



Article

Territorial Governance and Technological Convergence: Toward a Methodological Framework for Social Innovation Based on Artificial Intelligence and the Multi-Helix Model from the Global South

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Abstract

Social Innovation (SI) has emerged as a strategic paradigm for addressing systemic challenges in highly uncertain environments. However, its practice still reveals epistemological fragmentation that risks reducing SI to welfare-oriented approaches. This article presents a critical and constructive analysis aimed at mitigating the “methodological myopia” that persists in social impact assessment. Through a systematic literature review and a qualitative case study in the Antofagasta Region (Chile), the article argues that the scientific validity of SI depends on longitudinal, multidimensional, and territorially grounded evaluative frameworks. The study examines the relationship between SI and Artificial Intelligence (AI) as a source of methodological rigor, improving traceability and auditability while supporting the scaling of interventions. In response to techno-topian forms of determinism, the article proposes an ethical and participatory governance framework based on the Multi-Helix model, integrating academia, the public sector, private enterprise, and civil society in the co-creation of public value. The findings suggest that the institutionalization of SI through AI must move beyond procedural efficiency to foster structural transformation. In Antofagasta, this AI-supported certification architecture is already operational within the Regional Innovation Strategy (ERI) 2022–2028 through the executed FIC-R 2023 project on Social Innovation Certification. The Antofagasta experience is therefore presented as an illustrative case of territorial governance, offering transferable principles for other Global South contexts rather than a directly replicable model.

Keywords: social innovation; artificial intelligence; territorial governance; multi-helix model; Global South

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1. Introduction: The Paradigm Shift in Social Innovation (2020–2025)

Over the last five years, research on social innovation (SI) has shifted from conceptual consolidation toward epistemological and methodological reconfiguration driven by global systemic crises. Although foundational literature is focused on defining the concept, and mapping its various semantic meanings (Rüede and Lortz 2012), evaluating its position as an emerging area within innovation studies (Van Der Have and Robalcaba 2016), systematically reviewing its conceptual evolution and future research agenda (Adro and Fernandes 2020), examining its theoretical and practical contestation (Marques

et al. 2018), and providing comprehensive retrospective overviews of the field's evolution (Sataikina and Steiner 2022), contemporary scholarship (2020–2025) is characterized by a move toward operationalization and impact measurement in contexts of global crisis. Consequently, this change in focus has made it possible to examine SI not only as a response to market failures, but also as a critical component of the “dual transition” (ecological and digital). This perspective aligns with foundational contributions that conceptualize social innovation as a collective learning process embedded in power relations and institutional change (Howaldt et al. 2014; Molgan et al. 2011; Molgan 2019; Murray et al. 2010; Freire 2017; Hernández-Ascanio et al. 2016).

One of the pillars of this new stage is the digital transition. In this regard, authors such as Son et al. (2025) show that digital platforms are no longer mere support tools but environments for co-creation in which digital social networks expand the production of social value. This technological dimension is also closely linked to social inclusion, as research on social entrepreneurship shows that innovation can become a key driver of digital literacy among vulnerable populations, including older adults. This intersection reflects broader contemporary trends and discourses within the evolving scholarship of social entrepreneurship and innovation (Sampaio and Sebastião 2024), as well as institutional efforts to map regional best practices (UNESCO and CLACSO 2024).

Simultaneously, the question of the nature of SI has shifted from theoretical definition toward the evaluation of systemic impact. Recent studies, such as those by Jareh (2025) and Gómez-Cano (2023), propose rigorous metric frameworks linked to the Sustainable Development Goals (SDGs), arguing that transformative social innovation can fundamentally enhance the operational guidelines of the SDG framework (Pamplona et al. 2024). Consequently, the success of a social innovation increasingly depends on its capacity to be embedded in sustainable microfinance models and territorial development strategies. This metric-based approach is further reinforced by the study of individual capabilities; in this regard, Serrano Cárdenas and Casanova (2025) identify the “DNA of the social innovator” through a skills-based analysis that supports the standardization of human capital development in the sector.

Nevertheless, the issue of social impact measurement, previously analyzed by Jareh (2025), finds its epistemological roots in what Hernández-Ascanio et al. (2023) refer to as the “modeling problem.” According to these authors, SI suffers from a lack of theoretical consolidation that hinders the creation of universal models. This conceptual fragmentation and the structure of global scientific production have been visually mapped through network analyses (Melo and Soares 2021), confirming that the scientific community must address the conceptual fragmentation that prevents SI from being treated as a mature scientific discipline rather than merely a collection of best practices and project management guides (e.g., Ledec 2016).

Finally, the consolidation of SI is evident in its institutionalization within governance ecosystems. The longitudinal work of Andion et al. (2020) in Brazil, together with the proposals of Bocio-Mendoza and Solis-Navarrete (2025), underscores that resilience to crises (such as the post-pandemic period) depends on the robustness of collaborative networks between the State and civil society. Likewise, the integration of SI into the circular economy, validated by Ziegler et al. (2023), confirms that environmental sustainability is inseparable from innovation in social practices of consumption and production. This intersection is further demonstrated by the deployment of open innovation frameworks within corporate governance models for sustainable transitions (Lippolis et al. 2023). In summary, these authors configure a field of study in which SI is accepted as an indispensable management technology for systemic transformation in the 21st century.

Despite these advances, SI still faces a persistent challenge: the difficulty of evaluating its impact in a rigorous, comparable, and territorially grounded manner. In this re-

gand, systematic literature reviews on social innovation assessment underscore the complexities of capturing long-term societal outcomes (Mildenberger et al. 2020). Recent scholarship points to a recurring evaluative bias in SI research, characterized by an over-reliance on short-term, output-oriented indicators that fail to distinguish marginal improvements from systemic transformations. This limitation has been conceptualized here as “methodological myopia” because it obscures critical dimensions such as collective agency, the reconfiguration of power relations, and long-term social sustainability.

Under this premise, the acceleration of digital transformation has introduced new analytical tools. Within this framework, artificial intelligence (AI) is positioned as a methodological mediator capable of enhancing traceability and sustaining longitudinal evaluative processes. However, its uncritical adoption entails significant risks; namely, the technocratization of the social sphere and the reproduction of algorithmic biases. These risks underscore the critical need to align technological integration with global ethical guidelines to safeguard social inclusion (UNESCO 2025).

Against this background, this article proposes an integrative methodological framework that brings together SI, territorial governance, AI, and the multi-helix model from a perspective situated in the Global South. This positioning aligns with recent calls to deeper examine how social innovation becomes institutionalized within the specific institutional and socio-political realities of the Global South (Bocio-Mendoza and Solis-Navarrete 2024). Based on a systematic review (2020–2025) and a case study in the Antofagasta Region (Chile), the article suggests that the scientific study of SI benefits from longitudinal evaluative frameworks capable of capturing processes of structural transformation.

To this end, the article makes an original contribution in three dimensions. First, it offers a critical conceptualization of “methodological myopia” as a structural epistemological problem linked to the modeling process. Second, it proposes a multidimensional evaluative architecture explicitly designed for Global South contexts. Third, it examines this architecture through the Antofagasta case, treated as a “living laboratory”, illustrating how AI can function as an editing instrument without reducing SI to technocratic forms of assistance. In this way, the study helps bridge the gap between theory and implementation by proposing a territorially grounded governance framework with broader analytical relevance.

In these terms, the research problem addressed by this article is how to evaluate social innovation in territorially complex Global South contexts without falling into short-term, output-based reductionism. Two research questions guide the inquiry: (RQ1) What epistemological limitations of existing evaluative approaches are revealed by recent social innovation literature? (RQ2) Under what conditions can an AI-supported, multi-helix evaluative architecture contribute to a longitudinal and territorially grounded assessment of social innovation?

2. Theoretical Framework

2.1. Social Innovation in the Global South: The Modeling Problem and Innovation by Necessity

Social innovation (SI) has emerged as a robust interdisciplinary field aimed at addressing complex problems that transcend the operational capacities of both the State and the market. Nevertheless, despite its progressive institutionalization, the scientific literature converges on the view that the field still exhibits fragmented epistemological consolidation, which obstructs the structuring of comparable evaluative frameworks. Recent studies identify this deficit as a modeling problem, characterized by a lack of conceptual architectures capable of capturing nonlinear and territorially situated processes of social change. This limitation becomes critical in the Global South, where SI predominantly manifests as “innovation by necessity” rather than the incremental optimization of well-being (Bocio-Mendoza and Solis-Navarrete 2024; Rojas and Pérez Marchant 2025). In this con-

text, the transposition of standardized evaluative models—designed for contexts of abundance—tends to render underlying structural transformations invisible. Consequently, the value of SI in regions characterized by extractive economies and socio-environmental vulnerability, such as Antofagasta, cannot be reduced to conventional economic efficiency. Rather, its impact is reflected in the community's capacity to sustain livelihoods and strengthen territorial autonomy. Therefore, the imposition of exogenous standards may lead to cognitive extractivism. Overcoming this risk requires contextualized methodological approaches with heuristic sensitivity to territorial heterogeneity and conditions of structural scarcity, capable of weighing the density of social networks against geographic and technological adversity.

2.2. Territorial Governance, the Multi-Helix Model, and the Challenge of "Methodological Myopia"

Contemporary literature maintains that social innovation (SI) does not constitute an isolated phenomenon, but rather results from complex interactions among actors situated at multiple territorial scales. Under this premise, helix models have evolved from explanatory schemes of knowledge-based development into analytical infrastructures of governance essential for the co-creation of public value. This relational perspective is consistent with Moollaert et al. (2013), who conceptualize Social Innovation as a territorially embedded process of collective action, social learning, and institutional transformation. Rather than emerging from isolated organizational initiatives, social innovation evolves through collaborative governance arrangements that enable diverse actors to co-create public value within specific territorial contexts.

Epistemologically, the classic Triple Helix model (Etzkowitz and Leydesdorff 1995, 2000; Etzkowitz 2008) serves as the foundational cornerstone for conceptualizing innovation ecosystems. This framework originally developed as an institutional articulation matrix designed to drive economic and industrial growth during the Information and Communication Technology (ICT) revolution. Within this paradigm, the model conceptualized a synergistic triad of academia, state, and industry, prioritizing linear technology transfer and market competitiveness as the primary engines of development. Building upon this theoretical groundwork, the paradigm underwent a necessary conceptual evolution to address increasingly complex socio-technological environments. Consequently, Carayannis and Campbell (2009) formulated the "Quadruple Helix" model, which extends rather than diminishes the contributions of its predecessor by integrating civil society as a core actor. This expansion transforms the ecosystem through a "knowledge democracy", elevating citizens from passive recipients to active drivers of innovation. Carayannis and Campbell (2012) later consolidated this approach by introducing "Open Innovation Diplomacy", arguing that contemporary economic competitiveness hinges on a democratic regime capable of enabling the free co-evolution of knowledge. Further theoretical expansions culminated in the Quintuple Helix model (Carayannis et al. 2012), which integrates the natural environment and socio-ecological sustainability as an indispensable fifth dimension of the innovation ecosystem.

However, to effectively address Global South asymmetries and transition toward Social Innovation (SI), regional literature early on signaled the need for a structural reconfiguration of these helices. Grounded in this rationale, adaptive research conducted in the Antofagasta Region by the Universidad Católica del Norte (UCN)—specifically by Ricci and Concha (2018a)—strongly advocated for the Multi-Helix Model of Social Innovation (MMHIS). This proposal marks a critical shift away from the original techno-centric focus: it reconfigures territorial actors (academia, the public sector, private enterprise, and grassroots communities) to prioritize expanding network capacity, strengthening social capital, and fostering collective well-being over strict ICT-driven productive efficiency. Conse-

qoently, the complementary frameworks developed doring this period (Concha and Ricci 2018; Ricci and Concha 2018b) provided structural coherence and dynamism to a medium- and long-term trajectory that is fundamental to this article, precisely because it positions local communities as both the inspirational catalyst and the epistemic foundation underpinning territorial governance. Ultimately, it is this institutional legacy at UCN that provides the conceptual maturity and theoretical backing for the AI-driven algorithmic governance and certification architecture currently being examined under the Regional Innovation Strategy (ERI) 2022–2028 (Gobierno Regional de Antofagasta (2022).

By formally incorporating civil society, grassroots communities, and localized institutional trajectories, this integrated multi-helix framework provides an especially suitable infrastructure for analyzing SI in contexts of high institutional complexity. However, its application in the Global South requires critical adaptation because historic power asymmetries and extractive trajectories constrain the effectiveness of purely procedural approaches. From this perspective, territorial governance is defined not only as coordination among actors but also as a methodological mechanism for safeguarding legitimacy and social sustainability.

This governance dynamic faces a central challenge concerning impact evaluation. Recent evidence shows a persistent dependence on short-term, output-focused indicators that make it difficult to distinguish between marginal improvements and systemic transformations. This phenomenon, conceptualized here as “methodological myopia”, is limiting because it obscures substantive dimensions such as collective agency and the reconfiguration of power relations. From a critical standpoint, impact evaluation is recognized as an inherently political and epistemological process. Overcoming methodological myopia, therefore, requires the deployment of longitudinal and multidimensional evaluative frameworks capable of capturing emerging dynamics in complex social systems, especially in territories where structural scarcity conditions the viability of innovative solutions.

2.3. Artificial Intelligence as an Embedded Methodological Instrument for Ethical Governance

The incorporation of artificial intelligence (AI) into public management has opened new possibilities for traceability and the continuous evaluation of social interventions. In the domain of SI, AI can be understood as a methodological catalyst with the potential to strengthen the auditability of complex processes. At the same time, the literature warns against technocentric forms of adoption. This interpretation is consistent with recent conceptualizations of social technologies as instruments that should remain socially embedded and oriented toward sustainability and collective well-being (Osoegawa and Chaves 2024). In this regard, Calzada (2024) cautions that artificial intelligence for social innovation must move beyond the mere noise of algorithms and datafication, emphasizing instead context-sensitive, ethically governed, and socially embedded forms of technological mediation. AI should not supplant democratic deliberation; rather, it is conceptualized here as an instrument embedded in ethical governance arrangements and multi-actor participation. This hybrid-intelligence approach is essential to prevent technocratic forms of assistance and to ensure that technological mediation strengthens, rather than erodes, the social legitimacy of evaluation. The structural differences between conventional impact evaluation frameworks and situated approaches to social innovation in the Global South are synthesized in Table 1, highlighting the shift from efficiency-based metrics toward collective agency, territorial resilience, and ethical governance.

Table 1. Comparison of Evaluative Approaches: Traditional vs. Situated Social Innovation (Global South).

Evaluation Dimension	Traditional Approach (Global North)	Situated Approach (Global South/Antofagasta)
Nature of Impact	Operational efficiency and incremental well-being optimization	Sustaining livelihoods and addressing basic needs (structural transformation)
Predominant Metric	Quantitative outputs and linear scalability (growth)	Collective agency and network density under conditions of scarcity
Relationship with the Environment	Adaptation to digital markets and service economies	Resilience to extractive economies and socio-environmental tensions
Role of Technology	Inclusive digitalization and lifestyle improvement	Hybrid intelligence for traceability and territorial technological autonomy
Methodological Risk	Technical fragmentation of indicators	Cognitive extractivism and imposition of exogenous standards
Governance	Procedural multi-actor coordination	Mechanism of legitimacy and territorial sovereignty in the face of power asymmetries ¹

¹ Source: Prepared by the author.

3. Materials and Methods

3.1. Research Approach and Design

The study is situated within a qualitative paradigm, with a critical and proposal-oriented scope and an applied orientation. This design is epistemologically consistent with the nonlinear and multivariate nature of social innovation (SI) in highly complex systems. The methodological architecture is grounded in ecological validity, prioritizing interpretive robustness and territorial relevance over conventional statistical reductionism. The design is articulated through two synergistic axes: (a) a Systematic Literature Review (SLR) guided by protocols for identifying epistemological biases, and (b) an instrumental case study situated in the Antofagasta Region (Chile), analyzed as a living laboratory within the framework of the Regional Innovation Strategy (ERI) 2022–2028, where Social Innovation Certification has begun to be implemented through the executed FIC-R 2023 project. Crucially, the analytical design establishes an epistemological synchronization between both axes: the literature corpus is restricted to the contemporary 2020–2025 frontier to mirror the exact multi-year design, promulgation, and early institutionalization cycle of the regional public policy (Gobierno Regional de Antofagasta 2022).

3.2. Systematic Literature Review (SLR) and Identification of Epistemological Biases

An SLR was conducted focusing on the intersection of SI, territorial governance, and artificial intelligence (AI) during the 2020–2025 period. This temporal horizon captures the transition of the field from conceptual abstraction to impact operationalization. Furthermore, this five-year bounding (2020–2025) operates as a coeval observation window explicitly aligned with the empirical lifecycle of the Antofagasta case. By evaluating the scientific production published in parallel to the design and rollout of the ERI 2022–2028, the study strategically tests whether the methodological myopia identified in global literature remains an active epistemic bias in the current frontier of the discipline, rather than a legacy issue of past decades.

The final corpus (n = 31) was extracted from mainstream databases (Scopus, WoS, Scielo, and Redalyc) by applying inclusion criteria based on methodological consistency and thematic relevance. The SLR functioned not only as a state-of-the-art review but also as a mechanism for identifying recurring epistemological biases, such as the predominance of short-term output indicators and theoretical fragmentation. The data were processed using a categorical analysis matrix, which facilitated the identification of tensions

between global standardization and territorial singularity (see Methodological Appendix A.1 for the adapted PRISMA flow diagram).

In this study, the SLR is used not as a quantitatively exhaustive meta-analysis, but as a qualitative-analytical strategy for identifying conceptual gaps, epistemological tensions, and evaluative trends relevant to the proposed framework.

3.3. Situated Qualitative Case Study: Antofagasta Region

The unit of analysis is the Antofagasta Region, selected because of its condition as an extreme territory and its advanced process of SI institutionalization. The case is approached as a situated analytical setting for examining the convergence between multi-actor governance and AI.

The selection of this case also responds to its relevance for observing how social innovation is integrated into a territorial public policy framework rather than remaining confined to isolated projects. In Antofagasta, the ERI 2022–2028 provides the strategic umbrella under which Social Innovation Certification is linked to regional development priorities, allowing the study to examine the articulation between policy design, multi-actor governance, and evaluative operationalization.

To enhance traceability, the case reading draws on a bounded documentary corpus beyond the ERI 2022–2028 itself. The materials consulted include regional policy and implementation documents, public dissemination materials related to the Social Innovation Certification process, institutional web content, and project-related technical records associated with the executed FIC-R 2023 process. This documentary basis is also consistent with broader regional policy orientations in Latin America, where digital technologies are increasingly framed as instruments for sustainable development and data-based governance (CEPAL 2025). The observation window corresponds to the 2022–2025 period, selected because it covers the initial institutionalization of the ERI and the early operationalization of Social Innovation Certification in Antofagasta.

Within this framework, the process involves a multi-actor configuration that includes the Regional Government of Antofagasta, academic institutions and professionals linked to social innovation, territorial stakeholders participating in certification and validation dynamics, and an ad hoc governance committee responsible for reviewing the architecture's public legitimacy and operational coherence. The main objectives are to institutionalize social innovation as a regional policy capacity, provide traceable and transparent evaluative criteria, and align certification practices with broader territorial development goals.

Illustrative inventory of case materials consulted: (i) the Regional Innovation Strategy (ERI) 2022–2028; (ii) project documentation linked to the executed FIC-R 2023 initiative on transfer, management, and certification of Social Innovation in the Antofagasta Region; (iii) institutional and public-facing materials describing the certification process, governance architecture, and operational deployment of the AI-supported system; and (iv) complementary records used for case systematization, including methodological notes and documentary evidence of implementation milestones.

The case study was operationalized through four analytical dimensions:

- Participatory diagnosis: Collection of relational and narrative data on territorial resilience.
- Multi-helix governance: Analysis of public value co-creation among heterogeneous actors.
- Multidimensional evaluation: Design of longitudinal metrics that transcend quantitative bias.
- Technological convergence (AI): Assessment of AI as a mechanism for traceability and social auditing, subordinated to ethical algorithmic frameworks.

Building upon these analytical vectors, the algorithmic and governance workflow was explicitly designed to operationalize this infrastructure and directly counteract the biases of output-oriented reductionism. Specifically, the technological implementation was structured as a sequential pipeline driven by Natural Language Processing (NLP), aligning with contemporary frameworks for hybrid intelligence in public governance (Ansell and Gash 2018; Bryson et al. 2014). First, the NLP engine deploys an Information Extraction (IE) framework based on the 5W/1H syntactic paradigm (Who, What, Where, When, Why, How), adapted to parse the structured narrative data within the regional documentary corpus. This semantic decomposition systematically extracts core entities and relational vectors: the heterogeneous stakeholders involved (Who), the core social actions or innovative practices (What), the geopolitical and spatial boundaries (Where), the longitudinal implementation timeline (When), the underlying socio-territorial motivations and structural scarcities addressed (Why), and the operational mechanisms or collaborative dynamics deployed (How) (Menczer et al. 2020).

To achieve domain-specific semantic alignment for abstract conceptual categories—such as situated innovative merit and collective agency—the architecture underwent a rigorous human-in-the-loop (HITL) calibration protocol, a methodology validated for mitigating algorithmic bias in highly sensitive public domains (Amershi et al. 2014; Holzinger et al. 2019). This process involved the design of contextual rubrics and local analytical indicators that systematize the regional expert knowledge in social innovation. Simultaneously, the NLP tools were trained to process linguistic nuances, localized socio-economic variables, and the dense qualitative contexts inherent to Global South interventions. These expert-defined parameters function as an ontological baseline that guides the algorithmic constraint-satisfaction processing (Russell and Norvig 2020).

The structured parameters extracted through this calibration feed a multi-layer analytical matrix that automatically categorizes each initiative into one of three lifecycle stages (Ideation, Maturation, or Scaling). This classification is concurrently cross-referenced against five Qualitative Hyperparameters of Territorial Validation: Situated Innovative Merit, Multidimensional Sustainability, Capability Feasibility, Multi-Helix Governance, and Situated Impact.

Upon completion of this algorithmic processing, the system operationalizes a mixed-method evaluative framework by generating Automated Expert Analytical Reports. Crucially, these automated outputs do not supplant human judgment; rather, they serve as specialized analytical baselines for human verification, adhering to the principles of explainable and collaborative artificial intelligence (XAI) (Arrieta et al. 2020). Finally, these reports are submitted to the Multi-Helix Governance Committee—comprising representatives from academia, the public sector, private enterprise, and civil society. This pipeline provides explicit, auditable spaces for multi-stakeholder deliberation and democratic validation, combining advanced computational capabilities with localized expert knowledge to strengthen the transparency, analytical rigor, and public legitimacy of the certification architecture within a single, revelatory territorial setting (Janssen et al. 2020).

3.4. Analytical Procedure and Systematization

The analysis was structured in a five-phase logical sequence to ensure traceability of findings:

1. **Corpus organization:** Categorization of indexed material according to digital transition and sustainability axes.
2. **Construction of analytical axes:** Identification of “methodological myopia” as the guiding category for empirical contrast.
3. **Case systematization:** Analysis of operational dimensions in Antofagasta under the ERI 2022–2028 framework.

4. Conceptual triangulation: Comparative analysis of SLR trends, case evidence, and AI-mediated governance proposals.
5. Integrative synthesis: Formulation of conclusions based on the interdependence between scientific validity and situated relevance.

3.5. Rigor, Ethics, and Limitations

Study reliability is addressed through source triangulation and internal design consistency. In compliance with ethical standards, AI use is defined as an instrumental means subordinated to human deliberation. Intrinsic limitations include restricted causal attribution in complex environments and gaps in digital literacy; however, these are integrated into the analysis as structural conditions that support the relevance of a situated evaluative approach for the Global South.

In procedural terms, traceability was strengthened by maintaining a case inventory that linked each analytical dimension to specific documentary sources, dates, and implementation moments. This did not aim at exhaustive ethnographic reconstruction, but at ensuring that the interpretive claims advanced in the Results section remained anchored in identifiable documentary evidence.

The overall methodological architecture, including the units of analysis, analytical strategies, and corresponding rigor criteria, is summarized in Table 2, ensuring traceability and internal coherence between theory, method, and empirical outputs.

Table 2. Synthesis of the Methodological Design, Units of Analysis, Evidence, and Analytical Outputs ¹.

Component/Phase	Unit of Analysis (Source)	Analytical Strategy (What Is Done)	Output/Rigor Criterion (What Is Obtained/How It Is Supported)
Systematic Literature Review (2020–2025)	Corpus of 31 peer-reviewed articles (Scopus, WoS, Scielo, Redalyc).	Selection, screening, and organization into a Systematic Qualitative Content Matrix; identification of contemporary trends and operational gaps.	Four distinct thematic clusters (see Table 3); conceptual traceability through strict inclusion/exclusion criteria and PRISMA consistency.
Identification of Epistemological Tensions	Global social innovation field tensions (impact, measurement, standardization, governance).	Analytical deconstruction of “methodological myopia” and the “modeling problem” via a Global North/Global South critical contrast.	Guiding analytical axes for empirical contrast; theoretical coherence and internal consistency between theory and method.
Situated Single-Case Study (Antofagasta)	Antofagasta Region analyzed as a pioneering, revelatory living laboratory under the ERI 2022–2028 public policy framework.	Situated systematization of the regional ecosystem; deep qualitative territorial reading of a high-complexity, extractive setting (Yin 2018).	Analytical description of the case-pioneer and its paradoxes; high ecological validity and territorial relevance for the Global South.
Dimension 1: Participatory Diagnosis	Relational and narrative territorial data from regional initiatives.	Interpretive analysis to characterize localized needs, urgent community requirements, and endogenous assets.	Interpretive inputs; contextual relevance and coherence with the applied critical-qualitative paradigm.
Dimension 2: Multi-Actor (Multi-Helix) Governance	Academia–State–industry–civil society interactions within the FIC-R 2023 framework.	Analysis of multi-sector articulation as an institutional infrastructure for public value co-creation.	Legitimacy and cross-sector articulation mechanisms; consistency with ethical, decentralized, and participatory governance.
Dimension 3: Multidimensional/Longitudinal Evaluation	Long-term territorial evaluative parameters from the certification design.	Multidimensional approach to overcome output-based reductionism and track nonlinear structural transformation over time.	Ad hoc guidelines and evaluation criteria; coherence with complex social systems and capture of deep behavioral changes.
Dimension 4: Artificial Intelligence (Instrumental Use)	Narrative diagnosis records, certification-stage documents, implementation milestones,	Instrumental deployment of a sequential NLP pipeline using a 5W/1H syntactic framework and a Human-in-the-	Auditable traceability of SI processes; automated analytical reports subordinated to the Multi-

and multi-actor evaluative in-loop (HITL) calibration protocol (Rossell and Norvig 2020). Helix Governance Committee; mitigation of information asymmetries through explainable algorithms (XAI).

¹ Source: Prepared by the author.

Table 3. Thematic mapping of the literature corpus (2020–2025): Epistemological nodes and operational gaps.

Analytical Cluster	Core Epistemological/ Operational Tension Identified	Key Sources (n = 31)	Critical Node/Focus
Cluster I: Governance and Public Policy	Tension between top-down bureaucratic compliance and local multi-helix co-creation of public value.	Andion et al. (2020); Pérez-Hernández (2021); Castro et al. (2024); Matos et al. (2025); Ciasullo et al. (2020).	Public governance, collaborative networks, policy tools, and smart cities alignment.
Cluster II: Sustainability and Metrics (SDGs)	Methodological myopia: reliance on short-term, output-based indicators that obscure systemic, long-term transformation.	Bocio-Mendoza and Solis-Navarrete (2025); Jareh (2025); Pel et al. (2020); Vaquero García et al. (2025); Ziegler et al. (2023); Gómez-Cano (2023); Manzini (2022); Caeiro (2020).	Sustainable development goals, microfinance, circular economy, and design for sustainability.
Cluster III: Digitalization and Technology	Risk of technocentric automation vs. the need for embedded technological instruments for social inclusion.	Son et al. (2025); Morsalzade (2024); de França Filho (2024); Osoegawa and Chaves (2024); Cavazos-Arroyo and Poente-Díaz (2023); Edwards-Schachter (2021).	Digital platforms, social technology, data analytics, and digital literacy gaps.
Cluster IV: Epistemology and Territorial Capabilities	The “modeling problem” and cognitive extractivism: imposition of universal standards on territories characterized by scarcity.	Serrano Cárdenas and Casanova (2025); López Roiz (2024); Santos et al. (2025); Solís Navarrete et al. (2023); Hernández-Ascanio et al. (2023); Mazzucato (2023); Vázquez-Maguirre (2022); Larrán-Jorge et al. (2020); Severo et al. (2020); Melo and Soares (2021); Montgomery and Mazzei (2021).	Conceptual fragmentation, innovation by necessity, local scale, and human capabilities.

Source: Prepared by the author.

4. Results

4.1. Categorical and Thematic Mapping: From Conceptual Delimitation to Operational Gaps

The structural analysis of the selected literature corpus (n = 31) demonstrates a progressive epistemological maturation within the social innovation (SI) field. To ensure operational transparency and map these dynamics, the selected literature was organized into four specific analytical clusters (see Table 3), exposing the structural tensions between global standardization and localized territorial necessity.

As empirically illustrated in the co-occurrence network (Figure 1), this systematic grouping is marked by a clear disciplinary shift from abstract conceptual definitions toward empirical operationalization and complex impact measurement. The semantic map, validated through structural network analysis via VOSviewer, mathematically isolates the contemporary research frontier into four prominent, interconnected clusters that precisely correspond to the structure detailed in Table 3: (a) Cluster I, focusing on public governance and multi-helix co-creation policies; (b) Cluster II, capturing environmental sustainability and its strategic alignment with the Sustainable Development Goals (SDGs); (c) Cluster III, representing disruptive digitalization, artificial intelligence (AI), Big Data, and digital platforms; and (d) Cluster IV, examining the underlying epistemological foundations of territorial capabilities, structural scarcity, and innovation by necessity.

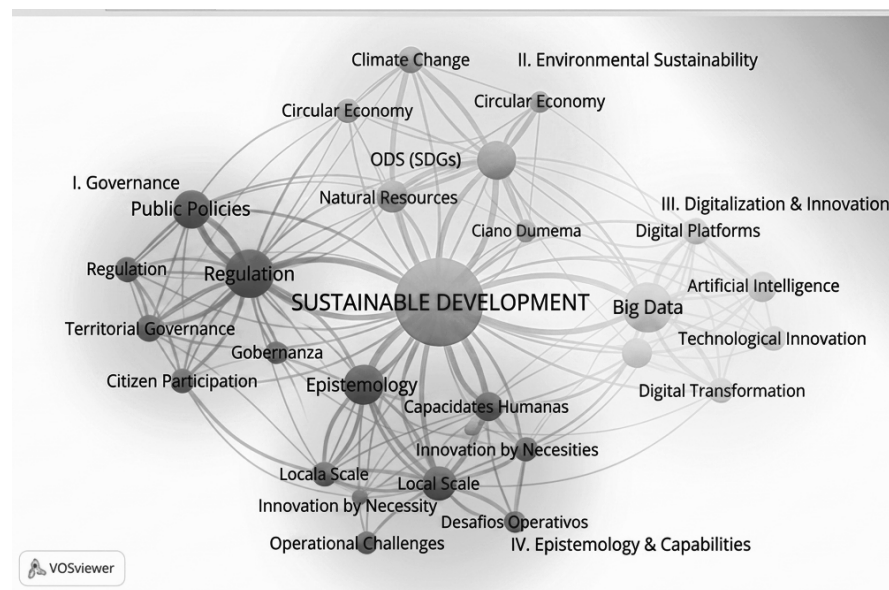


Figure 1. Co-occurrence network of author keywords and thematic clustering. Total keywords = 32, generated via VOSviewer software version 1.6.20, illustrating the structural grouping and spatial density of the four core epistemological and operational domains.

Despite this technological and conceptual expansion, a persistent operational gap remains evident across the current literature. Contemporary evaluative frameworks display a severely limited capacity to distinguish between superficial, marginal optimization and deep, systemic transformation. This analytical limitation routinely biases project evaluations toward short-term, output-based indicators. This systemic trend ultimately confirms the modeling problem identified in the theoretical framework, reinforcing the premise that the scarcity of comprehensive, longitudinal evaluative architectures represents an ontological constraint inherent to the discipline rather than a minor technical deficiency.

4.2. Empirical Institutionalization and Multi-Helix Governance in Antofagasta

In the Antofagasta Region, SI is examined not merely as an isolated conceptual construct but as an institutionalized strategic capacity embedded directly within the Regional Innovation Strategy (ERI) 2022–2028. The findings suggest that the multi-helix model can operate as an infrastructure for scientific governance, enabling forms of social legitimacy and territorial relevance capable of counterbalancing prevailing regional extractive logics. Specifically, the integration of the Antofagasta experience into the ERI 2022–2028 occurs through an operational pathway driven by the executed FIC-R 2023 project on Social Innovation Certification. This mechanism directly connects the strategic orientation of the regional policy with concrete procedures of evaluation, multi-actor validation, inter-institutional coordination, and AI-assisted traceability over time.

The analyzed documentary corpus—including regional strategy guidelines, staged implementation records, and technical milestone briefs—illustrates how this public anchoring provides essential temporal stability and political legitimacy within the Global South. Unlike many European or North American models—which frequently rely on isolated laboratories or unstable competitive funding—the Antofagasta case points toward an ongoing certification framework that minimizes ecosystem fragmentation and positions innovation as a continuous governance process rather than a discrete event.

However, the empirical reading also reveals a clear “paradox of institutionalization”. When multi-helix dynamics are over-subordinated to rigid, bureaucratic compliance metrics, their transformative potential is restricted, creating isolated “innovation islands.” The data suggests that the long-term effectiveness of the ERI depends heavily on its structural

capacity to safeguard long-term horizons against immediate procedural and short-term results.

4.3. Artificial Intelligence as a Methodological Catalyst: Traceability and Social Auditing

The integration of AI within the Antofagasta framework operates as a methodological catalyst, providing process-auditable traceability and multi-dimensional monitoring without replacing human deliberation. In the operationalized architecture, AI serves an epistemological mediation function by enabling the ordered comparison, linkage, and longitudinal interpretation of highly heterogeneous evaluative inputs across the certification lifecycle. These data assets comprise narrative territorial diagnoses, staged documentary evidence of project progression, milestone records, and qualitative reviews produced by the multi-helix governance committee, allowing a cohesive analysis that surpasses the capabilities of traditional manual review.

Crucially, the framework addresses the scaling challenge through the principle of “situated standardization”. This approach integrates Technology Readiness Levels (TRLs) to provide comparable parameters across initiatives, while explicitly decoupling technological maturity from automatic social impact. TRLs are reframed as dynamic indicators of governance capacity coupled with qualitative ethical criteria and indicators of territorial relevance, transforming technical uncertainty into parameters of scientific auditability without imposing decontextualized, exogenous metrics.

Finally, a reflexive reading of the case identifies three structural limitations that condition its implementation in the Global South:

- **Restricted Causal Attribution:** Isolating the specific impacts of SI remains challenging due to the confounding influence of macro-territorial variables, such as volatile extractive economic cycles.
- **Data Literacy Gaps:** The transition to an AI-supported system introduces a risk of digital exclusion, potentially marginalizing civil society actors with limited technological capacities.
- **The Standardization Paradox:** A persistent tension exists between the deployment of comparable global metrics and the preservation of local territorial singularity.

To ensure transparency, a clear distinction must be maintained between current territorial operations and projected expansion frameworks. The operational architecture deployed in Antofagasta was trained on the Multi-Helix model (Ricci and Concha 2018a), examined in the region with academic professionals in social innovation, and validated by an ad hoc governance committee. Conversely, the intellectual property and software registration currently under review applies strictly to the independent, secondary-stage software deployment frameworks designed to facilitate subsequent modular transfer to external territorial contexts where this architecture has not yet been institutionalized as public policy.

5. Discussion

5.1. Epistemological Implications and the Mitigation of “Methodological Myopia”

The findings of this study suggest that “methodological myopia” in social innovation (SI) evaluation is not merely an instrumental or technical deficit. Instead, it stems from deeper epistemological restrictions within the fields’ modeling processes. The categorical map generated from the systematic qualitative review highlights a severe polarization across the scientific frontier. The prevalence of short-term, output-centered approaches—crystallized within the sustainability metrics cluster—indicates that current difficulties in capturing structural transformations reflect ontological constraints embedded in traditional indicators. These insights align with critical perspectives that frame SI as an inher-

ently political and value-driven process rather than a neutral managerial practice (Montgomery 2016; Bacon et al. 2008).

These empirical dynamics challenge the widespread assumption that universal metric standardization is the definitive pathway to disciplinary consolidation. In the Global South, rigid, decontextualized standardization acts as a reductionist lens, rendering critical dimensions such as collective agency and the reconfiguration of local power relations invisible. Consequently, social impact assessment becomes a space of active epistemological negotiation. Methodological frameworks predetermine which forms of social value attain scientific and institutional legitimacy. Rather than rejecting standardization entirely, the systematic analysis of the current literature highlights the urgent need for adaptable conceptual architectures with the heuristic sensitivity required to capture non-linear processes of social change under conditions of structural scarcity.

5.2. Multi-Helix Governance and Institutional Continuity as Stabilizing Factors

The empirical analysis of the Antofagasta Region indicates that multi-helix governance frameworks can serve as viable institutional mechanisms to sustain longitudinal evaluation. Unlike the highly fragmented, short-term initiatives frequently documented in international literature—which often operate as isolated experiments dependent on volatile, competitive project funding—embedding SI within a formal policy framework like the Regional Innovation Strategy (ERI 2022–2028) provides the regional ecosystem with structural continuity, baseline resources, and public legitimacy.

This observation is highly consistent with contemporary scholarship positioning SI ecosystems as collaborative governance arrangements whose long-term viability depends on inter-organizational articulation and public anchoring. Methodologically, the Antofagasta experience operates as a revelatory and critical single-case study. It provides an empirical illustration of how a structured certification workflow can be successfully integrated into territorial public policy to counteract regional extractive cycles.

However, this institutionalization process reveals an inherent tension. When multi-helix frameworks are overly subordinated to rigid administrative compliance, the risk of creating isolated “innovation islands” increases. This crucial paradox suggests that territorial governance must function not merely as a bureaucratic coordination tool, but as a methodological infrastructure designed to safeguard the alignment between scientific rigor, local multi-stakeholder representation, and systemic territorial impact.

5.3. Algorithmic Mediation and “Situated Standardization”: Scope, Constraints, and Transferability

The convergence of SI and artificial intelligence (AI) serves as a methodological catalyst, enhancing process adaptability and the synthesis of highly heterogeneous qualitative data. However, the empirical evidence demonstrates that the evaluative utility of AI is not an intrinsic or autonomous feature of the technology itself. Instead, it operates as a dependent variable of the multi-helix governance framework in which it is embedded. This interpretation is fully aligned with contemporary debates on digital transformation in public domains, which emphasize that the contribution of algorithmic tools depends on their integration within participatory, explainable, and ethically governed architectures.

To anchor this discussion in a realistic, non-techno-utopian perspective, the AI-supported certification architecture evaluated here is not presented as a fully generalized, automatically scalable software platform. It is an operational pilot developed within the bounded parameters of the ERI 2022–2028 and the executed FIC-R 2023 project. Its scientific validity relies precisely on its hybrid design, where the automated Natural Language Processing (NLP) engine and the 5W/1H information extraction model are strictly subor-

minated to human-in-the-loop (HITL) expert calibration and the final deliberative validation of the Multi-Helix Governance Committee.

From this concrete experience, the concept of “situated standardization” is proposed. This approach suggests that it is possible to articulate comparable technical criteria—such as adapted Technology Readiness Levels (TRLs) reframed as measures of governance capability—without enforcing an institutional homogenization that erases local knowledge. Within this framework, the broader validity of an SI model relies on the transferability of its underlying governance principles rather than on linear software replication. This distinction is critical to counteract cognitive extractivism, ensuring that the deployment of advanced technological instruments remains subservient to local knowledge, community agency, and ethical accountability in the Global South.

6. Conclusions

6.1. Systemic Insights and Empirical Synthesis

This research suggests that when social innovation (SI) is constrained by reductionist, short-term evaluative logics, its transformative capacity weakens, increasing the risk of an inadvertent return to welfare-based rationales that neutralize systemic change and reinforce dependency loops. The empirical and theoretical evidence analyzed indicates that “methodological myopia” is not merely a transient technical deficit in indicators. Instead, it constitutes a deeper epistemological obstacle privileging immediate, easily quantifiable outputs over nonlinear processes of structural transformation within complex territorial systems.

The study directly addresses its guiding research questions through a synchronized theoretical and empirical design. Regarding RQ1, the contemporary literature review exposes that existing evaluative approaches suffer from severe epistemological fragmentation and a reductionist bias toward immediate outputs, failing to capture the structural density of innovations born out of necessity. Regarding RQ2, the investigation demonstrates that an artificial intelligence (AI)-supported multi-helix architecture becomes analytically relevant and territorially grounded only when it is embedded within regional public policy, structurally governed through a human-in-the-loop specialist validation pipeline, and intentionally oriented toward long-term qualitative parameters.

The structural contributions of this framework are three-fold:

- Epistemologically, it treats impact evaluation as an inherently political and ontological issue, explicitly linking conceptual fragmentation to the modeling problem under conditions of structural scarcity characteristic of the Global South.
- Methodologically, it outlines a longitudinal evaluative architecture that integrates computational natural language processing as a support mechanism for social auditing, offering a concrete, mixed-method response to the persistent absence of comparable international standards.
- Empirically, the analysis indicates that SI can effectively move beyond a fragmented, project-based logic when it is embedded in territorial public policy and conceived as a model of cooperative multi-helix governance.

Ultimately, the empirical experience suggests that structured certification can effectively support regional scaling and accountability efforts without eroding the essential territorial embeddedness and local legitimacy of situated initiatives.

6.2. Implications for Policy and Territorial Management

Beyond serving as a conceptual point of reference for multi-helix interactions, the findings offer immediate practical implications for public administration, policy design, and regional development management. The transition toward adaptive, localized SI

frameworks requires a critical reconfiguration of the State's conventional role in regional ecosystems. The case of the Antofagasta Region illustrates a plausible trajectory where the public sector shifts from a passive project funder to an active architect of trust-based ecosystems. This shift is structurally enabled by the strategic integration of the Regional Innovation Strategy (ERI 2022–2028) and the operational implementation of the Social Innovation Certification process under the executed FIC-R 2023 project.

Within this framework, an AI-supported certification system functions as a practical policy instrument to mitigate severe information asymmetries among heterogeneous actors. By establishing traceable, multidimensional, and verifiable evaluative criteria, this architecture allows both public and private sector investors to prioritize resources toward initiatives that demonstrate a verifiable capacity for systemic impact, rather than those optimized merely for short-term political visibility.

6.3. Algorithmic Infrastructure and the Logic of Conditional Transfer

The incorporation of AI within the social innovation domain of the Global South operates most effectively under a hybrid-intelligence paradigm. Within this framework, AI is not positioned as an automated or technocratic substitute for human deliberation, nor to replace local social judgment; instead, it provides an ethical data infrastructure designed to enhance process auditability, operational transparency, and the structured interpretation of qualitative, highly dispersed evaluative inputs under continuous participatory oversight.

Finally, this study concludes that the scaling of SI models in complex contexts should reject the logic of linear, uncritical replication in favor of a model of conditional transfer. What can be legitimately transferred to other territories is not the specific technical platform or localized metrics, but the underlying multi-helix governance architecture and the core principles of longitudinal tracking. The broader relevance of this work lies in its capacity to inform how other vulnerable or extractive territories in the Global South might systematically design their own pathways of institutionalization, ensuring that technological convergence remains subservient to local knowledge, community agency, and ethical accountability.

7. Patents

The AI-driven certification architecture evaluated in this study is operational within the Antofagasta Region, serving as an integral component of the Regional Innovation Strategy (ERI) 2022–2028 and the executed FIC-R 2023 project on Social Innovation Certification. The intellectual property and software registration currently undergoing official review do not pertain to this localized public policy implementation. Instead, the pending registration specifically governs the second-stage software deployment frameworks designed to facilitate territorial transferability and modular adaptation across external jurisdictions where this governance architecture has not yet been deployed.

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Conflicts of Interest: The author declares that the secondary-stage software deployment frameworks associated with this research are currently under official intellectual property and patent review. This pending registration is intended to facilitate subsequent territorial transferability in contexts outside the current public policy scope. The manuscript focuses strictly on the conceptual and operational architecture implemented in the Antofagasta Region and does not evaluate any commercial software products. The author affirms that this intellectual property process has not influenced the analysis, interpretation, or objectivity of the data presented in this study.

Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
FIC-R	Innovation Fund for Regional Competitiveness
MHM	Multi-Helix Model
ERI	Regional Innovation Strategy (Estrategia Regional de Innovación)
SDGs	Sustainable Development Goals
SI	Social Innovation
TRL	Technology Readiness Level

Appendix A. Methodological Appendix

This appendix is presented to reinforce the methodological transparency of the Systematic Literature Review (SLR), in coherence with the qualitative critical approach of the study.

Appendix A.1. Systematic Literature Review: Design and Purpose

The Systematic Literature Review (SLR) was designed with a dual analytical purpose:

(i) to identify trends, gaps, and tensions in recent scientific production regarding social innovation, territorial governance, and impact evaluation; and (ii) to serve as a mechanism to detect epistemological biases associated with short-term, output-based impact metrics and conceptual fragmentation within the field. Aligned with the article's epistemological positioning, the SLR is conceived not as an exercise in exhaustive bibliometric aggregation, but as an analytical strategy to sustain the theoretical and methodological coherence of the proposed framework, particularly within Global South contexts. Crucially, this temporal bounding (2020–2025) serves as a coeval observation window explicitly synchronized with the implementation cycle of the regional public policy (ERI 2022–2028) examined in the case study.

Appendix A.2. Information Sources and Databases

Databases were selected according to criteria of scientific quality, interdisciplinary coverage, and territorial relevance, considering the hybrid nature of the social innovation field.

The databases consulted were:

- Scopus;
- Web of Science (WoS—Core Collection);
- SciELO;
- Redalyc.

Scopus and WoS ensured coverage of mainstream academic journals, while SciELO and Redalyc enabled the inclusion of relevant scientific production from Latin America and other Global South contexts, mitigating epistemological exclusion biases.

Appendix A.3. Search Strategy and Key Terms

The search strategy was constructed in an iterative manner, combining key terms using Boolean operators (AND/OR) and adapting search strings to the architecture of each database.

Appendix A.3.1. Conceptual Axes

Four main conceptual axes were defined:

- Social innovation;
- Impact evaluation/impact measurement;
- Territorial governance and helix models;
- Digital transformation and artificial intelligence.

Appendix A.3.2. Examples of Search Strings

Scopus/Web of Science (Title–Abstract–Keywords):

("social innovation" AND ("impact assessment" OR "impact measurement" OR evaluation))

AND ("governance" OR "territorial governance" OR "multi-helix" OR "quadruple helix")
AND ("digital transformation" OR "artificial intelligence" OR "data analytics"))

SciELO/Redalyc (Spanish and Portuguese):

("innovación social" AND ("evaluación de impacto" OR "medición del impacto"))

AND ("gobernanza territorial" OR "modelo multihélice")

AND ("inteligencia artificial" OR "transformación digital"))

Search strings were linguistically adjusted without altering their semantic coherence.

Appendix A.4. Inclusion and Exclusion Criteria

Appendix A.4.1. Inclusion Criteria

Articles meeting the following criteria were included:

- Publication between 2020 and 2025.
- Peer-reviewed journal articles.
- Explicit engagement with at least two of the following components:
social innovation; impact evaluation; governance or public policy; digitalization or AI applied to social domains.
- Conceptual or methodological relevance for high territorial complexity contexts or the Global South.

Appendix A.4.2. Exclusion Criteria

The following were excluded:

- Non-peer-reviewed documents (editorials, technical reports, institutional documents);
- Studies focused exclusively on technological innovation without a social dimension;
- Purely instrumental approaches lacking methodological or epistemological reflection;
- Duplicate records across databases.

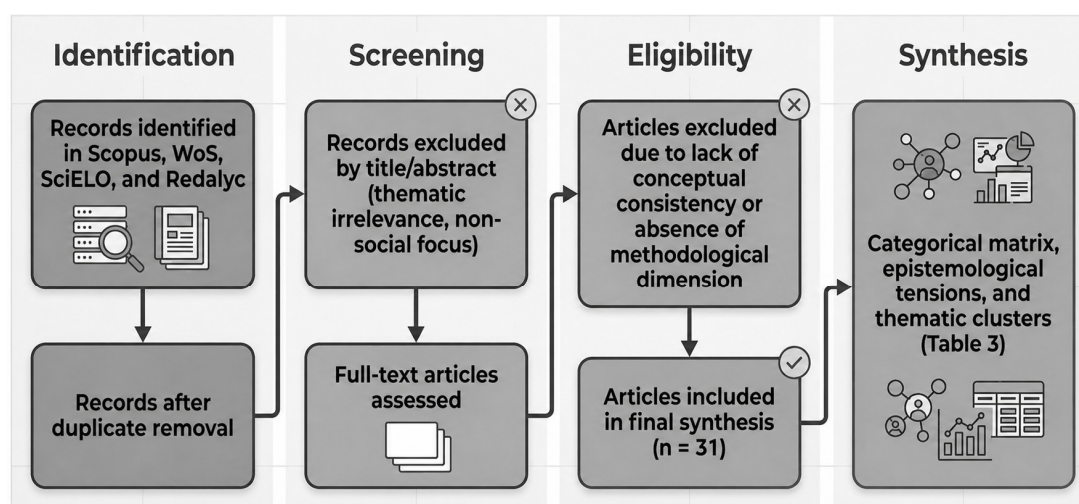
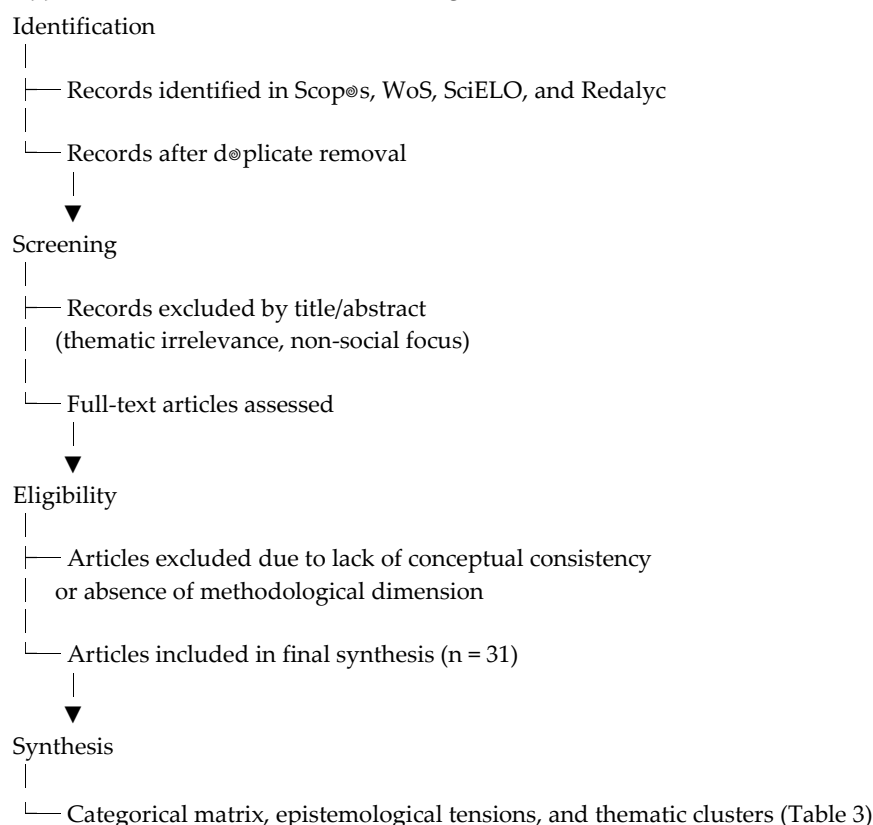
Appendix A.5. Corpus Selection Process

The corpus refinement process was conducted in four sequential stages:

1. Initial identification of records using the defined search strings;
2. Removal of duplicates across databases;
3. Title and abstract screening applying inclusion/exclusion criteria;
4. Full text assessment to determine conceptual relevance and analytical quality.

The final corpus consisted of 31 articles, systematized in a categorical analysis matrix used for the construction of the four analytical clusters and the deconstruction of contemporary epistemological tensions (see Table 3)

Appendix A.6. Review Process Flow Diagram



Note: Process adheres to PRISMA guidelines for systematic reviews.

Figure A1. Article selection process for the systematic literature review (PRISMA adapted).

Appendix A.7. Considerations on Rigor and Limitations

Consistent with the study's qualitative critical approach, the SLR prioritizes analytical validity and epistemological relevance over statistical exhaustiveness. One acknowledged limitation is the impossibility of capturing the entirety of a field characterized by high conceptual heterogeneity.

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