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THE INTELLECTUAL ARCHITECTURE OF THE BIOCEANIC ROUTE: A BIBLIOMETRIC ANALYSIS OF SOUTH AMERICAN INTEGRATION (2012–2025)

A ARQUITETURA INTELECTUAL DA ROTA BIOCEÂNICA: UMA ANÁLISE BIBLIOMÉTRICA DA INTEGRAÇÃO SUL-AMERICANA (2012–2025)

LA ARQUITECTURA INTELECTUAL DE LA RUTA BIOCEÁNICA: UN ANÁLISIS BIBLIOMÉTRICO DE LA INTEGRACIÓN SUDAMERICANA (2012–2025)

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ABSTRACT

As the Bioceanic Route (RILA) transitions from a logistical concept to a physical reality, academic interest has undergone a corresponding transformation. This study presents a comprehensive bibliometric analysis of 75 records retrieved from the SciELO Citation Index between 2012 and 2025. The findings reveal a dramatic research inflection point in 2019, marking the onset of an “explosive growth” phase in which 73% of the total output was generated. Despite the international nature of the corridor, the academic landscape exhibits a profound geographic asymmetry, with Brazilian institutions contributing 85,7% of the scientific production. Through keyword clustering, four primary research streams were identified: (1) Tourism and Economic Development; (2) Geopolitical Integration; (3) Sociocultural Impacts; and (4) Geographic Case Studies. The analysis further identified critical gaps in environmental impact assessments and technical engineering studies, as well as a significant “synthesis gap” due to the scarcity of review articles. Finally, the paper proposes a strategic roadmap for multinational scientific integration to match the corridor’s physical advancement.

Keywords: Bioceanic Route. RILA. Bibliometrics. Regional Integration. South America.

RESUMO

À medida que a Rota Bioceânica (RILA) transita de um conceito logístico para uma realidade física, o interesse acadêmico passou por uma transformação correspondente. Este estudo apresenta uma análise bibliométrica abrangente de 75 registros recuperados do SciELO Citation Index entre 2012 e 2025. Os achados revelam um ponto de inflexão dramático na pesquisa em 2019, marcando o início de uma fase de “crescimento explosivo”, na qual 73% da produção total foi gerada. Apesar da natureza internacional do corredor, o cenário acadêmico exibe uma profunda assimetria geográfica, com instituições brasileiras contribuindo com 85,7% da produção científica. Por meio do agrupamento de palavras-chave (clustering), quatro fluxos principais de pesquisa foram identificados: (1) Turismo e

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Desenvolvimento Econômico; (2) Integração Geopolítica; (3) Impactos Socioculturais e (4) Estudos de Caso Geográficos. A análise identificou, ainda, lacunas críticas em avaliações de impacto ambiental e estudos técnicos de engenharia, bem como uma significativa “lacuna de síntese” devido à escassez de artigos de revisão. Ao final, o artigo propõe um roteiro estratégico para a integração científica multinacional, de modo a acompanhar o avanço físico do corredor.

Palavras-chave: Rota Bioceânica. RILA. Bibliometria. Integração Regional. América do Sul.

RESUMEN

A medida que la Ruta Bioceánica (RILA) transita de un concepto logístico a una realidad física, el interés académico ha experimentado una transformación correspondiente. Este estudio presenta un análisis bibliométrico exhaustivo de 75 registros recuperados del SciELO Citation Index entre 2012 y 2025. Nuestros hallazgos revelan un punto de inflexión dramático en la investigación en 2019, marcando el inicio de una fase de “crecimiento explosivo” donde se produjo o 73% de la producción total. A pesar del carácter internacional del corredor, el panorama académico exhibe una profunda asimetría geográfica, con instituciones brasileñas aportando el 85,7% de la producción científica. A través de la agrupación de palabras clave (clustering), se identifican cuatro líneas de investigación principales: (1) Turismo y Desarrollo Económico, (2) Integración Geopolítica, (3) Impactos Socioculturales y (4) Estudios de Caso Geográficos. El análisis identifica además brechas críticas en las evaluaciones de impacto ambiental y estudios técnicos de ingeniería, así como una significativa “brecha de síntesis” debido a la escasez de artículos de revisión. Este trabajo concluye proponiendo una hoja de ruta estratégica para la integración científica multinacional que esté a la altura del avance físico del corredor.

Palabras clave: Ruta Bioceánica. RILA. Bibliometría. Integración Regional. América del Sur.

1 INTRODUCTION

The Bioceanic Integration Corridor, commonly known as the Bioceanic Route (RILA), is one of the most ambitious infrastructure projects in contemporary South America. Spanning from the Atlantic port of Santos in Brazil to the Pacific ports of Antofagasta and Iquique in Chile, the corridor is designed to revolutionize regional logistics and trade. However, while the physical construction of bridges and roads advances, the development of a corresponding “knowledge infrastructure”, the body of academic research required to guide sustainable and inclusive development, remains fragmented.

Academic interest in the corridor was marginal for nearly a decade, but a dramatic shift occurred around 2019, likely triggered by heightened intergovernmental policy announcements and tangible planning milestones. This expansion of scholarly engagement shifted the focus from speculative integration to empirical analysis. Yet, as the field expands, it faces significant structural challenges. The current body of literature is heavily concentrated in a single regional journal and is dominated by Brazilian institutional perspectives, creating a potential imbalance in the corridor’s multinational narrative.

This study aims to map the intellectual architecture of Bioceanic Route research using bibliometric techniques. By analyzing 14 years of SciELO indexed data, we address three fundamental questions: (1) What are the temporal dynamics and growth phases of the research field? (2) Who are the leading institutional and individual contributors? (3) What is the core thematic clusters and the primary gaps in existing knowledge? By answering these questions, this paper provides the first systematic overview of the field, offering a roadmap for future scientific integration across all stakeholder nations.

2 RELATED WORKS

2.1 BIBLIOMETRIC ANALYSIS OF INFRASTRUCTURE AND INTEGRATION

Other corridor studies While the physical development of infrastructure corridors is a priority for global trade, the theoretical and bibliometric analysis of these complex projects remains scarce (Vining; Moore; Boardman, 2023). Vining, Moore and Boardman (2023) argue that there is limited theory and policy guidance specifically related to multijurisdictional and multimodal (M&M) infrastructure corridors, noting that the existing research often focuses on trade flows or stakeholder perspectives rather than the specific design and governance structures required for implementation.

They further highlight that much of the information regarding major corridor projects, such as the Belt and Road Initiative or the Trans-European Networks, is found in "grey literature" rather than quantitative research papers, leading to a scarcity of empirical data.

Conversely, specific corridor case studies, such as the analysis of the Kannur-Iritty corridor in India by Sooraj *et al.* (2025), have begun to integrate spatial and functional analyses to assess resilience strategies. This study defines a corridor as a spatially connected linear system integrating transport and land-use patterns, demonstrating how infrastructure can act as a catalyst for regional development and tourism beyond simple logistics.

Regional integration bibliometrics Bibliometric studies have also been utilized to map the intellectual structure of regional integration and governance, particularly within the Global South (Winters; Prado; Lazzari; Jardim, 2018). For instance, in the context of MERCOSUR, Winters *et al.* (2018) utilized bibliometrics to analyze the integration of higher education, identifying how knowledge exchange and free movement, key components of the bloc's consolidation, are reflected in scientific production.

Their findings highlighted a predominance of qualitative studies and a concentration of research output in Brazil, suggesting an asymmetry in regional knowledge production. Similarly, Gomes and Merchán (2017) employed bibliometric analysis to examine transnational governance, noting that despite the growing importance of the topic, there is a significant lack of studies addressing the Latin American context (Gomes; Merchán, 2017). Their analysis revealed that most influential papers are theoretical rather than empirical, indicating a field still in maturation where research often relies on European contexts rather than the specific realities of the Global South (Gomes; Merchán, 2017).

Methodological approaches Recent scholarship on infrastructure and urban development has employed increasingly sophisticated bibliometric workflows that combine quantitative performance analysis with content mining. Cardona *et al*. (2024) demonstrated the utility of combining the PRISMA methodology with text mining tools like "Voyant" and the R package "Bibliometrix" to analyze energy matrices, allowing for the identification of thematic clusters and trends over time (Cardona *et al.*, 2024).

Similarly, Menezes and Macadar (2025) utilized a mixed-methods approach using R Studio to perform content analysis alongside bibliometrics, enabling the identification of governance frameworks for Smart City Living Labs. In the transport sector, Sangroni-Laguardia *et al*. (2021) utilized density visualization maps and cluster analysis via UCINET software to identify variables connecting urban quality of life with transportation systems.

Furthermore, Schiavi and Hoffmann (2025) highlighted the value of technological mapping by integrating patent data from the Derwent Innovation Index with scientific publications from the Web of Science, a methodological approach that provides a more comprehensive view of innovation ecosystems in the automotive sector. Additionally, the use

of similarity analyzers and tools like VOS viewer has been effective in creating bibliometric networks to visualize keyword relevance and conceptual correlations in urban energy studies (Tobar; Robaina, 2024).

2.2 BIBLIOMETRIC ANALYSIS OF INFRASTRUCTURE AND INTEGRATION

The Latin American Integration Route (RILA), commonly known as the Bioceanic Corridor, represents a strategic infrastructure project designed to connect the Atlantic and Pacific oceans, linking the territories of Brazil, Paraguay, Argentina, and Chile (Almeida; Teixeira; Figueira, 2019; Asato; Gonçalves; Wilke, 2019).

Historically framed within the Initiative for the ntegration of Regional Infrastructure in South America (IIRSA), the corridor aims to drastically reduce logistical costs and transit time for South American exports, particularly commodities like soy and meat, to Asian markets, offering a competitive alternative to the Panama Canal (Alves; Violin; Benites, 2021; Weber; Marques, 2024).

Beyond its economic rationale, the route carries profound geopolitical significance, transitioning regional integration from diplomatic rhetoric to physical connectivity and transforming border zones into central logistical hubs (Akamine; Oliveira; Shiota, 2023; Almeida; Silva; Sales; Laura, 2021).

This acceleration in physical infrastructure has catalyzed a parallel phenomenon in the academic landscape. While political discussions date back to the early 2000s, scientific production regarding the corridor experienced a decisive "inflection point" around 2019 (Barretto; Cunha; Assis, 2024).

This surge correlates directly with the institutionalization of the University Network of the Latin American Integration Route (UniRila), a diplomatic-academic alliance formed to provide the technical and social studies required by national governments (Maciel; Siufi; Tabilo; Leiva, 2019; Almeida; Teixeira; Figueira, 2019). Consequently, the bibliometric analysis of this topic reveals not just the organic growth of a research field, but the organized mobilization of a "knowledge infrastructure" essential for supporting transnational development.

3 MATERIALS AND METHODS

This study employs a systematic three-phase methodology to analyze research trends concerning the Bioceanic Route/Corridor. The workflow integrates established bibliometric techniques with a custom analytical pipeline to ensure reproducibility and accuracy across multilingual regional datasets.

3.1 DATA RETRIEVAL AND SEARCH STRATEGY

The SciELO Citation Index, accessed via the Web of Science (WoS) platform, was selected as the primary data source. This choice was driven by SciELO's specialized coverage of Latin American scientific literature, essential for a topic focused on the regional development of Brazil, Paraguay, Argentina, and Chile. By indexing journals in Portuguese, Spanish, and English, SciELO provides a comprehensive view of the regional scholarly output often underrepresented in global databases.

A multi-lingual Boolean search string was executed in January 2026 to capture relevant publications: TS = ("Rota Bioceânica" OR "Corredor Bioceânico" OR "Ruta Bioceánica" OR "Bioceanic Corridor" OR "Bioceanic Route" OR "Route Biocéanique").

The temporal scope encompassed publications from 2012 to 2025. This search yielded 75 records, which were exported with full metadata (including abstracts, author, keywords and affiliations) for analysis.

3.2 DATA CURATION AND PROCESSING

All 75 retrieved records were retained for analysis. A custom Python script was developed to parse, clean, and standardize the raw metadata. This included normalizing author names and keywords. A critical step involved parsing affiliation data to accurately identify the country of origin for each author, with specific attention to the core Bioceanic Corridor nations. The resulting structured dataset was validated before analysis.

3.3 BIBLIOMETRIC ANALYSIS

The analytical phase utilized three complementary approaches: performance metrics, including Bradford's Law to identify core journals; network analysis, via a co-authorship map filtered to authors with at least two publications to highlight significant collaborations; and thematic analysis, using keyword co-occurrence to trace the field's conceptual evolution through bilingual visualizations.

3.4 METHODOLOGICAL LIMITATIONS

While rigorous, this study has limitations. Reliance on SciELO may exclude relevant works indexed only in Scopus or the WoS Core Collection. The citation impact of very recent publications (2024–2025) may not be fully realized. Finally, affiliation parsing depends on the consistency of the source metadata, which can occasionally use non-standard formats.

4 RESULTS

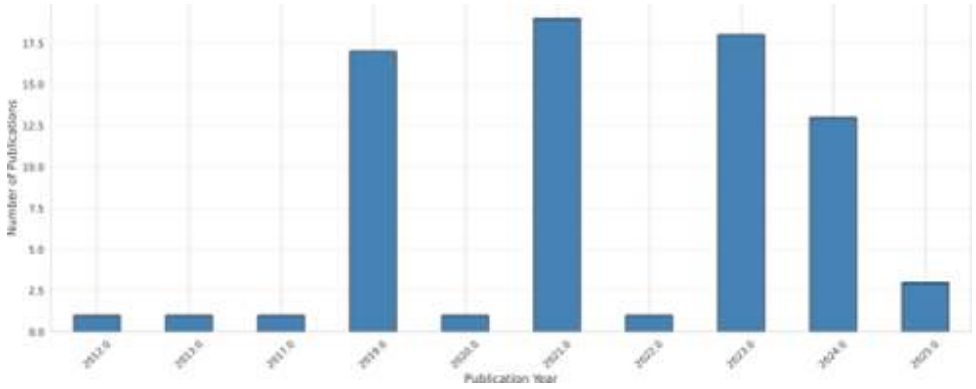
4.1 DATASET OVERVIEW AND TEMPORAL EVOLUTION

The bibliometric analysis encompasses a total of 75 research outputs indexed in the SciELO Citation Index over a 14-year period, from 2012 to 2025. This dataset provides a comprehensive snapshot of the academic discourse surrounding the Bioceanic Route (RILA) during its transition from a conceptual proposal to a concrete infrastructure project.

The temporal distribution of these publications reveals a non-linear growth pattern, characterized by a prolonged period of dormancy followed by an abrupt acceleration in scholarly activity. As illustrated in Figure 1, the cumulative growth curve exhibits a strong upward convexity, indicating that the field did not develop through gradual incrementalism but rather through a series of significant surges.

Figure 1

Temporal evolution of Bioceanic Route research (2012–2025)



Source: Elaborated by the authors.

The evolution of the field can be categorized into three distinct phases:

Emergence Phase (2012–2018): During this initial seven-year window, academic production was marginal, accounting for only 4% of the total corpus (n = 3). These sporadic publications represent isolated efforts before the corridor achieved a unified research agenda.

Explosive Growth (2019–2021): A critical inflection point occurred in 2019, which saw 17 publications in a single year. This phase accounted for 49% of the total dataset (n = 37), reaching an all-time peak in 2021 with 19 publications.

Sustained Activity (2022–2025): Following the peak, the field transitioned into a period of stabilization, contributing 46% of the total output (n = 35). This sustained volume suggests that the Bioceanic Route has moved beyond a transient trend to become a consolidated theme in South American regional studies.

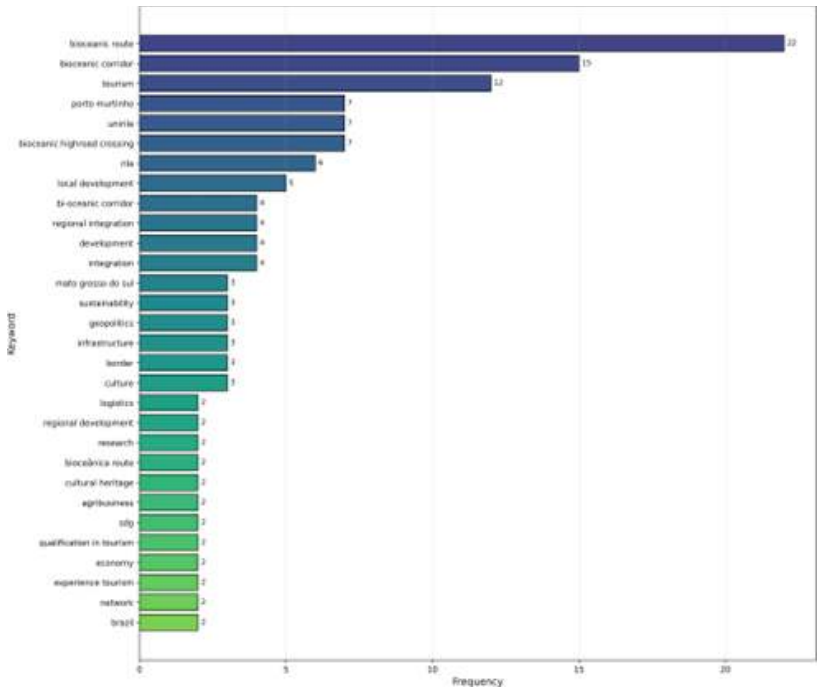
The dramatic surge initiated in 2019 likely reflects a response to heightened intergovernmental policy announcements and specific milestones in the Bioceanic Corridor's infrastructure timeline. These external catalysts effectively triggered a significant expansion of scholarly engagement, shifting the focus from speculative integration to empirical analysis of regional development and logistics.

4.2 THEMATIC LANDSCAPE AND KEYWORD CLUSTERING

The intellectual structure of Bioceanic Route research is defined by a multidisciplinary landscape centered on regional development and corridor identity. An analysis of the 186 unique author keywords reveals a thematic concentration on the definition of the corridor itself and its potential for tourism-driven growth. The most frequent terms, such as "bioceanic route" (n = 22) and "bioceanic corridor" (n = 15), establish the primary focus, while "tourism" (n = 12) emerges as the most prominent application domain (Figure 2).

Figure 2

Frequency analysis of top author keywords, highlighting the dominance of tourism and regional integration themes



Source: Elaborated by the authors.

The academic discourse is organized around five dominant thematic clusters. The Core Corridor Identity establishes the technical and symbolic definition of the route, while Tourism and Regional Development focuses on socioeconomic expectations surrounding

local sustainability. Strategic dimensions are addressed through the Integration and Geopolitics cluster, which emphasizes logistics and border dynamics.

Empirically, the field is centered on a Geographic Anchor, specifically Porto Murtinho and Mato Grosso do Sul, identifying them as the corridor's primary gateways. Finally, an Institutional Framework dominated by the UNIRILA university network highlights the pivotal role of academic collaboration in driving the current research agenda (Figure 3).

Figure 3

Word cloud visualization of author keywords, representing the conceptual hierarchy of the Bioceanic Route discourse

Source: Elaborated by the authors.

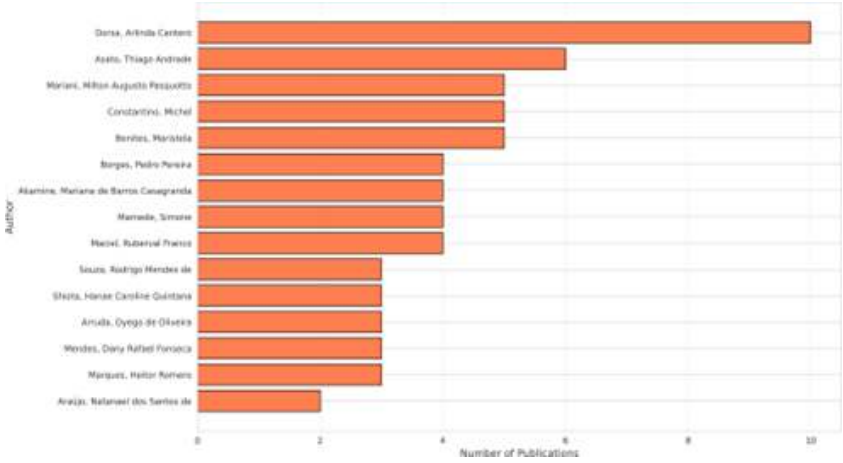
Despite the multidisciplinary character of the corpus, several “thematic frontiers” remain underexplored. Environmental impacts, indigenous perspectives, and technical engineering dimensions appear rarely in the keyword analysis. This suggests that while the narrative of tourism and regional integration is well-established, the technical feasibility and long-term sustainability of the corridor represent significant gaps for future scholarly investigation.

4.3 RESEARCH LEADERSHIP AND INSTITUTIONAL ANCHORING

The intellectual landscape of Bioceanic Route research is characterized by a high degree of concentration, both in terms of individual productivity and institutional affiliation. An analysis of the 161 unique authors identified in the dataset reveals a core-periphery structure typical of emerging scientific fields. Productivity is led by a small, highly active group of researchers, with Arlinda Cantero Dorsa (n = 10; 13,3% of total output) and Thiago Andrade Asato (n = 6) emerging as the most prolific contributors (Figure 4).

Figure 4

Top 20 most productive authors in Bioceanic Route research based on SciELO- indexed publications



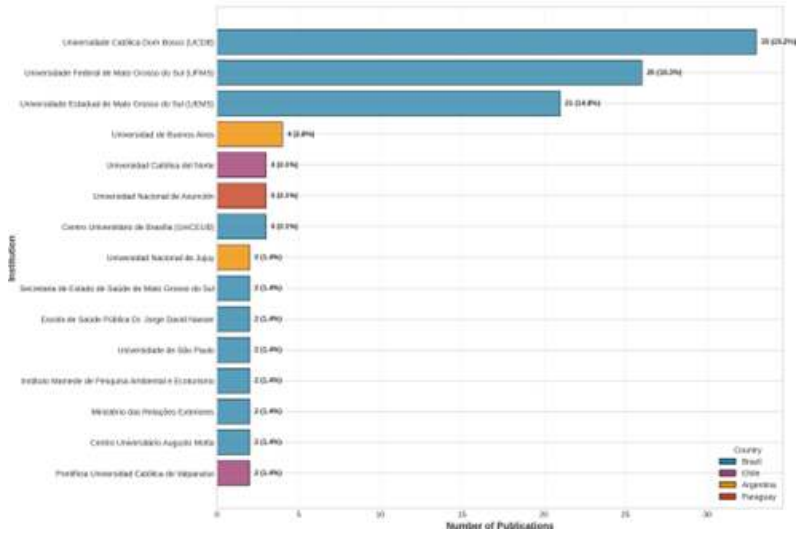
Source: Elaborated by the authors.

The distribution of authorship conforms to the patterns described by Lotka's Law (Lotka, 1926), indicating a centralized knowledge production base. Approximately 77,6% of authors (125 of 161) have contributed only a single publication, while the top 15 authors account for 47,4% of the total research output. This suggests that while a broad peripheral community engages with the topic sporadically, the field's theoretical and empirical foundation is anchored by a narrow leadership group.

This individual concentration is mirrored at the institutional level, where production is heavily dominated by universities located in Mato Grosso do Sul, Brazil (Figure 5).

Figure 5

Leading institutions by affiliation mentions, highlighting the dominance of the Mato Grosso do Sul research hub

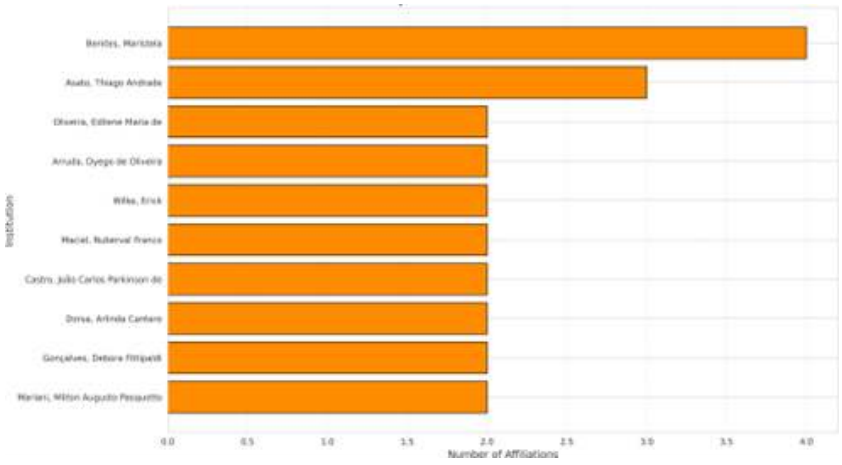


Source: Elaborated by the authors.

The Universidade Católica Dom Bosco (UCDB), the Universidade Federal de Mato Grosso do Sul (UFMS), and the Universidade Estadual de Mato Grosso do Sul (UEMS) represent the primary research hubs, collectively accounting for most institutional mentions (Figure 6).

Figure 6

Top 15 research institutions by publication count and percentage. Colors represent country of origin



Source: Elaborated by the authors.

This regional anchoring reflects the corridor's geographic origin and the strategic mobilization of local research capacity.

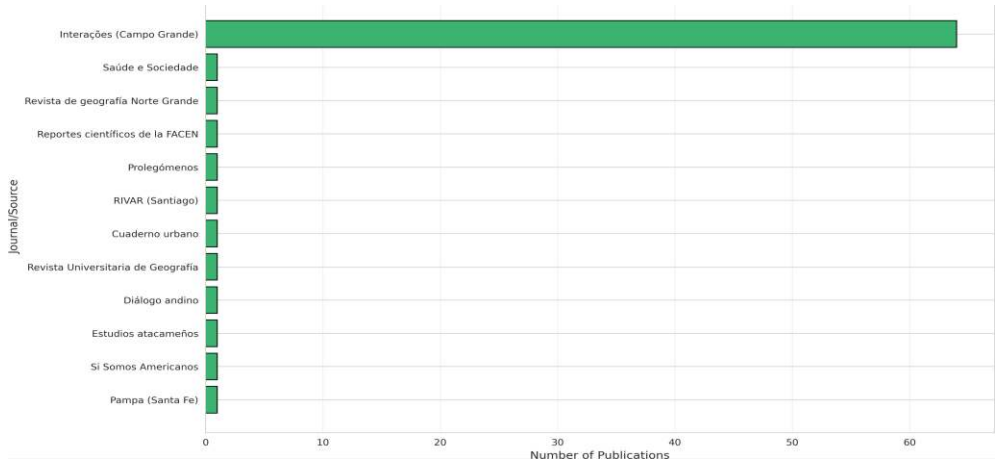
While the institutional landscape is predominantly Brazilian, the presence of international institutions (such as the Universidad de Buenos Aires - Argentina; Universidad Católica del Norte - Chile; Universidad Nacional de Asunción - Paraguay), is detectable. However, their combined contribution remains marginal, totaling only 10 mentions. This institutional imbalance reinforces the characterization of the field as a Brazil-centered research agenda, despite the corridor's inherently transnational objectives.

4.4 PUBLICATION OUTLETS AND LINGUISTIC LANDSCAPE

The dissemination of Bioceanic Route research is characterized by extreme outlet concentration and a fragmented linguistic landscape. An analysis of the 75 records reveals that publication venues are heavily anchored in a single regional source rather than dispersed across international platforms. "Interações" alone accounts for 85,3% of the total output (n = 64), while the remaining 14,7% is distributed among 11 distinct journals (Figure 7).

Figure 7

Distribution of publications by source, highlighting the extreme concentration in a single regional jornal



Source: Elaborated by the authors.

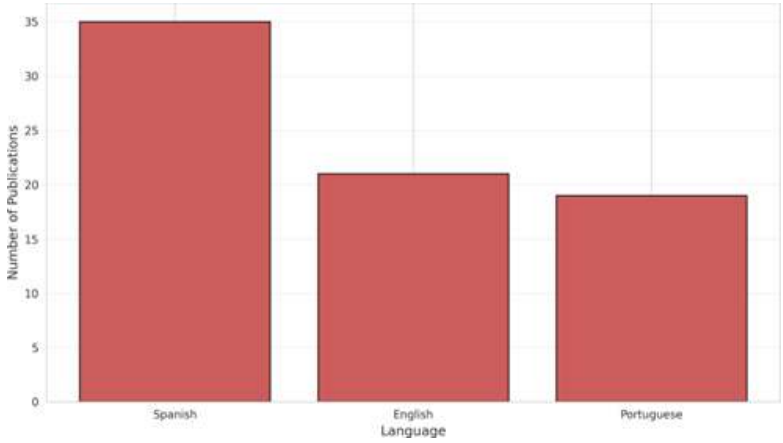
This distribution represents a significant deviation from the classical patterns described by Bradford's Law (Alabi, 1979). Instead of a multi-journal core, the field relies on a single dominant platform. While "Interações" provides a highly specialized and interdisciplinary venue for regional development themes, this extreme concentration may act as a visibility constraint, limiting the international reach and cross-disciplinary diffusion of the research. The peripheral outlets, though few, span diverse fields such as geography,

public health, and Latin American studies, indicating that while the themes are multidisciplinary, the outlet dispersion is not.

The linguistic profile of the corpus reflects the regional and transnational context of the corridor, distributed across three primary languages (Figure 8).

Figure 8

Language distribution of Bioceanic Route research publications



Source: Elaborated by the authors.

Spanish is the most frequent language of publication (46,7%), followed by English (28,0%) and Portuguese (25,3%). This trilingual pattern, while natural given the stakeholder countries (Brazil, Paraguay, Argentina, and Chile), creates a "fragmentation effect" that may slow knowledge transfer across language communities.

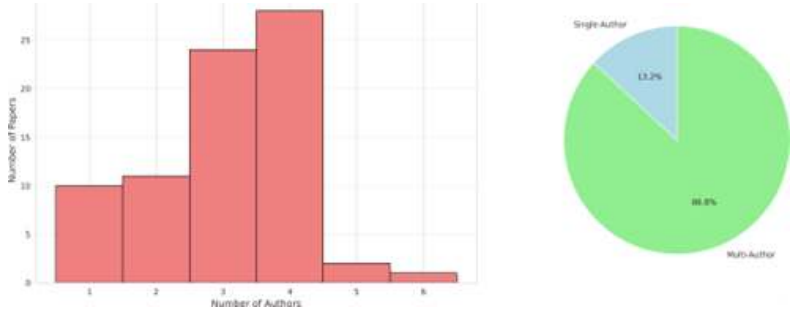
Notably, while the 28% English-language presence indicates an effort toward global dissemination, the heavy reliance on regional languages and a single local journal remains a strategic challenge for increasing the field's international citation potential and influence.

4.5 COLLABORATION NETWORKS AND TEAM STRUCTURES

The analysis of collaboration patterns reveals a research community characterized by high team-based activity but significant structural fragmentation. A strong collaborative culture is evident, as 88% of the publications are multi-authored, with only 12% produced by single authors (Figure 9).

Figure 9

Collaboration statistics and team size distribution in Bioceanic Route research



Source: Elaborated by the authors.

The average team size is 3.08 authors per paper, indicating that the field is driven by small, consistent research groups rather than isolated scholarly efforts. The distribution of team sizes, as detailed in Table 1, shows that most publications involve 3 to 4 authors (69,3% combined), a moderate intensity of collaboration that is typical of interdisciplinary social science research. However, the co-authorship network is organized around these small, localized teams rather than expansive consortia; papers involving five or more contributors remain rare (4% combined). This structural characteristic suggests a fragmented landscape where research clusters operate with limited large-scale integration across the field.

Table 1

Distribution of Research Team Sizes

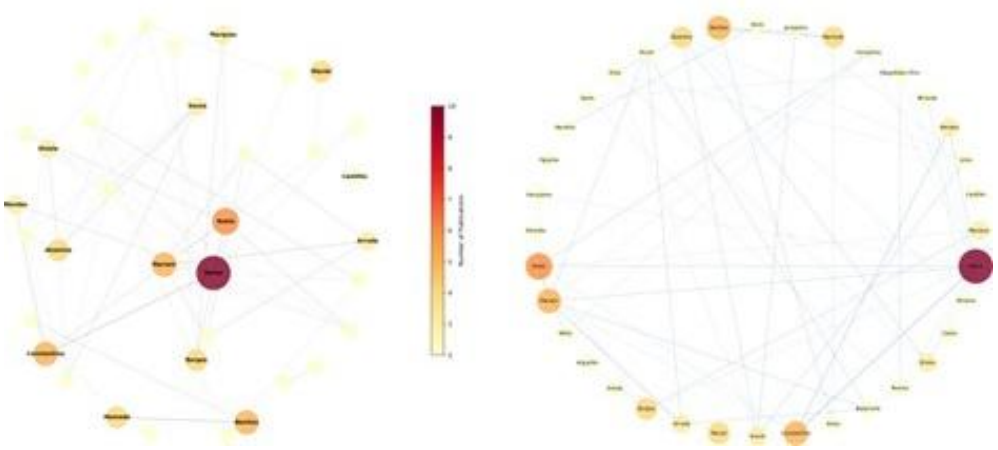
Team Size	Publications	Share (%)
1 author	9	12%
2 authors	11	14,7%
3 authors	24	32%
4 authors	28	37,3%
5 authors	2	2,7%
6 authors	1	1,3%

Source: Elaborated by the authors.

Key connectors within this network are the most productive authors, notably Dorsa *et al.* (2024); Asato *et al*. (2019); Constantino *et al*. (2019) and Benites *et al.* (2019), who serve as anchors for recurring collaboration clusters (Figure 10). Despite the high internal collaboration rate, cross-country and international partnerships are limited.

Figure 10

Co-authorship network visualization showing localized research clusters and key connector authors



Source: Elaborated by the authors.

This lack of transnational integration represents a significant gap for a field centered on a multinational corridor, highlighting a clear opportunity for future regional integration and institutional diversification in research production.

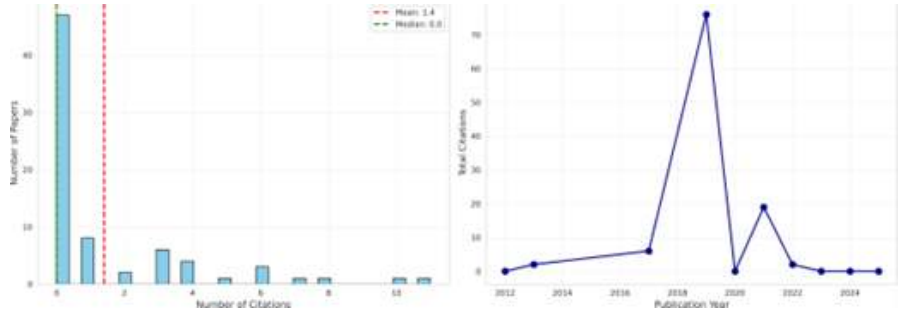
4.6 CITATION IMPACT AND KNOWLEDGE INFLUENCE

The citation impact of Bioceanic Route research remains in an emergent state, reflecting the field's rapid and recent expansion. A total of 105 citations were identified across the 75 publications, resulting in a mean of 1.40 citations per paper. The median citation count of zero - indicating that 50% of the corpus remains uncited - and an estimated h-index of 6 further characterizes this as an early-stage research domain where impact is still consolidating.

Influence within the field is highly concentrated in works published during the 2019 inflection year, which serves as the intellectual foundation for subsequent research. As shown in Figure 11, the top cited papers are foundational to the discourse, led by Castro *et al.* (2021) (11 citations) and Asato *et al*. (2019) (10 citations), both focusing on the corridor's potential for tourism development.

Figure 11

Citation metrics and distribution for Bioceanic Route research, highlighting the foundational role of 2019 publications



Source: Elaborated by the authors.

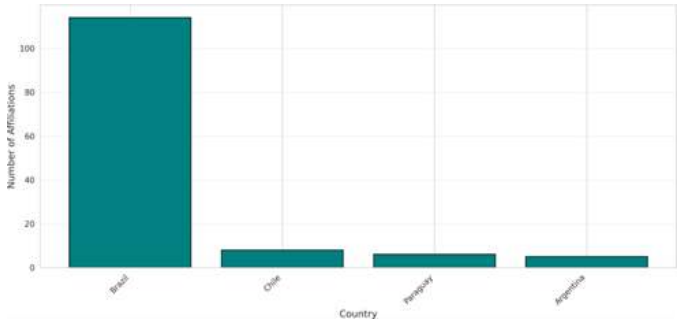
Temporal analysis of citation patterns confirms this concentration: 2019 alone accounts for 76 citations, while recent outputs from 2023–2025 have yet to accumulate significant citations due to standard citation lag. The relatively modest metrics are largely the result of structural and temporal constraints, including the field's recentness and its concentration in regional, multilingual outlets. These foundational works establish the baseline upon which the current sustained research activity is built.

4.7 GEOGRAPHIC DISTRIBUTION AND DOCUMENT TYPOLOGY

The geographic distribution of author affiliations reveals a pronounced asymmetry across the four corridor nations. Although the Bioceanic Corridor is a transnational project physically connecting four equal partners, research participation is heavily concentrated in a single country. Brazil accounts for more than five-sixths of all institutional affiliations (85,7%), while the contributions from Chile (6%), Paraguay (4,5%) and Argentina (3,8%) combined represent less than 15% of the total output (Figure 12).

Figure 12

Geographic distribution of institutional affiliations, highlighting the significant Brazilian dominance in corridor research



Source: Elaborated by the authors.

This geographic imbalance likely stems from a combination of factors, including Brazil's larger academic infrastructure and the strategic concentration of research around the corridor's Brazilian gateway in Porto Murtinho (Almeida *et al.*, 2021; Arguelho *et al.*, 2023).

Furthermore, the fact that the field's primary journal, "Interações", is edited by the Dom Bosco Catholic University in Campo Grande, Brazil, has established it as the primary vehicle for the thematic dossiers that consolidated the field, which may naturally facilitate submissions from Brazilian authors and perpetuate a regional concentration of scientific output (Barretto *et al.*, 2024).

This disparity poses a significant challenge for the field, as the underrepresentation of perspectives from the Pacific terminus in Chile and the transit regions of Paraguay and Argentina risks a Brazil-centric interpretation of corridor dynamics (Barretto *et al.*, 2024; Oliveira *et al.*, 2023).

Recent qualitative assessments from the Chilean terminus confirm the dangers of this disconnect; local transport service providers in Antofagasta report feeling detached from the corridor's planning, viewing it as an external initiative with limited local integration or information flow (Scholvin; Franco, 2024).

Moreover, the lack of balanced academic scrutiny from all four nations obscures critical asymmetries in labor protections and legal frameworks, potentially masking social vulnerabilities in the Paraguayan Chaco and Northern Argentina that a purely logistical, Brazil-originating perspective might overlook (Félix *et al.*, 2024; Oliveira *et al.*, 2023). Regarding document typology, the dataset is overwhelmingly composed of original empirical research. Research articles account for 94,7% of the corpus (n = 71), while review articles and editorials each represent only 2,7% (n = 2).

The near-absence of review articles is a critical indicator of the field's maturity; it suggests that while original data is being produced rapidly, the scientific community has yet to engage in the systematic synthesis required to consolidate findings and guide future policy across all stakeholder countries.

4 DISCUSSION

The bibliometric profile of Bioceanic Route research reveals a field in an early stage of scientific maturation. A defining characteristic of this corpus is its temporal concentration: 73% of all publications indexed in SciELO appeared after 2019 (Almeida *et al.*, 2019; Barretto *et al.*, 2024). This pattern suggests that the RILA research agenda is not the result

of a long-standing academic tradition, but rather a recently consolidated response to tangible infrastructure and policy milestones (Barretto *et al*., 2024; Asato *et al*., 2019).

The identified 2019 inflection point serves as a clear marker of this transition (Barretto; Cunha; Assis, 2024). This surge in scholarly output aligns with heightened institutional attention to the corridor, specifically the formation of collaborative networks such as UniRila, which served to legitimize the topic as a transdisciplinary research priority (Dorsa; Borges, 2024; Maciel *et al*., 2019).

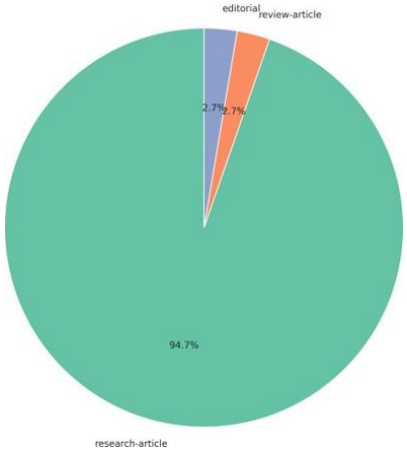
Such patterns are typical in emerging research areas, where academic engagement often “trails” the formalization of public policy or large-scale physical projects, as evidenced by the gap between the initial political agreements in 2015 and the subsequent strengthening of the academic network in 2017 and 2018.

When contextualized against other global and regional integration agendas, the Bioceanic Route exhibits significant growth potential despite its current size. While established initiatives like the Belt and Road Initiative or IIRSA represent mature or developing ecosystems (Quiñones; Pinto; Ponce-Hille, 2019; Vining; Moore; Boardman, 2023), the 75-publication *corpus* of the RILA corridor reflects a nascent stage of consolidation (Barretto; Cunha; Assis, 2024).

However, the fact that research volume did not collapse following the 2021 peak, but instead maintained a high baseline through 2024, indicates that the field has achieved a level of durable relevance (Figure 13). This stability suggests that Bioceanic Route research has moved beyond a transient academic trend and is poised to become a sustained line of inquiry as the physical corridor nears operational completion (Shiota; Dorsa; Corazza; Vilhanueva, 2023; Castro, 2021).

Figure 13

Distribution of publication types, showing the scarcity of review articles and synthesis Papers



Source: Elaborated by the authors.

The structural architecture of Bioceanic Route research is defined by high levels of concentration across four dimensions: authorship, publication outlets, institutional affiliations and geography. This concentrated profile simultaneously defines the field's leadership core and exposes it to risks of academic insularity.

At the individual level, authorship follows a pronounced Lotka-style distribution (Lotka, 1926) where a small productive core anchors nearly half of the field's output. The top 15 authors appear in 47,4% of publications, contrasted against a large peripheral group (77,6%) that has published only once. This productive core is largely composed of researchers linked to the University Network of the Latin American Integration Route (UniRila), specifically those who have actively participated in the thematic working groups established since 2017 (Weber; Marques, 2024).

While this concentration ensures a coherent research agenda and strong leadership, it also signals an over-reliance on a limited number of researchers, potentially constraining succession capacity and the influx of diverse perspectives. Recent bibliometric reviews confirm this trend, noting that despite the existence of international networks, the production remains heavily reliant on a specific group of Brazilian researchers who often appear across multiple thematic dossiers (Barretto; Cunha; Assis, 2024).

The most extreme form of concentration is observed in publication outlets, where "Interações" accounts for 85,3% of the total research volume. This significant deviation from the multi-core structure typically expected under Bradford's Law indicates that the field is heavily reliant on a single regional platform.

This dominance is not accidental but structural; "Interações" has served as the primary vehicle for the field's consolidation through the publication of specific "Thematic

Dossiers" in 2019 and 2021, which aggregated the initial scientific output of the corridor (Weber *et al*., 2024; Barretto *et al*., 2024). While this strengthens the sense of community identity and ensures editorial continuity, it inevitably limits international visibility and slows the integration of Bioceanic Route studies into broader global debates on infrastructure and logistics.

This pattern of local anchoring is mirrored institutionally and geographically. The dominance of a Mato Grosso do Sul - based institutional hub (UCDB, UFMS, and UEMS) ensures strong local ownership of the research agenda but can reduce methodological diversity (Akamine *et al*., 2021). These institutions were the signatories of the "Carta de Campo Grande" in 2016, which formally established the academic commitment to the corridor, thereby centralizing the initial scientific coordination within the state of Mato Grosso do Sul (Dorsa; Borges, 2024; Basso; Ferretti, 2021).

Most critically, there is a fundamental mismatch between the corridor's transnational infrastructure scope and its research participation. With Brazil representing 79,7% of affiliations compared to the combined 18% from Argentina, Chile, and Paraguay, the current scholarly narrative is significantly Brazil-centered. This asymmetry risks marginalizing the viewpoints of Pacific terminus and transit countries, which are essential for a holistic understanding of the corridor's multinational impacts.

Indeed, external analyses have already pointed to a "diffuse" governance and a lack of coordination between key actors across the four countries as a major weakness of the corridor's implementation (Scholvin; Franco, 2024). Without a more balanced academic production from Chile, Argentina, and Paraguay, the "integration" aspect of the RILA risks remaining a unilateral projection rather than a multilateral reality (Barretto *et al*., 2024).

The geographic imbalance in the research landscape stems from Brazil's robust academic infrastructure and the strategic positioning of Porto Murtinho as a logistics "hub." As the corridor's primary Brazilian gateway and a recipient of massive infrastructure investment, this municipality has naturally become the focal point of initial scientific inquiry.

This concentration is further reinforced by editorial factors. The journal "Interações", based in Campo Grande, has served as the primary vehicle for the thematic dossiers that consolidated the field. This institutional link naturally facilitates a higher volume of submissions from Brazilian authors, perpetuating a regional concentration of output.

This disparity poses a significant structural challenge: the underrepresentation of perspectives from the Chilean Pacific terminus and the transit regions of Paraguay and Argentina risks a "Brazil-centric" interpretation of corridor dynamics. For the field to reach

maturity, it is essential to integrate these multinational perspectives to match the physical advancement of the project.

Furthermore, comparative research, benchmarking the RILA against other international integration corridors, is almost non-existent. Perhaps most critically, the "synthesis gap" is evidenced by the fact that only 2,7% of the corpus consists of review articles. The shortage of systematic reviews and meta-analyses hinders cumulative knowledge building and complicates the consolidation of evidence for regional planners.

Future research should prioritize multinational collaboration to integrate the socioeconomic and political perspectives of all stakeholder nations; comprehensive impact assessments focusing on environmental sustainability and the welfare of vulnerable communities; systematic knowledge synthesis to bridge the fragmentation between existing regional studies and longitudinal monitoring to evaluate the corridor's performance as advances to full operational status.

The modest citation metrics observed, a mean citation rate of 1.40 per paper and an h-index of 6, must be interpreted through the lens of structural and temporal constraints. As a nascent field where 73% of the corpus is less than five years old, the primary driver for low citation counts is the field's youth rather than a deficit in research quality. However, two additional factors likely suppress the global visibility of Bioceanic Route research: linguistic fragmentation and journal indexing.

The trilingual nature of the literature - Spanish (46,7%), English (28%), and Portuguese (25,3%) - reflects the corridor's regional context but also creates significant "readership siloes". While the 28% English-language presence indicates an attempt at global outreach, it remains below the thresholds typically required for high-velocity international dissemination. Furthermore, the extreme concentration of 85,3% of publications in a single regional journal, "Interações", limits the field's exposure to audiences who primarily monitor global transport and regional studies databases. To bridge this "visibility gap," strategic diversification into international outlets and the adoption of multilingual metadata are essential next steps for the community.

5 CONCLUSION

This bibliometric analysis provides the first comprehensive mapping of the academic discourse surrounding the Bioceanic Route (RILA). Our findings reveal a research field that underwent a dramatic "Big Bang" in 2019, transitioning from a decade of dormancy to a state of sustained and significant growth. This surge, largely centered in Brazilian institutions, has established tourism and regional integration as the dominant thematic pillars of the field.

However, the field faces three critical challenges as it moves toward maturation. First, there is a profound geographic asymmetry: while the corridor is an international project, 85,7% of research production is concentrated in Brazil, leaving the perspectives of Chile, Paraguay, and Argentina significantly underrepresented. Second, the “synthesis gap”, evidenced by the near-absence of review articles (2,7%), indicates that the field has yet to consolidate its empirical findings into actionable policy frameworks. Finally, critical themes such as environmental sustainability, indigenous rights, and technical infrastruc- ture engineering remain underexplored frontiers.

To achieve a balanced “knowledge infrastructure” that matches the physical comple- tion of the corridor, we recommend the formation of a multinational research consortium and the prioritization of systematic reviews. Only through integrated, transborder scien- tific collaboration can the Bioceanic Route realize its potential as a truly inclusive and sustainable development project for South America.

Despite the comprehensive nature of this mapping, several limitations must be acknowledged. First, the scope of the analysis is restricted to the SciELO Citation Index. While SciELO is the premier repository for Latin American scholarship, it does not capture the entirety of global output. Relevant publications indexed exclusively in Scopus, the Web of Science Core Collection, or gray literature sources (technical government reports, for example) were not included, which may lead to an underrepresentation of purely technical engineering studies or global logistics analyses published in non-regional outlets.

Second, the study is subject to the inherent “citation lag” associated with bibliometric metrics. Because 73% of the publications in this corpus appeared after 2019, many of the most recent and potentially impactful studies from the 2024-2025 period have not yet had sufficient time to accumulate citations. Consequently, the reported citation impact should be viewed as a preliminary baseline rather than a definitive measure of long-term influence.

Finally, technical constraints related to metadata quality and parsing must be noted. Keyword analysis was dependent on the availability of author-provided terms, and missing metadata in some records may have obscured emerging or niche research topics. Additionally, the geographic distribution relies on the automated parsing of affiliation strings, which is subject to minor classification errors in cases of non-standard institutional for- matting. These limitations do not invalidate the findings but suggest that they should be interpreted as a focused characterization of the regional, SciELO - indexed academic discourse rather than a global census of all corridor-related knowledge.

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