations (NGOs) increasingly engage in the innovation sector. Globally, these models have driven innovation and development across various regions, particularly in Europe (Figueiredo *et al.*, 2023). In Brazil, these approaches have gradually evolved, reflecting the country's unique dynamics and its pursuit of a more innovative and inclusive future through the establishment of science parks (Mineiro, Castro, & Amaral, 2023).

The Quintuple Helix, in turn, incorporates the environment as a central element of innovation. Carayannis and Campbell emphasize that a truly effective innovation ecosystem must account for the relationship between society and the environment. By integrating sustainability and social responsibility into the innovation process, this model contributes to building a more sustainable future (Gandia *et al.*, 2020; Mineiro *et al.*, 2023). This expanded framework reflects a growing global awareness of environmental challenges and the need to incorporate environmental concerns at every stage of the innovation process. The inclusion of the environment as a distinct helix underscores the importance of prioritizing sustainable societal development.

In Brazil, this fifth helix requires further attention, as the integration of sustainability into governmental and organizational strategies remains underdeveloped. Planning and investment in infrastructure, urban mobility, and public policy are among the key issues that demand more

prominence on the national agenda (Gandia *et al.*, 2020). Establishing regulatory frameworks that foster sustainable innovation and intersectoral collaboration is essential. Additionally, promoting the circular economy, renewable energy sources, and biodiversity protections are critical steps toward the effective implementation of the Quintuple Helix in Brazil (Mineiro *et al.*, 2023).

The synergy promoted by the interaction of the helices, as highlighted by the authors studied, demonstrates the relevance of this theoretical framework within economic and social contexts. Policies and initiatives that stimulate innovation in academia, aligned with the real needs of society, represent powerful mechanisms for development. They enable an autonomous and flexible relationship among the private sector, academia and the state – strengthening research, supporting students, and boosting the economy.

The helix theory holds transformative potential by acknowledging the complexity of interactions among the diverse actors involved in the innovation process. It provides a conceptual foundation that can support the development of more effective public policies while also promoting a more sustainable and inclusive model of economic development.

3. Methodology

This study analyzes the theoretical foundations of articles addressing the Triple Helix and its evolution within the Brazilian context, including research related to the Triple, Quadruple, and Quintuple Helix models. A literature review was carried out following the criteria outlined by Kraus, Breier, and Dasí-Rodríguez (2020), involving the following steps: (1) formulation of the preliminary research question, (2) definition of a protocol with research parameters (search strings, databases, inclusion and exclusion criteria), (3) data extraction and synthesis, and (4) data analysis and interpretation.

The search was conducted on April 28, 2023, using the Capes Journal Portal database. To identify relevant articles within the Brazilian context, the search terms used were in Portuguese: “Triple Helix”, “Quadruple Helix”, “Quintuple Helix” and “innovation”, with a temporal filter for the past five years. The choice of Portuguese terms reflects the focus on Brazilian academic and scientific production. The terms “Triple Helix”, “Quadruple Helix”, and “Quintuple Helix” were selected to ensure comprehensive coverage of the theoretical frameworks related to innovation systems, while the inclusion of the term “innovation” aligned with the study’s objective. The temporal filter was applied to capture recent publications.

The research initially yielded 33 documents (online resources), of which 16 were peer-reviewed scientific articles. Documents that were not peer-reviewed journal articles or were written in Arabic were excluded, resulting in a total of 15 articles. After screening, two duplicates were removed and three were excluded for not presenting a theoretical reference to the Triple, Quadruple, or Quintuple Helix models. The final sample comprised ten articles, which were selected for content analysis (Table 1).

After the articles were selected according to the previously described protocol, a content analysis was conducted with a focus on the theoretical framework of the selected texts. Content analysis allows for the identification of patterns, themes and linguistic meanings within the texts, highlighting connections between terms, discourse structure, and thematic groupings. The goal is to identify the main theoretical approaches, central concepts, and the way authors structure their arguments in relation to the Triple Helix model. This method is widely used to analyze qualitative data, such as texts, and is particularly relevant for understanding phenomena involving multiple actors and social dynamics.

The content analysis method proposed by Bardin (2011) comprises three main stages: pre-analysis, material exploration, and treatment of the results. Pre-analysis involves the organizing and preparing the data for analysis. At this stage, the researcher performs a floating reading – an initial reading to become familiar with the material and gain an overview –, identifies recording units (words, phrases, paragraphs, or other meaningful units), and defines the criteria and categories to be used in the analysis.

Table 1. Articles selected of literature review

Research	Title
Iata and Cunha (2018)	A Atuação da Tríplice Hélice em Santa Catarina pela Visão dos Núcleos de Inovação Tecnológica (NITs) do Estado
Severo, Sampaio, Linhares, and Dorion (2020)	A relação entre Tríplice Hélice e ecoinovação
Ortega, Angarita, and Urbano (2020)	Modelo de Quintuple Hélice en la generación de ejes estratégicos durante y postpandemia 2020
Maldonado and Pereira (2020)	A Importância de uma Ampla Interação entre Universidades e os Habitats de Inovação
Cóser, Brandão, Raposo, and Gonçalves (2018)	Determinantes das patentes em ciências da vida e da saúde nas universidades federais de Minas Gerais, Brasil: uma análise de dados em painel para o período 1995–2016
Gandia <i>et al.</i> (2020)	The Quintuple Helix Model and the Future of Mobility: The role of Autonomous Vehicles in a Developing Country
Silva <i>et al.</i> (2019)	Inovações Desenvolvidas em Universidades – a Tríplice Hélice Atuando no Monitoramento da Qualidade de Combustíveis
Costa, Castro Júnior, Ferreira, Benedicto, and Novaes (2019)	Teoria da Tríplice Hélice: uma proposta de modelo de gestão estratégica aplicado à agência de inovação do café (inovacafé)
Aligod and Hassane (2018)	Gouvernance et innovation verte dans les clusters, une approche par la Quintuple Hélice
Patias <i>et al.</i> (2022)	O distrito industrial como agente da inovação, na Perspectiva da Hélice Quádrupla

Source(s): Prepared by the authors, based on the results of literature review

In the material exploration stage, the researcher analyzes the material according to the criteria established during pre-analysis. The final stage, treatment of results, involves interpreting and analyzing the findings from the previous step. This includes identifying themes, trends, relationships, or patterns within the material. The researcher may also employ additional techniques, such as creating subcategories or constructing descriptive narratives, to explain the results.

The analyses were performed using the Iramuteq software, which offers appropriate tools for content and textual statistical analysis, including word clouds, similarity analysis, Correspondence Factor Analysis (CFA), and Hierarchical Descendant Classification (CHD) (Camargo & Justo, 2013).

Textual statistical analysis involves quantifying linguistic elements such as words or phrases, identifying frequencies, patterns, and trends in their usage. A commonly used visualization is the word cloud, which visually represents the most frequent words in the material, with word size proportional to frequency. This provides a quick overview of the main themes or topics addressed in the texts.

Similarity analysis identifies relationships between recording units based on specific criteria, such as keywords, themes, or shared characteristics. This approach is useful for grouping similar units and detecting patterns or relationships.

Correspondence Factor Analysis (CFA) is an exploratory technique that examines and visualizes associations between categorical variables. CFA helps to uncover association patterns and supports the interpretation of data. It is applied in social research, marketing, and text analysis, offering insights into trends and relationships relevant to decision-making.

Hierarchical Descendant Classification (CHD) groups recording units into categories or clusters based on similarity. This technique helps identify hierarchical patterns and organizational structures in the data. In this study, a minimum text segment retention of 75% was adopted to ensure reliable analysis (Camargo & Justo, 2013; Moragas, Costa, Rangel, & Araújo, 2022). However, the literature also accepts a minimum retention rate of

Conversely, universities and the government appear grouped together but remain detached from innovation. This result corroborates the study by [Andrade, Rocha, and Nascimento \(2023\)](#), who argue that the contribution of universities to innovation in Brazil remains insufficient. Therefore, despite the relevance of additional elements introduced in the Quadruple and Quintuple Helix models, reinforcing the core of the original Triple Helix model – particularly through increased involvement of universities and government support – remains essential. [Table 2](#) presents the results of the correspondence factor analysis, highlighting the main terms associated with each extension of the Triple Helix model in the Brazilian context.

[Table 2](#) presents the most relevant and frequent terms related to the Triple Helix: *each*, *industry*, *other*, *institutional*, *company*, and *interaction*. These results reinforce the findings of the similarity analysis and highlight that, within the Triple Helix framework, interaction among the three helices of the model is essential. As [Iata and Cunha \(2018\)](#) stated:

Scholars continue to find the Triple Helix a useful concept for understanding the production system of a knowledge-based economy... For the creators of the model, the university, government, and industry must act in synergy to foster *innovation* (p.181).

Similarly, [Silva et al. \(2019\)](#) emphasized:

The fundamental mechanism for *innovation* and economic growth is the university-*industry*-government *interaction*, as the model allows regional development based on knowledge. In addition, these *interactions* allow *companies* to become more competitive through more knowledge-dense products (p. 248).

These perspectives confirm that the Triple Helix framework is central not only to innovation but also to the broader process of economic development – particularly in emerging economies such as Brazil, where synergies between these sectors are crucial to overcoming barriers to progress.

According to the correspondence factorial analysis, the relevance of the Triple Helix as an analytical model is evident, especially in how it incorporates additional helices to provide a broader view of the innovation process. The study by [Andrade et al. \(2023\)](#) shows that

Table 2. The correspondence factorial analysis of the research studies

Words	Triple helix		Quadruple helix		Quintuple helix	
	Force	Frequency	Force	Frequency	Force	Frequency
Each	3	20	-2	0	-2	0
Industry	3	30	-1	3	-3	0
Other	2	18	-1	1	-1	1
Institutional	2	14	-1	0	-1	1
Company	2	27	-2	0	-1	5
Interaction	2	14	-1	1	-2	0
Policy	-1	8	-1	0	3	7
System	-1	8	-1	1	3	7
For	-1	32	-1	7	2	15
Development	-1	16	-1	4	2	9
Base	-1	6	3	5	-1	1
Has	-1	9	2	5	-1	3
Was	-1	7	2	4	-1	1
Environment	-2	6	-1	1	4	8
Promote	-3	3	3	5	1	4
Social	-3	3	2	4	1	4
Enterprise	-7	0	15	12	-1	1

Source(s): Prepared by the authors, based on the results of IRAMUTEQ.

interaction in the Brazilian context predominantly market-oriented. The main terms associated with this interaction are *industry* and *company*, which had the highest strength and frequency values (3 and 30 for *industry*; 2 and 27 for *company*, respectively). Notably, Table 2 reveals the absence of terms associated with the other two helices – *university* and *government* – underscoring a weakness in the interaction between industry and these sectors.

Continuing the analysis of Table 2, terms relevant to the Quadruple Helix model – *enterprise* (strength 14, frequency 12), *base* (strength 3, frequency 5), *promote* (strength 3, frequency 5), and *social* (strength 2, frequency 4) – are also identified. These words suggest that incorporating the fourth helix, civil society, is key to promoting innovation. As Patias, Baggio, and Brizolla (2022) noted:

The university has an important role to play in *promoting* innovation and *entrepreneurship*, and must join forces with companies and government to promote economic and *social* development, emphasizing that the community must be involved in this process (p. 390).

Similarly, Table 2 highlights terms with high strength and frequency within the Quintuple Helix framework: *policy* (strength 3, frequency 7), *system* (strength 3, frequency 7), *development* (strength 2, frequency 9), and *environment* (strength 4, frequency 8). These terms illustrate the significance of the environmental dimension in the Quintuple Helix and its relevance to innovation. Aligod and Hassane (2018) explained:

This model, however, sees *environmental* and ecological problems as new opportunities, identifying them as possible vectors for future knowledge production and innovation. It highlights the socio-ecological transition necessary for the progress of society and the economy in the 21st century (p. 49).

The integration among the helices is organic and not necessarily linear, occurring in different contexts – particularly in a country like Brazil, with significant regional socioeconomic diversity. Therefore, the Quadruple and Quintuple Helix frameworks can be operationalized through technology parks focused on innovation (Mineiro *et al.*, 2023).

The content analysis conducted enabled the exploration of the data using Descending Hierarchical Classification (DHC), which revealed linguistic groupings where text segments were classified according to their lexical content. This method identifies classes of text segments that share similar lexical items but are distinct from those in other classes. Figure 3 presents the resulting phylogram, showing two main classes: **Innovation** and **Sustainable Development**. These classes were named based on the clustering of related terms within each group. The **Innovation** class represents 32.8% of the analyzed content, while the **Sustainable Development** class is divided into two subclasses: **Academia**, which comprises 40.8% of the content, and **Innovation Models**, with 26.4%. These percentages reflect the proportion of total content each class or subclass represents. For instance, the **Academia** subclass (40.8%), which comprises the largest share, includes terms and concepts emphasizing the relationship between sustainable development and the role of academic institutions. The **Innovation** and **Innovation Models** classes further demonstrate how innovation is approached in the context of this analysis.

The analysis of the phylogram and its division into classes reveals the complexity of interactions within the innovation process, especially when examining the interplay among different helix models. The **Innovation** class (32.8% of the content) is strongly associated with the Triple Helix model, which emphasizes the need for collaboration among universities, government, and industry. Words linked to this class – such as *network*, *communication*, *cooperation*, and *consensus* – highlight the importance of interaction and alignment among these actors to foster innovation. Additionally, terms like *institutional*, *organization*, and *overlap* suggest that innovation occurs in a dynamic environment, where sectoral boundaries must be transcended to enable the development of innovative solutions.

The **Sustainable Development** class is divided into two subclasses. The **Academia** subclass (40.8% of the content) reflects the central role of academic institutions in the innovation process, underlining the importance of research, development, and collaboration

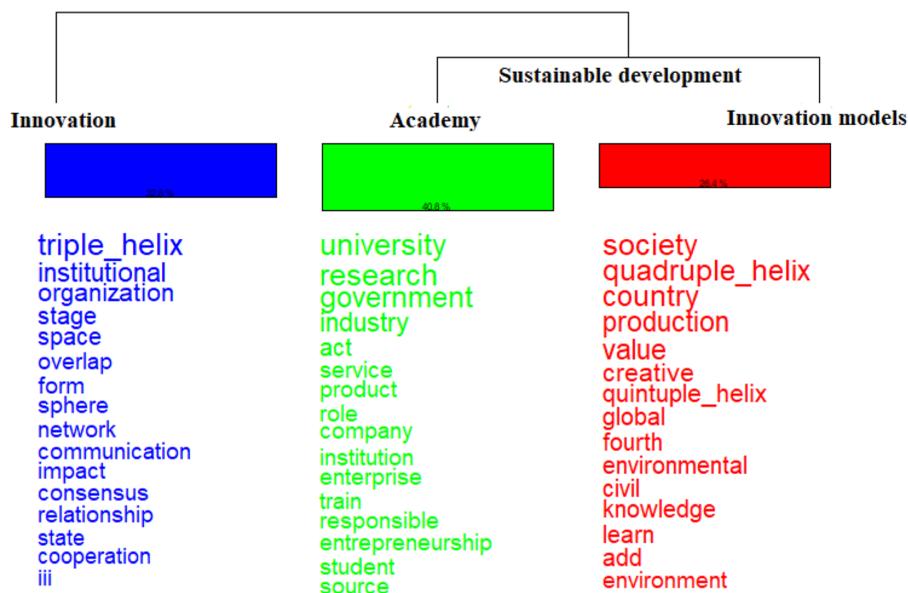


Figure 3. The descending hierarchical classification phylogram on the representation of the classes of the research studies. Source: Prepared by the authors, based on the results of IRAMUTEQ

with industry and government. Terms such as *university*, *research*, *company*, and *role* emphasize the active participation of universities in generating new products and services and their influence on broader development goals. The **Innovation Models** subclass (26.4%) extends this perspective by integrating *civil society* and the *environmental* considerations – key features of the Quadruple and Quintuple Helix models. Words such as *society*, *environment*, and *global* indicate that innovation, in this context, is shaped by multifaceted factors beyond academia and industry, promoting a more inclusive approach.

The classification of content into these classes and subclasses reinforces a core point in innovation discourse: the necessity for integration across different societal sectors. However, a more detailed analysis of the phylogram reveals the formation of two distinct classes – **Innovation** and **Sustainable Development** – with significant percentages of 32.8% and 40.8%, respectively. This denotes a separation between the concepts, despite the presence of terms related to integration. This division suggests that although the lexicon and ideas associated with innovation and sustainable development often emphasize integration and collaboration between different spheres (such as academia, government, industry, and society), there is a distinction in the approaches and emphases of these two fields in the texts analyzed in this research.

The **Innovation** class, with 32.8% of the content, is strongly linked to the Triple Helix model, wherein collaboration among universities, government, and industry is essential. Terms such as *institutional*, *organization* and *network* highlight the importance of networks in the innovation process, while *stage*, *space* and *overlap* suggest that innovation occurs across different stages and spaces where interactions between sectors are intertwined.

On the other hand, the **Sustainable Development** class, representing 67.2% of the content, addresses broader issues that go beyond technological innovation and include social, environmental and economic dimensions. The subdivision of this class into **Academia** (40.8%) and **Innovation Models** (26.4%) highlights the centrality of academia in the process of reflecting on and formulating new models that more broadly integrate innovation and

sustainability – though still with some separation between the sectors. This distinction may indicate that although there is increasing attention to the importance of integrating innovation and sustainable development, the two concepts continue to be treated separately in the texts analyzed. This suggests that full integration of innovation and sustainable development remains a challenge.

Table 3 presents the most frequent and significant words in the analyzed articles for a deeper understanding. Among the most cited and significant terms in the **Innovation Models** class are *university, society, environment* and *helix*, which reflect studies on the Triple Helix model and its developments within universities. Innovation models have been studied and applied in spaces established by universities, such as technological parks, which are focal points for innovation model research in Brazil (Bencke, Dorion, Prodanov, & Olea, 2020).

In the context of the **Academia** subclass, frequent and significant terms include *university, company, industry, government* and *development*. This result underscores the university's role as a key actor in promoting development by integrating the elements of the Triple Helix. However, without the cooperation of other actors, academia alone cannot drive development and foster innovation. Additionally, the frequent and significant terms in the **Innovation Models** subclass – *model, Triple Helix, actor, and relationship*—underscore the necessity of collaboration among all Triple Helix elements for innovation to occur, as theorized by Etzkowitz and Zhou (2017).

The findings indicate a misalignment between government, academia, and business, suggesting a gap in collaboration among these actors in the promotion of innovation and development. This lack of synchronization may result from various factors. Structural issues – such as the disconnect between academic research agendas and market demands – can hinder the generation of knowledge and its practical application. Additionally, government bureaucracy and the absence of specific incentive policies for collaboration may limit cooperation between academia and business.

This misalignment among academia, the government, and the business sector has implications for Brazil's ability to fully leverage its innovation capacity. The lack of strong linkages between scientific research and technological development in business can hinder the

Table 3. The main significant words by class of the descending hierarchical classification of the research studies

Words	Innovation models		Academy		Innovation	
Knowledge	18	8.064	16	-0.35	9	-4.19
Society	14	21.062	4	-4.945	3	-3.925
Production	11	14.859	6	-0.247	0	-9.604
University	9	-5.091	36	24.716	10	-9.522
System	7	4.519	1	-7.394	6	0.723
Environment	7	6.967	0	-9.149	5	0.473
Helix	7	6.967	2	-3.201	3	-0.366
Model	11	0.182	9	-6.622	18	5.257
triple_helix	6	-5.693	9	-11.637	29	33.77
Actor	4	-0.189	4	-3.005	10	4.94
Development	4	-0.502	12	3.634	4	-1.77
Research	4	-2.379	22	23.597	1	-13.228
Company	3	-1.906	14	6.992	4	-2.166
Relationship	2	-2.53	5	-1.476	11	7.647
Government	2	-12.554	27	20.688	9	-2.058
Industry	2	-7.392	21	15.625	6	-2.513
Role	1	-9.13	17	7.004	9	0.004
Institutional	0	-4.761	1	-5.793	11	20.869

Source(s): Prepared by the authors, based on the results of IRAMUTEQ

transformation of ideas into marketable products and services. This, in turn, can impact the country's global competitiveness and its ability to meet the evolving needs of society. To effectively implement the Triple Helix model in Brazil, a better understanding of its dynamics is required. In [Iata and Cunha \(2018\)](#) have demonstrated this:

the use of "ready-made" models for articulating the helixes without taking into account the state's regional differences and that regardless of the model adopted, it will be necessary to understand the regional players in each helix and the best way for them to work in an integrated manner (p. 186).

The isolated development of the Triple Helix actors does not promote innovation. Instead, integrated action among the helixes is essential to generate meaningful results in innovation – an approach successfully implemented in the United States, for instance. In Brazil, despite national and state-level efforts to foster innovation, the primary obstacle remains the lack of integration among Triple Helix actors ([Silva et al., 2019](#)).

Expanding the Triple Helix into the Quadruple and Quintuple Helix models offers a promising pathway to address these challenges. Including civil society and the environment as active stakeholders in the innovation process can provide more diverse and comprehensive perspectives. The incorporation of civil society can help ensure that innovations are more responsive to the real needs of the population.

Technology parks offer a viable mechanism for Brazil to engage in innovation development through the Triple Helix model. However, the original three helices may be insufficient. [Bencke et al. \(2020\)](#) suggest that the fourth helix – represented by civil society – is indispensable for the effective implementation of technology parks in Brazil.

The fifth helix – the environment – can promote more sustainable and responsible solutions. However, it is important to recognize that the successful implementation of the Quadruple and Quintuple Helix models also requires coordinated alignment and collaborative will among all stakeholders to foster green innovation ([Aligod & Hassane, 2018](#)). This underscores the need for a broader cultural shift in which collaboration is encouraged, barriers are removed, and incentives are aligned to promote more harmonious interaction among sectors.

Ultimately, the results of this research reinforce the importance of fostering greater understanding, cooperation, and coordination among government, academia, and business in Brazil. Only through this integrated collaboration – grounded in a more comprehensive approach that includes civil society and the environment – can the country unlock its full innovative potential and address the complex challenges it faces both globally and locally.

5. Final considerations

This research provides an overview of the literature on the dynamics of the Triple Helix and its developments in the Brazilian context, highlighting the interactions among universities, industry, and government. Through a content analysis of academic texts, the study identifies the challenges associated with integrating these elements to achieve economic, social, and environmental progress.

In response to the guiding question of this research – *How has the academic literature approached the Triple Helix theory and its developments as a model for implementing innovation in Brazil, identifying the main challenges for its application in society?* – the study finds that integration among diverse social sectors lies at the core of Helix models. However, this very integration also emerges as the main barrier to effective innovation.

Another key finding is the need for the Triple Helix model to be adapted to local and regional specificities, avoiding a one-size-fits-all application across varied contexts. The misalignment among key sectors – government, academia, and business – is a significant conclusion of this study, underscoring the necessity of fostering greater cooperation and mutual understanding among the involved parties. Creating spaces for dialog and collaboration, establishing more innovation-oriented public policies, and promoting

strategic partnerships can significantly contribute to aligning the objectives and interests of these actors.

For future research, case studies conducted within innovation habitats are recommended to further examine the relationships among the involved actors, with the goal of enhancing innovation processes in the Brazilian context.

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