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Exploring the Infrastructures for Institutionalizing Knowledge Brokerage in Innovation Ecosystems

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ABSTRACT

This study aimed to identify and conceptualize the essential infrastructures required to support effective knowledge brokerage in innovation ecosystems and enhance knowledge flows and innovation processes. The study is fundamental–applied in purpose and adopts an exploratory qualitative design based on an interpretivist approach. Data were collected through semi-structured interviews with 15 experts from the innovation ecosystem, including managers and specialists from science and technology parks and knowledge-based companies, selected through purposive sampling. The collected data were analyzed using inductive thematic analysis, leading to the identification of initial codes, sub-themes, and overarching themes and the development of a conceptual framework for knowledge-brokerage infrastructures. Subsequently, a Delphi process was conducted to assess and confirm the relevance, clarity, and adequacy of the identified components and items. The findings revealed ten interrelated infrastructures required to support knowledge brokerage: institutional, technological, human, financial–economic, network, processual and operational, data and knowledge governance, organizational, physical, and cultural–discursive infrastructures. The results indicate that the effectiveness of knowledge brokerage depends not solely on individual brokers or isolated infrastructures, but on the coordinated interaction and complementarity among these infrastructures. Their integrated development can enhance knowledge flows, strengthen collaboration among ecosystem actors, facilitate knowledge commercialization, support evidence-informed decision-making, and contribute to innovation ecosystem performance. This study conceptualizes knowledge brokerage as an ecosystem-level capability rather than merely an intermediary function and highlights the importance of aligning complementary infrastructures to bridge the gap between knowledge creation and application. **©authors.**

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1. Introduction

Over the past few decades, the global economy has undergone a profound transformation from a resource-based model to a knowledge-based and innovation-driven economy, where knowledge has emerged as the most strategic resource for sustainable competitive advantage and long-term economic development (Zarifian et al., 2023).

Within this paradigm, innovation ecosystems—dynamic networks of interdependent actors, institutions, policies, and resources—play a pivotal role in fostering technological advancement, entrepreneurship, and value co-creation (Adner, 2017; Thomas & Autio, 2014; Hwang & Horowitt, 2012). In today's knowledge-intensive environment, no single organization possesses all required capabilities; therefore, firms increasingly rely on collaborative relationships within their innovation ecosystems to access complementary resources and drive innovation (Jalilian et al., 2021).

However, realizing the full potential of these ecosystems depends on effective linkages between knowledge producers and users. A substantial proportion of knowledge generated by research institutions fails to reach commercialization due to weak institutional interactions and ineffective transfer mechanisms. This persistent gap highlights the vital role of knowledge brokerage as a mechanism for facilitating the transfer, exchange, translation, and application of knowledge. First introduced by Hargadon and Sutton (1997), knowledge brokers bridge the divide between producers and users, enhancing knowledge flows and promoting innovation across organizational boundaries (Sverrisson, 2001). Knowledge brokerage is a dynamic and multidimensional process that fosters evidence-informed decision-making, cross-sectoral collaboration, and shared understanding among stakeholders (Glegg & Hoens, 2016; Meagher et al., 2008; Neal et al., 2022).

Despite their importance, in many innovation ecosystems, knowledge brokerage remains largely informal, fragmented, and person-dependent rather than embedded within robust institutional structures. A fundamental challenge in this field is the lack of a comprehensive understanding of the infrastructures required to institutionalize knowledge brokerage sustainably. Although prior research has examined the roles of brokers and transfer processes, considerably less attention has been devoted to identifying the enabling conditions and infrastructures that allow knowledge brokers to operate effectively.

From a theoretical perspective, the novelty of this study lies in reconceptualizing knowledge-brokerage infrastructure as a multidimensional, interdependent, and ecosystem-level configuration. Rather than depending solely on individual initiatives, sustainable knowledge brokerage requires the alignment and interaction of ten complementary infrastructural domains: institutional, technological, human, financial–economic, network, processual, data and knowledge governance, organizational, physical, and cultural–discursive infrastructures.

Furthermore, to provide conceptual clarity, this study analytically distinguishes infrastructures (relatively stable foundational conditions necessary for continuity) from critical success factors (conditions influencing implementation effectiveness) and drivers (forces accelerating development). By establishing this unified ecosystem-oriented framework, the study bridges the gap between research on knowledge broker roles and innovation ecosystem theory, providing a theoretical foundation for designing supportive mechanisms that transform dispersed knowledge into sustainable economic and societal value.

2. Literature Review

Research in the fields of knowledge management, knowledge brokering, and innovation ecosystems indicates that the effectiveness of knowledge creation, transfer, translation, and utilization processes depends on a combination of managerial, organizational, technological, relational, and institutional factors. These factors not only

facilitate knowledge flows but also enhance interactions among ecosystem actors, support innovation development, promote knowledge commercialization, and improve the performance of organizations and innovation ecosystems. Although previous studies have examined these dimensions from different perspectives, most have focused on specific components, with limited attention paid to developing a comprehensive understanding of the requirements for effective knowledge brokering within innovation ecosystems. A substantial body of research has identified knowledge management as one of the fundamental prerequisites for establishing effective knowledge-based systems. Existing findings suggest that organizational culture, organizational structure, information technology, human resource empowerment, and organizational capabilities play critical roles in the success of knowledge management initiatives. In this regard, Samadian & Ahangaran (2016) demonstrated that although knowledge management conditions within knowledge production structures were relatively satisfactory in some dimensions, further development of technological capabilities and organizational structures remained necessary.

Similarly, Iran Zadeh & Karimi (2016) found that knowledge management contributes indirectly to the productivity of knowledge-based companies by enhancing absorptive capacity and increasing supply chain agility.

Furthermore, Ardalan et al. (2017) developed a knowledge management model for the banking sector and identified fourteen key components that facilitate the implementation of knowledge management cycles through their interaction with knowledge domains and managerial tools.

More recently, Tavassoli et al. (2023) showed that knowledge management contributes to the creation and maintenance of organizational competitive advantage by strengthening knowledge processes and intellectual capital. Collectively, these studies emphasize the importance of managerial, human, technological, and structural factors as essential foundations for effective knowledge management and knowledge circulation. Another stream of research has focused on the role of innovation ecosystem factors and environmental conditions in supporting innovation development. Findings from these studies indicate that the development of innovation ecosystems is not solely dependent on internal organizational capabilities; rather, it requires interaction among policies, institutions, collaboration networks, and environmental conditions. Using a meta-synthesis approach, Khan-Ahmadlou et al. (2020) identified key dimensions underlying the development of university-based innovation ecosystems, including policy, culture, interactions, structures, and environmental factors.

Likewise, Ramazanpour Nargesi et al. (2022) demonstrated that the success of knowledge-based companies is influenced by a combination of individual, organizational, national, and transnational factors, with economic policies and marketing capabilities playing significant roles.

In addition, Asadi et al. (2023) revealed that knowledge commercialization depends on the simultaneous interaction of market conditions, technological innovation, entrepreneurial characteristics, and environmental factors. These findings suggest that innovation development requires an integrated environment in which institutional, economic, technological, and policy-related components operate collectively.

Studies focusing on knowledge brokering further indicate that knowledge brokers are not merely transmitters of information; rather, they act as intermediaries, facilitators, coordinators, and boundary-spanners between knowledge producers and knowledge users. Mansouri-Moeid et al. (2020) showed that knowledge brokers accelerate the commercialization of technical knowledge by facilitating knowledge access, transfer, and utilization. Similarly, Asadian, et al. (2025), through developing an internet-based business model for knowledge brokers, emphasized the importance of digital, relational, and managerial components in facilitating knowledge exchange, improving productivity, and enhancing coordination among innovation ecosystem actors. These studies demonstrate that knowledge

brokering cannot effectively contribute to innovation networks without appropriate relational, managerial, and technological foundations.

International research has also increasingly conceptualized knowledge brokering as a network-based, interactive, and multidimensional process. Lee et al. (2023) identified human capital, information infrastructures, technology, and collaborative networks as the primary factors supporting the development of knowledge services in think tanks and highlighted their contribution to innovation advancement Krystallis & Jassem (2023) further demonstrated that knowledge brokering evolves through three stages of maturity, accompanied by increasing interaction, collaboration, and integration among network actors. Moreover, McKillop et al. (2023) argued that knowledge brokerage organizations perform broader functions beyond knowledge transfer, including relationship management, legitimacy building, facilitating evidence use, and strengthening connections between knowledge producers and users. These studies suggest that the role of knowledge brokers has evolved from simple information intermediaries into strategic facilitators within innovation and policy systems. Recent studies have placed greater emphasis on the relational, network, and institutional dimensions of knowledge brokering.

Kadouf et al. (2024) demonstrated that extensive, diverse, and reciprocal relationships between knowledge brokers and stakeholders enhance knowledge transfer, resource acquisition, and organizational capacity.

Similarly, Malin & Szoczak (2024) identified trust, relationship development, respect for diverse perspectives, and recognition of multiple forms of knowledge as key prerequisites for successful equity-oriented knowledge brokering.

In the same vein, Bandola-Gill (2023) showed that dialogue, advocacy, evidence-informed interventions, and institutional interactions represent the main mechanisms through which knowledge transfer is facilitated at the science–policy interface.

Overall, these studies indicate that knowledge brokering is not merely a technological activity but rather a social, relational, and institutional process grounded in trust, interaction, collaboration, and participatory governance.

2.1 Research Gap and Theoretical Positioning of the Present Study

A comparative review of domestic and international studies indicates that, although scholarly attention to knowledge brokerage, knowledge management, and innovation ecosystems has increased, a comprehensive framework explaining the infrastructures required for the formation, continuity, and effective functioning of knowledge brokerage at the ecosystem level remains underdeveloped. Research in knowledge management has predominantly examined organizational, technological, human, and managerial enablers of knowledge creation, sharing, and utilization, whereas innovation ecosystem studies have emphasized institutions, policies, networks, economic conditions, and interorganizational interactions. Similarly, knowledge brokerage research has explored brokers' roles and functions, relational and network dynamics, and dimensions such as trust, collaboration, boundary spanning, legitimacy, and stakeholder engagement. For instance, Mansouri-Moeid et al. (2020), McKillop et al. (2023), and Kadouf et al. (2024) emphasized the intermediary, relational, and networking roles of knowledge brokers, while Christalis and Jassem (2023) conceptualized knowledge brokerage as an evolutionary process within policy networks. Khan-Ahmadlou et al. (2020) likewise highlighted institutional and network interactions in innovation ecosystem development.

Despite these contributions, the relevant dimensions have largely been examined in relation to specific functions, contexts, or outcomes rather than systematically conceptualized as complementary and relatively stable infrastructures for knowledge brokerage. The first major research gap, therefore, concerns the absence of a systematic, infrastructure-oriented approach to knowledge brokerage at the ecosystem

level. Although institutional, technological, human, organizational, network, and cultural dimensions have been widely discussed in knowledge management and related fields, their specific meanings, positions, and functions as infrastructural foundations of knowledge brokerage remain insufficiently conceptualized. Existing research has established their relevance to knowledge creation, sharing, transfer, utilization, and innovation capabilities, but has not adequately explained how they provide the conditions necessary for the formation and continuity of knowledge brokerage across an innovation ecosystem. The gap thus extends beyond identifying additional factors to establishing a clear theoretical understanding of these dimensions as infrastructures that can help knowledge brokerage evolve from fragmented, person-dependent, and temporary arrangements into a sustainable and reliable ecosystem-level capability. A second gap concerns research methodology and empirical context. Several domestic studies, including Samadian and Ahangaran (2016), Karimi and Iranzadeh (2016), Ramazanpour Nargesi et al. (2022), and Tavassoli et al. (2023), have predominantly employed quantitative, survey-based approaches to examine relationships among variables. Although studies such as Khan-Ahmadlou et al. (2020) and Asadian et al. (2025) have used meta-synthesis approaches, their findings have primarily relied on existing literature, with comparatively limited direct engagement with experts actively operating within innovation ecosystems.

Furthermore, research conducted in settings such as banking systems, knowledge-production structures, and knowledge-based firms has largely reflected the characteristics of those specific contexts. International studies, including Lee et al. (2023), Malin and Szoczak (2024), and Bandola-Gill (2024), have primarily addressed knowledge services, knowledge equity, policymaking, and network interactions.

Consequently, an empirically grounded framework informed by innovation ecosystem experts and capable of systematically identifying and conceptualizing the multidimensional infrastructures of knowledge brokerage remains insufficiently developed. A third gap involves the conceptual distinction among infrastructures, critical success factors, and drivers. Previous studies have not sufficiently differentiated relatively stable foundational conditions that enable the formation and continuity of knowledge brokerage from critical success factors that influence its implementation and effectiveness, and drivers that stimulate or accelerate its development and change. This ambiguity risks placing structural requirements, managerial interventions, and driving forces at the same analytical level, obscuring their distinct roles.

An ecosystem-level investigation therefore requires these concepts to be analytically distinguished to clarify the nature and scope of the findings. To address these gaps, the present study adopts an ecosystem-level, infrastructure-oriented perspective and employs a qualitative approach and thematic analysis to identify and conceptualize knowledge brokerage infrastructures based on the perspectives of innovation ecosystem experts. It examines ten interrelated domains: institutional, technological, human, financial–economic, network, processual, data and knowledge governance, organizational, physical, and cultural–discursive infrastructures. These domains are examined specifically in terms of their roles in establishing the conditions required for the formation, continuity, and development of knowledge brokerage. Accordingly, the study does not merely reproduce dimensions recognized in the knowledge management literature; rather, it clarifies their meaning, position, and function within the specific context of knowledge brokerage and examines their contribution to a coherent infrastructural foundation. The theoretical contribution of this study lies in shifting the analytical focus from what knowledge brokers do and what influences brokerage performance to the foundations that enable knowledge brokerage to emerge, persist, and develop. This shift extends the analysis beyond individual brokers, interpersonal relationships, and temporary arrangements to the conditions established across

organizations, networks, and the wider ecosystem.

The proposed framework thus provides a conceptual basis for understanding how complementary and interrelated infrastructures can sustain knowledge flows, interactions among actors, and innovation processes across organizational and sectoral boundaries, positioning knowledge brokerage as a coherent, sustainable, and potentially scalable capability within innovation ecosystems.

3. Methodology

This study adopted an applied–developmental research purpose and a qualitative, exploratory, and interpretive approach to identify and explain the infrastructures required for the establishment of knowledge brokerage within innovation ecosystems. A qualitative approach was considered appropriate because knowledge-brokerage infrastructure is a multidimensional and context-dependent phenomenon whose various dimensions emerge through interactions among actors, institutions, organizational structures, technologies, processes, and cultural and discursive contexts. Accordingly, developing an in-depth understanding of this phenomenon required access to experts' experiences, perceptions, and interpretations of the conditions and capacities necessary for the emergence, and continuity of knowledge brokerage. Therefore, data were collected through in-depth semi-structured interviews and analyzed using inductive thematic analysis. This approach enabled the study to derive concepts and higher-order themes from the empirical data as far as possible and to develop a conceptual framework grounded in the innovation-ecosystem context, rather than imposing a predetermined classification on the data.

Participants and Sampling

The study population comprised experts and knowledgeable professionals with direct professional experience in innovation ecosystems and processes related to knowledge creation, transfer, exchange, translation, utilization, and commercialization. Given the specialized nature of the research topic, purposive sampling with a maximum-variation strategy was employed to select information-rich participants with diverse yet relevant professional perspectives. The inclusion criteria were defined based on three main criteria: (1) substantial professional experience in innovation, knowledge, technology, or related activities; (2) direct involvement in knowledge interactions, technology transfer, commercialization, innovation projects, or interorganizational collaboration; and (3) sufficient conceptual and practical understanding of knowledge flows, exchange, translation, and utilization within innovation ecosystems.The participants primarily comprised senior managers and experts from knowledge-based, technology-oriented, and innovation-driven companies, as well as managers and experts from science and technology parks and other relevant ecosystem actors involved in knowledge and innovation processes. This diversity was intended to capture perspectives from different organizational and institutional positions and to avoid relying on a single category of ecosystem actors. In total, 15 experts participated in the study. The sample size was not determined solely on the basis of a predetermined numerical target; rather, data collection continued until the interviews provided sufficient conceptual coverage of the phenomenon under investigation and the emerging thematic structure reached relative stabilization, such that subsequent interviews did not result in substantial changes to the main conceptual categories or the developing framework. Accordingly, sample adequacy was assessed based on the depth, relevance, and diversity of the information obtained, rather than solely on the number of participants.

Table 1. *Demographic Characteristics of the Statistical Population*

No	Gender	Work Experience	Type of Organization/Ecosystem Actor
1	Male	10 years	University
2	Male	12 years	Knowledge-Based Company
3	Male	8 years	Policy-Making Institution
4	Female	9 years	Innovation Center

5	Male	15 years	Science and Technology Park
6	Male	11 years	Accelerator
7	Male	17 years	University
8	Male	10 years	Technology Company
9	Female	15 years	Knowledge-Based Company
10	Female	8 years	Knowledge-Based Company
11	Female	17 years	Support Institution
12	Male	13 years	Science and Technology Park
13	Male	16 years	Venture Capital Investor
14	Male	14 years	Knowledge-Based Company
15	Male	9 years	Large Industry

Data Collection and Analysis

Data were collected through in-depth semi-structured interviews. The interview guide was developed in accordance with the research objective and central research question, and the questions were designed to enable participants to articulate their experiences, perceptions, and views regarding the requirements and infrastructures needed for the establishment of knowledge brokerage within innovation ecosystems. Interviews continued until conceptual saturation and data adequacy were reached. Each interview was fully transcribed and reviewed repeatedly.

The data were analyzed using inductive thematic analysis. First, the interview transcripts were read in their entirety to develop familiarity with the content of the data and the patterns of meaning expressed in the participants' accounts. Meaningful segments of the data were then identified and assigned initial codes. Subsequently, related codes with conceptual similarities were compared and organized into sub-themes, while main themes were developed at a higher level of abstraction through the integration and conceptual synthesis of related sub-themes. Throughout the analytical process, continuous comparison was undertaken across the raw data, initial codes, sub-themes, and main themes. Codes and themes that were conceptually overlapping, weakly supported, or insufficiently grounded in the empirical data were reviewed, merged, or excluded. The resulting analytical chain was therefore structured as "raw data → initial codes → sub-themes → main themes → comprehensive framework of knowledge-brokerage infrastructures."

This analytical process enabled the study to move beyond presenting a simple list of factors and to develop a higher-order conceptual understanding of the relationships among different infrastructural dimensions and their role in the institutionalization of knowledge brokerage.

Trustworthiness and Rigor

To enhance the rigor and trustworthiness of the findings, four established criteria of qualitative research (credibility, dependability, confirmability, and transferability) were addressed.

Credibility was strengthened through systematic and repeated review of the interview transcripts, continuous comparison of data, codes, and emerging themes, and retention of themes supported by sufficient empirical evidence. Dependability was enhanced through systematic documentation of participant selection, interview procedures, transcription, coding, theme development, and analytical decisions, ensuring a traceable research process. Confirmability was supported by maintaining a transparent link between empirical data, initial codes, sub-themes, and main themes, while insufficiently supported codes and themes were revised, merged, or excluded. Transferability was addressed through detailed reporting of the study context, participant characteristics, sampling strategy, analytical procedures, and study boundaries. It does not imply statistical generalization; rather, the contextual information enables assessment of the applicability of the findings to other settings based on similarities and differences in institutional, organizational, technological, network, and cultural contexts.

Overall, this process enabled the systematic identification of knowledge-brokerage infrastructures, resulting in a framework comprising ten domains: institutional, technological, human, financial–economic,

network, processual, data and knowledge governance, organizational, physical, and cultural–discursive infrastructures.

Contextual Limitations and Transferability of the Framework

The findings of this study were developed within the specific context of the Iranian innovation ecosystem and were based on the perspectives of the participating experts. Therefore, the proposed framework cannot be statistically generalized to other innovation ecosystems, and its transferability should be assessed in light of the institutional, organizational, cultural, and technological characteristics of each context. Although the components and items of the framework were derived from qualitative data and subsequently evaluated and validated through an expert Delphi process in terms of their relevance, clarity, adequacy, and content validity, this process does not substitute for empirical testing of the relationships among the infrastructures or assessment of their effects on innovation performance. Accordingly, quantitative validation of the framework, empirical examination of the relationships among the identified infrastructures, and assessment of its applicability across different innovation ecosystems and policy- and decision-making contexts constitute important directions for future research.

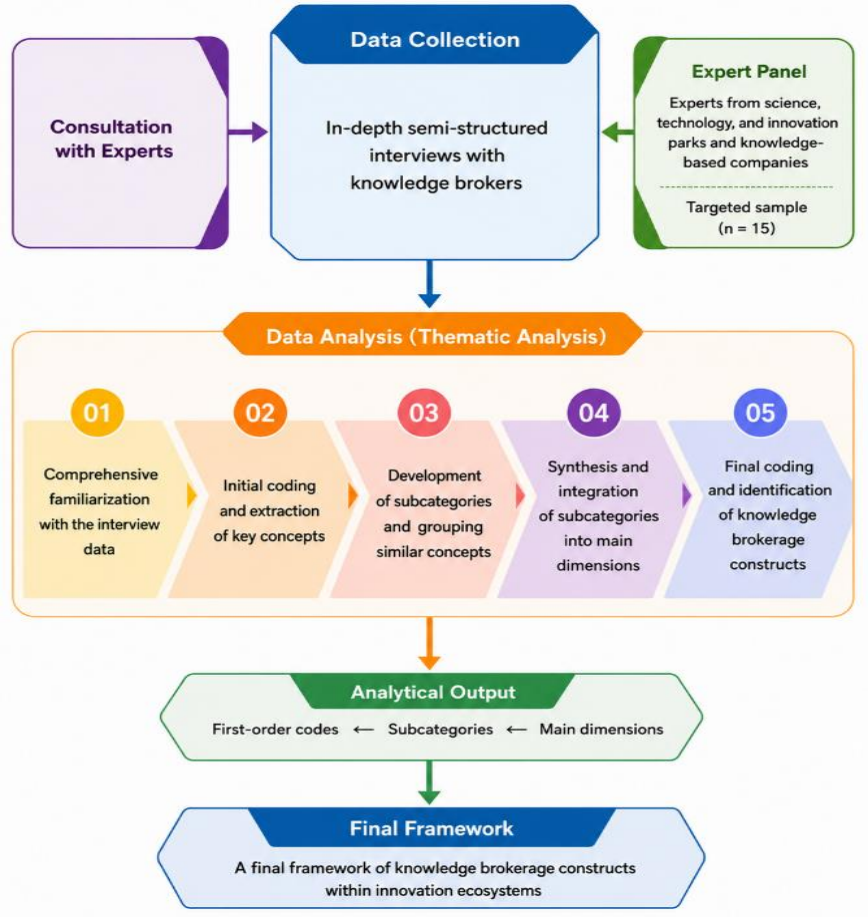


Figure 1. *Research Process*

4. Findings

Q1: What Are the Required Infrastructures for Knowledge Brokering in the Innovation Ecosystem?

- Institutional Infrastructure
- Technological Infrastructure
- Human Infrastructure
- Financial–Economic Infrastructure
- Network Infrastructure
- Processual Infrastructure
- Data & Knowledge Governance Infrastructure

- Organizational Infrastructure
- Physical Infrastructure
- Cultural–Discursive Infrastructure of Knowledge Brokerage

Table 2. *Institutional Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Institutional support for connecting diverse and heterogeneous knowledge actors; Institutional incentives and support for knowledge transfer and innovation risk reduction; Institutional capacity building to develop knowledge brokering capabilities and competencies; Establishing enabling infrastructures (cultural, procedural, and technological) to facilitate knowledge sharing.	Supportive Institutions	Supportive Knowledge Ecosystem
Developing strategic policies, defining research priorities, and promoting the professional development of knowledge brokers; Designing monitoring, evaluation, and feedback mechanisms for knowledge policies; Formulating policies to integrate and enhance synergies among knowledge networks and foster coordination among policymaking institutions; Strengthening the resilience of knowledge-flow institutions under crisis conditions	Policy-Oriented Institutions	
Regulating knowledge interactions and establishing legal frameworks for secure, transparent, and responsible knowledge exchange; Developing policies and regulations related to intellectual property rights, knowledge rights, data privacy, and information confidentiality; Standardizing and facilitating processes of knowledge transfer, translation, and transformation; Developing flexible regulations to support knowledge-based innovations; Strengthening ethics, trust, and institutional legitimacy in knowledge exchange	Laws and Regulations	
Facilitating university–industry–government interactions; Identifying and prioritizing knowledge opportunities and aligning demand-driven knowledge needs with supply-side knowledge resources; Providing specialized advisory services to facilitate knowledge transfer and absorption; Institutional mediation to reduce conflicts, uncertainties, and risks among knowledge actors; Developing and managing digital platforms for knowledge exchange; Facilitating commercialization and utilization of research outcomes and promoting international and cross-border knowledge collaborations; Monitoring the effectiveness of knowledge flows and providing feedback to policymakers	Intermediary Institutions	

Institutional infrastructure, as one of the fundamental pillars of knowledge brokering, enhances the capacity of the innovation ecosystem to create and sustain knowledge value by providing a coherent framework for knowledge generation, circulation, and utilization. Supportive institutions facilitate sustainable knowledge interaction and sharing among actors through capacity building, the creation of incentives, the development of soft infrastructures, and the reduction of innovation risks. Moreover, policy-oriented institutions align knowledge flows with the strategic objectives of the ecosystem through evidence-based policymaking, stakeholder coordination, monitoring systems, intellectual property protection, and the professional development of knowledge brokers. In addition, laws and regulations strengthen institutional trust and responsible knowledge transfer by establishing transparent, secure, and flexible frameworks while reducing legal and operational risks. Furthermore, intermediary institutions contribute to continuous improvement, institutional learning, and the dynamism of knowledge flows within the innovation ecosystem through mediation, the development of knowledge exchange platforms, the facilitation of commercialization, international collaborations, and the provision of feedback to policymakers.

Table 3. *Technological Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
An Integrated Data-Driven Architecture for Knowledge Flow and Governance; Integrated Knowledge Collaboration Platforms and Intelligent Portals for Multi-Level Access to Knowledge Resources; Intelligent Dashboards for Monitoring and Governing Knowledge Performance Indicators; Technical Standards for Knowledge System Interoperability; and Security, Data Privacy, and Digital Trust Layers.	Ecosystem-Oriented Information and Digital Architecture	Knowledge Interaction and Intelligence System

Multi-Stakeholder Digital Collaboration Systems and Interaction Brokerage Management Systems; AI-Driven Knowledge Networking Tools; Intelligent Systems for the Formation and Coordination of Collaborative Research Projects; Real-Time Feedback and Interactive Learning Platforms; and Dynamic Knowledge Network Mapping Tools.	Knowledge Interaction, Networking, and Collaboration	
Intelligent Knowledge Discovery, Search, and Retrieval Engines; Intelligent Systems for Identifying and Predicting Knowledge Gaps; Intelligent Monitoring of Knowledge Flows, Knowledge Supply–Demand Matching, and Knowledge Value Creation Modeling; and Knowledge Brokerage Decision Support Systems.	Knowledge Analytics, Intelligence, and Decision Support Capabilities	
Digital Data and Knowledge Governance Frameworks; Algorithmic Ethics, Intelligent Decision Transparency, and Mechanisms for Digital Trust and Legitimacy; and Cyber Resilience, Security Infrastructure, Data Confidentiality, and Knowledge Trust.	Digital Governance and Technological Trust	

The technological infrastructure of knowledge brokerage, serving as the backbone of the innovation ecosystem, facilitates the intelligent flow, processing, and utilization of knowledge through a data-driven architecture and integrated digital systems, while enabling secure and coordinated interactions among diverse stakeholders. By fostering knowledge networking, collective learning, and the integration of heterogeneous knowledge resources, this infrastructure strengthens the ecosystem's capacity for co-creation and value generation. Furthermore, intelligent data analytics and knowledge decision support systems enable the continuous monitoring of knowledge flows, the identification of knowledge gaps, and the alignment of knowledge supply with demand, thereby enhancing the effectiveness of innovation processes. In addition, digital governance, information security, algorithmic transparency, ethical AI governance, and cyber resilience safeguard the integrity, trustworthiness, and sustainability of knowledge flows, creating an enabling environment for sustainable, data-driven innovation.

Table 4. *Human Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
The Ability to Analyze, Interpret, Evaluate, and Critically Reflect on Complex Knowledge; Knowledge Translation, Reframing, Knowledge Reconfiguration, and Narrative Development Skills for Diverse Audiences and Specialized Domains; Proficiency in Knowledge Search, Retrieval, Validation, and Critical Evaluation of Knowledge Sources; Competence in Designing Knowledge Maps, Models, and Conceptual Frameworks; The Ability to Identify Knowledge Gaps, Overlaps, and Synergies, and to Integrate Knowledge Across Domains; and Proficiency in Foresight, Trend Monitoring, Weak Signal Detection, and the Identification of Emerging Knowledge.	Specialized and Cognitive Competencies	Knowledge Actor Capital Development Layer
A Systemic Understanding of the Relationships Among Data, Information, and Knowledge, and the Transformation of These Resources into Actionable Insights; The Ability to Acquire, Internalize, and Integrate New Knowledge with Existing Knowledge and Prior Experience; The Capacity to Rapidly Comprehend Emerging Technologies and Knowledge Transformations and Adapt Accordingly; Cognitive Flexibility, Continuous Learning, and the Ability to Identify Learning Opportunities within Knowledge Networks; and the Effective Transfer of Acquired Knowledge Across Individuals, Teams, and Networks	Knowledge Absorption, Learning, and Adaptation Capabilities in Human Capital	
Intrinsic Motivation for Knowledge Participation, Co-Creation, and Knowledge Sharing; Commitment to Transparency, Integrity, Accountability, and Professional Impartiality in Knowledge Management; and Willingness to Leverage Digital Tools and Actively Engage in Knowledge Networks and Knowledge-Sharing Forums.	Motivation, Attitudes, and Professional Knowledge Ethics	
The Ability to Direct, Orchestrate, and Govern Knowledge Flows within the Ecosystem; The Capability to Establish, Sustain, and Strengthen Trust and Social Capital Among Knowledge Actors; The Ability to Manage Conflicts, Divergent Interests, and Knowledge-Related Tensions in Network Interactions; Strategic Networking and the Creation of Synergies Between Knowledge Supply and Demand Across Organizations; Leading Knowledge Transfer, Knowledge Translation, and Co-Creation Initiatives while Empowering Participants; and Knowledge-Based Decision-Making and the Monitoring of Knowledge Flows and Networks under Complex Conditions.	Knowledge Leadership and Knowledge Network Orchestration	

Training in the Design and Management of Knowledge Transfer, Knowledge Translation, and Knowledge Brokerage Processes; Empowerment in the Development, Commercialization, Value Assessment, and Impact Evaluation of Knowledge-Based Products and Assets; and the Development of International Competencies through Experiential Learning, Mentoring, Communities of Practice, Knowledge Diplomacy, and Cross-Cultural Interactions.	Capacity Building, Training, and Professionalization	

The human infrastructure of knowledge brokerage serves as the primary driving force of the innovation ecosystem by leveraging specialized, cognitive, and analytical competencies to enable the intelligent management of knowledge flows, the identification of emerging opportunities, and the integration of diverse knowledge resources. By fostering continuous learning, cognitive flexibility, and the transformation of knowledge into actionable insights, this infrastructure facilitates effective knowledge transfer while cultivating a culture of learning and innovation. Furthermore, intrinsic motivation, professional ethics, knowledge leadership, and trust strengthen collaboration, promote synergies among knowledge actors, and support knowledge-based decision-making in complex environments, thereby enhancing the effectiveness of knowledge networks. In addition, capacity building and professional development enhance the capabilities of human capital through the cultivation of specialized expertise, intercultural competencies, knowledge commercialization skills, and experiential learning, thereby strengthening the workforce's capacity to manage knowledge flows in a sustainable and value-creating manner.

Table 5. *Financial–Economic Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Specialized Knowledge Investment Funds; Sustainability-Oriented Contracts and Knowledge Value-Sharing Partnerships; Investment Attraction from Knowledge-Based and Technology Firms; Government-Sponsored Funding Programs; Impact Investing; Crowdfunding for Collaborative Knowledge Projects; Revenue Generation through Digital Knowledge Platforms; Financial Risk Management within the Innovation Ecosystem; and Cash Flow and Return on Investment (ROI) Management for Knowledge-Based Projects.	Sustainable Financial Resources	Sustainable Value Creation Logic
Knowledge Platform Economy Model; Knowledge Circular Economy Model; Knowledge Sharing Economy Model; Knowledge Demand-Driven Economy Model; Data–Knowledge Economy Model; Scalable Digital Economy Model; Knowledge Standardization-Based Economy Model; Outcome-Based Knowledge Exchange Economy Model; Knowledge Network Economy Model; and Intelligent Knowledge Consulting Economy Model.	Sustainable Economic Models	

The financial and economic infrastructure of knowledge brokerage provides the foundation for implementing knowledge-based initiatives and creating value within the innovation ecosystem by ensuring sustainable financial resources, managing financial risks, and establishing adaptive economic models. Funding mechanisms such as specialized knowledge investment funds, investments from knowledge-based and technology firms, government-sponsored funding programs, impact investing, crowdfunding, and digital knowledge platform–based revenue models contribute to economic sustainability and the continuity of knowledge flows. Furthermore, the adoption of innovative economic models—including the circular economy, sharing economy, data-driven economy, demand-driven economy, network economy, and outcome-based economy—enables the efficient utilization of knowledge resources, enhances economic performance, and supports sustainable value creation mechanisms. Overall, this infrastructure strengthens collaboration among ecosystem actors, facilitates knowledge commercialization, mitigates financial risks, and enhances ecosystem resilience, thereby creating the conditions necessary for achieving sustainable innovation.

Table 6. *Network Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Structured Frameworks, Systems, and Protocols for the Exchange of Knowledge and Scientific Findings Across Organizations; Formal Platforms for Sharing Experiences, Lessons Learned, and Integrating Project Knowledge Across Networks; Formal Collaboration Pathways Linking Universities, Industry, and Other Knowledge Institutions; Mechanisms for Knowledge Curation, Validation, Preparation, and Standardization Prior to Dissemination; and Specialized Platforms for Knowledge Collaboration, Knowledge Transfer, Knowledge Dissemination, and Collaborative Problem-Solving	Formal Knowledge Exchange Networks	Knowledge Network Connectivity and Management Architecture
Institutionalization of Multi-Stakeholder Knowledge Governance Structures; Consensus- and Evidence-Based Participatory Decision-Making Frameworks; Transparency, Accountability, Traceability, and Knowledge Flow Monitoring Protocols; Participatory Processes for Assessing the Value, Impact, and Quality of Knowledge; and Legal Frameworks Governing Knowledge Ownership, Access, Sharing, and Utilization	Collaborative Knowledge Governance Mechanisms	
Integrated Platforms for Ecosystem-Wide Knowledge Management, Knowledge Brokerage, and Coordination; Shared, Interoperable, and Integrated Knowledge Databases Across Institutions; Intelligent Systems for the Analysis, Traceability, Documentation, and Version Control of Knowledge Flows; and Intelligent Recommendation and Decision Support Systems for Facilitating Knowledge Exchange and Knowledge Brokerage	Technological Networks for Governance and Inter-Institutional Coordination	

The network infrastructure of knowledge brokerage facilitates interactions, knowledge exchange, and the flow of knowledge among actors within the innovation ecosystem, thereby fostering synergy, integrating distributed knowledge resources, and enhancing the effectiveness of knowledge networks. Through formal knowledge exchange networks, experience-sharing platforms, and knowledge integration mechanisms, this infrastructure enables the systematic, secure, and reliable management of knowledge flows. Furthermore, collaborative knowledge governance strengthens transparency, accountability, collective decision-making, and process standardization, thereby improving coordination among stakeholders and reinforcing the sustainability of knowledge networks. In addition, the technological network leverages social network analytics, shared interoperable databases, and intelligent digital systems to monitor and orchestrate knowledge flows, identify emerging opportunities and knowledge gaps, and enhance the effectiveness of research, innovation, and knowledge brokerage initiatives.

Table 7. *Processual Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Standardized Processes for Identifying, Formulating, and Prioritizing Knowledge Needs; Protocols for the Evaluation, Validation, and Continuous Updating of Knowledge, Resources, and Experts; Systematic Processes for Matching Knowledge Needs with Available Resources and Capabilities; Standard Frameworks for Knowledge Transfer, Knowledge Translation, and Knowledge Flow Management across the Ecosystem; Security, Confidentiality, Protection, and Access Governance Protocols for Knowledge Resources; and Monitoring, Evaluation, Risk Management, Feedback, and Continuous Improvement Cycles for Knowledge Brokerage Processes	Standardized Operational Processes	Knowledge Implementation System
Dashboards for Monitoring and Tracking Interactions, Performance, and Knowledge Flows; AI-Based Intelligent Models for Predicting Knowledge Gaps and Prioritizing Knowledge Needs; Tools and Models for Assessing Absorptive Capacity, Organizational Maturity, and Readiness for Knowledge Brokerage; Value Creation Models, Impact Assessment Frameworks, and Effectiveness Evaluation Models for Knowledge Brokerage; and Intelligent Decision Support Tools for Matching Knowledge with Needs and Application Contexts	Supporting Tools, Frameworks, and Models	
Operational Roles and Capabilities: Definition of the Roles, Responsibilities, and Operational Functions of Knowledge Brokers within the Ecosystem; and Development of Professional Competencies and Collaboration Mechanisms between Human Knowledge Brokers and Intelligent Systems.	Operational Roles and Capabilities	

The process and operational infrastructure of knowledge brokerage facilitates the systematic management, transfer, and utilization of knowledge flows within the

innovation ecosystem by establishing standardized frameworks, transparent protocols, and coordinated mechanisms, thereby enhancing the operational, economic, and social value of knowledge. Through the identification, assessment, validation, and alignment of knowledge resources with emerging needs, this infrastructure strengthens effective knowledge transfer while reducing process-related risks and inefficiencies. Furthermore, the integration of intelligent tools, value creation models, knowledge flow mapping techniques, and knowledge gap prediction systems enables advanced analytics, data-driven decision-making, and the optimization of knowledge brokerage activities. In addition, the synergy between the professional capabilities of knowledge brokers and intelligent systems ensures the monitored and effective management of knowledge flows, while fostering productive interactions between human resources and technological infrastructures.

Table 8. *Data & Knowledge Governance Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Policies for Regulating the Quality, Reliability, and Credibility of Knowledge; Policies for the Standardization of Data, Knowledge, and Metadata; Policies for Equitable Access, Controlled Knowledge Sharing, and Open Knowledge; Policies for Privacy Protection, Data and Knowledge Security, and Confidentiality; Policies for Knowledge Lifecycle Management from Creation to Preservation and Archiving; Policies for the Evaluation, Classification, and Validation of Knowledge Resources and Assets; Policies for Ensuring the Authenticity, Integrity, Transparency, and Traceability of Data and Knowledge; Policies for Monitoring, Oversight, Accountability, and the Advancement of Data Literacy and Knowledge Governance; Policies for Intellectual Property, Licensing, and Responsible Knowledge Utilization; and Policies for Data Ethics, Artificial Intelligence, and Algorithmic Governance.	Knowledge Governance Policies	Knowledge Governance and Trust Architecture
Data and Knowledge Architecture Aligned with the Requirements of Knowledge Brokerage; Interoperable Data, Knowledge, and Metadata Architecture Across Institutions; Architecture for Distributed Knowledge Repositories and the Integration of Heterogeneous Knowledge Resources; Knowledge Graph and Semantic Network Architecture for the Innovation Ecosystem; Architecture for Knowledge Flow Monitoring, Traceability, and Analytics Systems; Architecture for Knowledge Recommendation, Knowledge Matching, and Decision Support Systems; and Governance-by-Design Architecture for Intelligent Knowledge Brokerage Systems	Knowledge Brokerage–Supporting Data and Knowledge Architecture	
Data and Knowledge Trust Frameworks for Ensuring Trusted Interactions; Mechanisms for Conflict Resolution, Arbitration, and Institutional Coordination in Knowledge Governance; and Alignment of Policies, Data Architecture, and the Strategic Objectives of the Innovation Ecosystem.	Trust, Legal, and Institutional Coordination Mechanisms	

The data and knowledge governance infrastructure constitutes a fundamental pillar of knowledge brokerage by ensuring quality, security, transparency, and trust, thereby enabling the sustainable and value-driven management of knowledge flows within the innovation ecosystem. Through comprehensive knowledge governance policies—including regulatory frameworks, standards, and governance mechanisms—this infrastructure safeguards data quality, secure knowledge sharing, knowledge lifecycle management, and adherence to the principles of data ethics and artificial intelligence governance. Furthermore, an integrated data and knowledge architecture, supported by distributed knowledge repositories, knowledge graphs, and intelligent systems, optimizes knowledge access, analytics, and evidence-based decision-making. In addition, trust, legal, and institutional coordination mechanisms strengthen policy alignment, facilitate conflict resolution, and reinforce legitimacy and trust among ecosystem actors, thereby ensuring that knowledge flows are governed in a transparent, coordinated, and effective manner.

Table 9. *Organizational Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Structural Flexibility of Organizational Units to Facilitate External Collaboration; Avoidance of Excessive Centralization in Knowledge-Related Decision-Making; Capacity to Establish Cross-Functional Roles and Responsibilities within the Organizational Structure; Recognition of Non-Linear Knowledge Interactions within the Formal Organizational Structure; and	Organizational Structural Readiness	

Organizational Tolerance for Ambiguity, Experimentation, and Knowledge Uncertainty.		Internal Alignment and Legitimacy Framework
Alignment of the Organization's Mission with Knowledge Creation, Transfer, and Utilization; Alignment of the Organization's Mission and Strategic Logic with Knowledge Brokerage; Recognition of the Organization's Intermediary Role within the Knowledge Value Chain; Prioritization of Problem Solving over the Mere Production of Knowledge Outputs; Adoption of a Cross-Sectoral Perspective on the Value of Knowledge; and Organizational Readiness to Serve as a Bridge among Diverse Knowledge Stakeholders	Alignment of the Organization's Mission and Strategic Logic with Knowledge Brokerage	
The Ability to Coordinate Knowledge-Related Activities Across Organizational Units; The Capacity to Facilitate Internal Knowledge Flows; The Absence of Knowledge Silos Across Organizational Functions; Transparency of Internal Knowledge Flow Pathways; and the Organization's Ability to Align Organizational Units around Shared Knowledge Challenges	Internal Organizational Coordination Capacity for Knowledge Flows	
Recognition of Knowledge Brokerage as a Legitimate Organizational Function; Formal Recognition of Knowledge Brokerage Activities within Organizational Performance Evaluation; Explicit or Implicit Managerial Support for Knowledge Brokerage Roles; Recognition of Knowledge Brokerage as a Core Organizational Function Rather than a Peripheral Activity; and Organizational Trust in the Outcomes and Value Added of Knowledge Brokerage Activities	Organizational Positioning and Internal Legitimacy of Knowledge Brokerage	

The organizational infrastructure fosters effective and value-creating knowledge flows within and across organizations by establishing flexible, coordinated, and legitimate organizational structures. Through organizational structural readiness, alignment of the organization's mission and strategic logic with knowledge brokerage, and reinforcement of its intermediary role, this infrastructure enables the dynamic and strategic management of knowledge flows to address complex challenges and achieve organizational objectives. Furthermore, internal organizational coordination capacity enhances the integration of knowledge-related activities by preventing the emergence of knowledge silos, improving the transparency of knowledge flow pathways, and strengthening collaboration across organizational units. In addition, the organizational positioning and internal legitimacy of knowledge brokerage are reinforced through managerial support, formal organizational recognition, and the cultivation of organizational trust, thereby establishing knowledge brokerage as a strategic organizational function that enhances organizational performance, innovation, and long-term value creation.

Table 10. *Physical Infrastructure*

Concept (Initial Code)	Sub-theme	Main Theme
Availability of Dedicated Physical Space for a Knowledge Brokerage Unit or Center; Establishment of Knowledge Liaison Offices within Universities and Research Institutions; Presence of Innovation Centers or Business Accelerators as Physical Hubs for Knowledge Brokerage; Existence of a Formal Organizational Structure for the Knowledge Brokerage Unit within the Host Organization; Physical Separation of Knowledge Brokerage Workspaces from Unrelated Operational Units; and Spatial Stability of the Knowledge Brokerage Unit to Ensure Continuity of Relationships and Collaborative Interactions.	Physical Establishment and Organizational Configuration of Knowledge Brokerage	Physical Ecosystem Infrastructure
Access to Shared Physical Spaces for Face-to-Face Interaction among Knowledge Actors; Flexible Workspace Design for Formal and Informal Meetings; Availability of Dedicated Venues for Knowledge Exchange Events (e.g., Workshops, Seminars, and Roundtable Discussions); Access to Interorganizational Meeting Facilities for Knowledge Brokers; Physical Co-location of Key Innovation Ecosystem Actors (Universities, Industry, and Government); Availability of Informal Meeting Spaces to Foster Trust Building and Network Development; and Strategic Placement of Knowledge Brokers at Key Nodes within Knowledge Networks	Interactive Spaces for Knowledge Exchange	
Easy Physical Access to Policymaking and Supporting Institutions; Shared Access to Physical Infrastructure across Ecosystem Institutions; Availability of Secure Spaces for the Exchange of Sensitive Data and Knowledge; Physical Infrastructure to Support the Documentation and Management of Knowledge Interactions; Physical Environment Design Tailored to Knowledge Facilitation and Brokerage Activities; and Access of Knowledge Brokers to Essential Physical Support Facilities, Including Equipment, Communication Resources, and Support Spaces	Physical Support Infrastructure	

The physical infrastructure provides the tangible foundation for knowledge brokerage by creating environments that facilitate interaction, networking, and knowledge exchange, thereby strengthening knowledge flows within the innovation ecosystem.

Through the structured establishment of knowledge brokerage units and the provision of a stable organizational and physical presence, this infrastructure fosters sustained engagement among ecosystem stakeholders and supports the continuity of knowledge flows. Furthermore, the design of flexible collaborative spaces, the physical co-location of key ecosystem actors, and convenient access to policymaking and supporting institutions enhance the transfer of tacit knowledge, foster mutual trust, and promote effective collaboration. In addition, the provision of appropriate physical facilities and infrastructure, secure environments for the exchange of sensitive information and knowledge, and dedicated resources for documenting and managing knowledge interactions significantly improve the efficiency and effectiveness of knowledge brokerage activities.

Table 11. *Cultural–Discursive Infrastructure of Knowledge Brokerage*

Concept (Initial Code)	Sub-theme	Main Theme
Mutual Trust among Universities, Industry, and Policymakers; Recognition of Cross-Sector Collaboration as a Shared Value; Reduction of Unhealthy Competitive Attitudes toward Knowledge Sharing; Willingness to Exchange Experience and Tacit Knowledge; Establishment of Ethical Norms for the Responsible Use of Others' Knowledge; and Shared Belief in the Collective Benefits of Knowledge Sharing	Institutionalization of a Culture of Collaboration and Trust among Knowledge Actors	Semantic and Normative Foundations of Knowledge Brokerage
Use of Language that is Accessible to Non-Specialists; Translation of Scientific Knowledge into Practical and Actionable Concepts; Reduction of the Linguistic Gap between Research and Practice; Standardization of Knowledge Concepts and Terminology across Interactions; and Establishment of Shared Meaning for Key Concepts among Innovation Ecosystem Actors	Development of a Shared Discourse and Boundary-Spanning Language for Knowledge Brokerage	
Recognition of Knowledge Brokerage as a Specialized Profession; Trust in the Knowledge Broker's Neutrality among Ecosystem Actors; Recognition of the Knowledge Broker's Value Added in Decision-Making Processes; Symbolic Support from Intellectual and Organizational Leaders for Knowledge Brokerage; and Institutionalization of the Knowledge Broker's Role within the Discourse of Development and Innovation	Social Legitimization of the Knowledge Broker's Role	

The cultural and discursive infrastructure of knowledge brokerage provides a sustainable foundation for effective knowledge flows within the innovation ecosystem by fostering trust, collaboration, and shared normative and ethical frameworks. Through the institutionalization of a culture of collaboration, mutual trust, cross-sectoral cooperation, knowledge sharing, and adherence to ethical principles, this infrastructure strengthens synergies among ecosystem actors and promotes the responsible governance of knowledge flows.

Furthermore, the development of a shared discourse and a boundary-spanning language enables the translation of scientific knowledge into practical and actionable concepts, facilitates the standardization of knowledge concepts and terminology, and bridges the gap between research and practice, thereby enhancing knowledge exchange and collaborative knowledge creation. In addition, the social legitimization of the knowledge broker's role—through trust, support from intellectual and organizational leaders, and the institutionalization of knowledge brokerage as a recognized profession—reinforces the sustainability of collaborative networks and enhances the effectiveness and long-term impact of knowledge brokerage.

Conceptual Clarifications of Infrastructure Dimensions and Coding Categories

The following conceptual clarifications are provided to establish clear distinctions among the identified dimensions of knowledge brokerage infrastructure and to prevent conceptual overlap across different levels of analysis.

- *Intellectual property policies (institutional/data), ethics, trust, legitimacy (institutional/data governance), and knowledge exchange regulations (institutional/data governance):*

These components have different meanings depending on the analytical level at which they are examined. Within institutional infrastructure, they represent macro-level policy, legal, and regulatory arrangements associated with broader governance frameworks, formal rules, and the institutional environment. In contrast, within

data and knowledge governance infrastructure, they refer to operational and architectural governance arrangements concerned with the implementation, management, monitoring, and control of data and knowledge flows. Accordingly, macro-level policymaking and institutional regulation should be analytically distinguished from the operational governance of data and knowledge systems.

- *Technological infrastructure*

Technological infrastructure (as presented in Table 2) refers specifically to the technical capabilities, digital resources, and technological systems that enable the creation, exchange, processing, analysis, and utilization of knowledge within the innovation ecosystem.

- *Network infrastructure*

Network infrastructure (as presented in Table 5) refers to the governance logic, structural configuration, and coordination mechanisms underlying interactions and relationships among innovation ecosystem actors. Its emphasis is therefore not merely on the existence of connections, but on how collaborative knowledge networks are established, maintained, coordinated, and governed.

Regarding the following codes

- Guiding knowledge flows (human/process)
- Broker roles (process/organizational)
- Brokerage legitimacy (organizational/institutional)

These dimensions represent three analytically distinct levels:

- Within human infrastructure, the emphasis is placed on the competencies, capabilities, expertise, and agency of knowledge actors and knowledge brokers in identifying, interpreting, connecting, and guiding knowledge flows.
- Within processual infrastructure, the focus is on how knowledge brokerage activities are structured, performed, coordinated, and managed through formalized operational procedures, processes, and protocols.
- Within organizational infrastructure, the emphasis is placed on the formal position, recognition, authority, legitimacy, and institutionalization of knowledge brokerage roles within organizations.

Accordingly, although these concepts are closely interconnected and may contribute jointly to the functioning of knowledge brokerage, they should not be regarded as overlapping constructs. Rather, they represent complementary dimensions operating at different analytical levels within the knowledge brokerage system. This distinction allows the identified infrastructures to be interpreted according to their specific functional and analytical roles while preserving their interdependence within the broader architecture of knowledge brokerage.

This conceptual differentiation is particularly important because the institutionalization of knowledge brokerage requires simultaneous attention to the macro-level institutional and regulatory environment, the organizational and processual arrangements through which brokerage is operationalized, the human capabilities of knowledge actors, and the technological, network, data-governance, and cultural foundations that sustain knowledge flows. Therefore, the ten infrastructure dimensions identified in this study are treated as analytically distinguishable but functionally complementary components of an ecosystem-level infrastructure architecture rather than as isolated or mutually exclusive categories. Taken together, these dimensions should therefore be understood as interdependent components of a common infrastructural configuration rather than as isolated or mutually exclusive categories. Their distinct contributions become meaningful through their interaction, through which the broader capacity for knowledge brokerage is formed and sustained across the innovation ecosystem.

The proposed model demonstrates that knowledge brokerage within an innovation ecosystem should not be viewed merely as an operational activity or an intermediary mechanism; rather, it constitutes a systemic and ecosystem-level capability whose establishment and effectiveness depend on

the existence of a set of complementary and interconnected infrastructures.

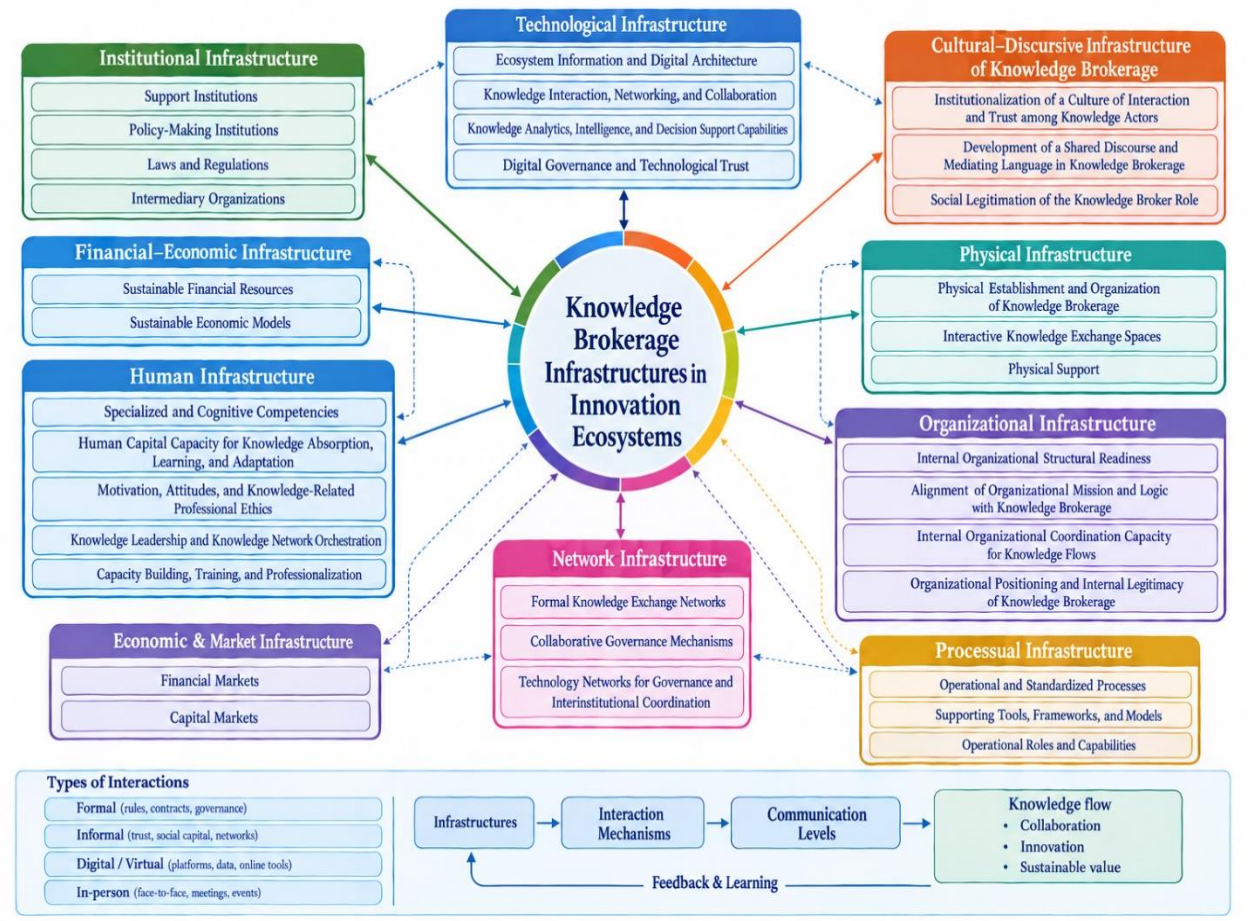


Figure 1. *Final Model of Knowledge Brokerage Infrastructure in the Innovation Ecosystem*

Accordingly, the principal contribution of this study lies in identifying the foundational infrastructures that enable the emergence, institutionalization, and sustainability of knowledge brokerage. The model indicates that effective knowledge brokerage cannot be achieved solely through the establishment of intermediary organizations or the adoption of advanced technologies. Instead, it requires the development of an enabling environment capable of facilitating continuous interaction, trust, collaboration, and knowledge flows among all actors within the innovation ecosystem. In this regard, ten key infrastructures were identified as the fundamental pillars underpinning knowledge brokerage: institutional infrastructure; cultural–discursive infrastructure; organizational infrastructure; data and knowledge governance infrastructure; process–operational infrastructure; network infrastructure; financial–economic infrastructure; human infrastructure; technological infrastructure; and physical infrastructure. Each of these infrastructures contributes a distinct yet complementary set of capabilities required for the effective functioning of the knowledge brokerage system. The analysis further reveals that these infrastructures do not operate independently; rather, they function as an integrated and mutually reinforcing system. Institutional and governance infrastructures establish legitimacy, regulatory frameworks, and the rules governing interactions among ecosystem actors. Cultural–discursive and human infrastructures foster social capital, trust, shared values, and the competencies necessary for effective knowledge exchange. Organizational, process–operational, and network infrastructures provide the structural and procedural foundations for coordination, collaboration, and the circulation of knowledge. Meanwhile, technological and financial–economic infrastructures supply the technical capabilities and financial resources

required to sustain knowledge brokerage activities over time. Finally, the physical infrastructure provides the spatial environment necessary to support interaction, collaboration, and knowledge exchange among ecosystem participants. From a theoretical perspective, the value of this model lies in conceptualizing knowledge brokerage not as the outcome of a single organization or intermediary actor, but as an emergent property arising from the synergy of multiple hard and soft infrastructures. Through their continuous interaction, these infrastructures collectively create the capacity for knowledge creation, sharing, transfer, and utilization across the innovation ecosystem. Consequently, deficiencies in any single infrastructure are likely to diminish the effectiveness of the others, thereby weakening the overall performance of the knowledge brokerage system. This finding underscores that the successful implementation of knowledge brokerage requires the simultaneous, balanced, and coordinated development of all supporting infrastructures to foster innovation, interorganizational learning, and sustainable value creation within the innovation ecosystem. Furthermore, the relationships among these ten infrastructures are inherently reciprocal, interactive, and feedback-driven. Strengthening or weakening any one infrastructure generates cascading effects that influence the performance of the others. Therefore, the successful institutionalization of knowledge brokerage depends on the coordinated and balanced development of all infrastructure dimensions. Only through such systemic synergy can an innovation ecosystem effectively support knowledge creation, sharing, transfer, and application, ultimately enhancing innovation capacity and enabling sustainable value creation.

Table 12. *Results of the Delphi Round for the Evaluation and Acceptance of Knowledge Brokerage Infrastructures and Themes*

Infrastructures	Themes	Likert Scale					Mean	Acceptance (Yes/No)
		Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree		
Institutional Infrastructure	Support Institutions	20.00%	53.33%	20.00%	6.67%	0%	3.87	Yes
	Policy-Making Institutions	46.67%	40.00%	13.33%	0%	0%	4.33	Yes
	Laws and Regulations	73.33%	26.67%	0%	0%	0%	4.73	Yes
	Intermediary Institutions	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
Technological Infrastructures	Ecosystem Information and Digital Architecture	53.33%	33.33%	13.33%	0%	0%	4.40	Yes
	Knowledge Interaction, Networking, and Collaboration	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
	Analytical, Intelligent, and Knowledge Decision-Support Capabilities	26.67%	40.00%	20.00%	13.33%	6.67%	3.87	Yes
	Digital Governance and Technological Trust	33.33%	40.00%	26.67%	6.67%	0%	4.20	Yes
Human Infrastructures	Professional and Cognitive Competencies	66.67%	26.67%	6.67%	0%	0%	4.60	Yes
	Human Capacity for Knowledge Absorption, Learning, and Adaptation	40.00%	46.67%	13.33%	0%	0%	4.27	Yes
	Motivation, Attitudes, and Knowledge-Related Professional Ethics	26.67%	40.00%	26.67%	6.67%	0%	3.87	Yes
	Knowledge Leadership and Knowledge Network Facilitation	33.33%	40.00%	20.00%	6.67%	0%	4.00	Yes
	Capacity Building, Training, and Professionalization	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes

Financial–Economic Infrastructures	Sustainable Financial Resources	53.33%	33.33%	13.33%	0%	0%	4.40	Yes
	Sustainable Economic Models	26.67%	40.00%	26.67%	6.67%	0%	3.87	Yes
Network Infrastructures	Formal Knowledge Exchange Networks	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
	Participatory Governance Mechanisms	26.67%	40.00%	26.67%	6.67%	0%	3.87	Yes
	Technological Networks for Governance and Interinstitutional Coordination	20.00%	40.00%	20.00%	13.33%	6.67%	3.53	Yes
Process–Operational Infrastructures	Standardized Operational Processes	53.33%	33.33%	13.33%	0%	0%	4.40	Yes
	Supporting Tools, Frameworks, and Models	26.67%	40.00%	26.67%	6.67%	0%	3.87	Yes
	Operational Roles and Capabilities	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
Data and Knowledge Governance Infrastructures	Knowledge Governance Policies	53.33%	33.33%	13.33%	0%	0%	4.40	Yes
	Supporting Data and Knowledge Architecture for Knowledge Brokerage	60.00%	40.00%	0%	0%	0%	4.60	Yes
	Trust, Rights, and Institutional Coordination	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
Organizational Infrastructure	Internal Organizational Structural Readiness	26.67%	40.00%	26.67%	6.67%	0%	3.87	Yes
	Alignment of Organizational Mission and Logic with Knowledge Brokerage	20.00%	33.33%	26.67%	13.33%	6.67%	3.47	Yes
	Intra-organizational Coordination Capacity for Knowledge Flows	26.67%	46.67%	20.00%	6.67%	0%	3.93	Yes
	Intra-organizational Positioning and Legitimacy of Knowledge Brokerage	20.00%	46.67%	20.00%	6.67%	6.67%	3.67	Yes
Physical Environment Infrastructure	Physical Deployment and Organization of Knowledge Brokerage	13.33%	40.00%	26.67%	13.33%	6.67%	3.40	Yes
	Interactive Spaces for Knowledge Exchange	33.33%	40.00%	20.00%	6.67%	0%	4.00	Yes
	Physical Support	13.33%	26.67%	26.67%	13.33%	6.67%	3.40	Yes
Cultural–Discursive Infrastructure of Knowledge Brokerage	Institutionalization of a Culture of Interaction and Trust among Knowledge Actors	60.00%	40.00%	0%	0%	0%	4.60	Yes
	Development of a Shared Discourse and Bridging Language in Knowledge Brokerage	53.33%	33.33%	13.33%	0%	0%	4.40	Yes
	Social Legitimization of the Knowledge Broker Role	33.33%	40.00%	26.67%	6.67%	0%	4.20	Yes

5. Discussion

Knowledge brokerage within innovation ecosystems extends beyond conventional knowledge transfer activities and requires a supportive configuration of complementary conditions. The findings indicate that effective brokerage depends on the availability and coordination of institutional, organizational, human, technological, network, financial, processual, data and knowledge governance, cultural–discursive, and physical infrastructures. Together, these infrastructures support key knowledge-related activities, including knowledge creation, exchange, translation, absorption, utilization, and commercialization, while also facilitating coordination among diverse ecosystem actors. The findings further

indicate that weaknesses in one infrastructural domain may constrain the effectiveness of others. For example, advanced technological capabilities may have limited impact in the absence of appropriate organizational processes and data and knowledge governance, while human capabilities may not translate into effective brokerage without adequate institutional support, resources, and opportunities for network interaction. This suggests that strengthening knowledge brokerage requires attention not only to the development of individual infrastructural domains but also to the conditions that enable their coordinated functioning. From a practical perspective, the findings highlight the importance of considering knowledge brokerage as a cross-cutting ecosystem concern rather than assigning responsibility for it to a single organization, intermediary, or policy instrument. Strengthening brokerage therefore requires coordinated attention to institutional support, capability development, technological and data infrastructure, network development, process improvement, resource provision, and a supportive cultural environment. Such an integrated approach can facilitate more effective knowledge flows among ecosystem actors and improve the conditions for knowledge utilization, innovation, and value creation. The findings also provide a basis for future empirical assessment of knowledge-brokerage capacity across innovation ecosystems. The identified infrastructural domains can serve as reference points for developing assessment criteria, identifying infrastructural gaps, prioritizing interventions, and informing evidence-based policy and investment decisions. The proposed framework therefore provides a practical basis for examining the current capacity of an ecosystem for knowledge brokerage and for identifying areas requiring further development.

5.1. Theoretical Contribution and Added Value of the Proposed Framework

The theoretical added value of the proposed framework lies in moving beyond the identification of individual factors toward an integrated architecture of complementary infrastructures that explains how knowledge brokerage emerges, continues, and develops as an ecosystem-level capability. Rather than attributing brokerage to a single actor, function, or enabling factor, the framework conceptualizes it as an emergent capability arising from the interdependence, alignment, and interaction of multiple infrastructural domains. By integrating ten complementary domains, it provides a coherent account of the foundations required to sustain knowledge flows and brokerage activities across innovation ecosystems. A key contribution is the shift in analytical focus from "who performs knowledge brokerage and how?" to "what foundations are required for knowledge brokerage to emerge and continue within an innovation ecosystem?" This perspective connects three analytical levels that have often been examined separately: the actor and capability level, the organizational and institutional level, and the ecosystem and network level. At the actor level, specialized and cognitive competencies, knowledge absorption and learning capabilities, motivation, professional ethics, knowledge leadership, and network orchestration support brokerage activities. At the organizational and institutional levels, structures, regulations, roles, processes, resources, and legitimacy enable their coordination and continuity. At the ecosystem level, collaborative networks, data and knowledge infrastructures, relationships among actors, and cultural–discursive conditions support the coordination of knowledge flows. The framework thus explains how individual and organizational capabilities, when embedded in appropriate institutional and ecosystem arrangements, can contribute to sustainable knowledge brokerage. The framework further demonstrates that the ten infrastructures are not independent determinants but complementary and mutually reinforcing domains. Their interaction supports the identification and matching of knowledge supply and demand, knowledge translation and reconfiguration, the coordination of knowledge flows, the establishment of governance and trust, knowledge absorption and utilization, and the transformation of knowledge into application and value. For example, technological infrastructure cannot

ensure effective brokerage without appropriate data and knowledge governance and supporting processes; collaborative networks depend on trust, legitimacy, and coordination; and capable knowledge brokers require organizational positions, adequate resources, and an enabling cultural environment. Accordingly, the theoretical contribution lies not merely in identifying ten domains but in explaining their complementarity, interdependence, and alignment within an integrated infrastructural architecture. The substantive scope of these domains further strengthens the framework. Institutional infrastructure encompasses institutional support, policy-oriented institutions, laws and regulations, and intermediary institutions, providing foundations for legitimacy, coordination, and reduced uncertainty. Technological infrastructure extends beyond information technology provision to include ecosystem-oriented data and digital architecture, knowledge interaction and intelligence systems, analytics and decision support, and digital governance and technological trust. Human infrastructure incorporates specialized and cognitive competencies, knowledge absorption and learning, motivation and professional ethics, knowledge leadership and network orchestration, and professionalization and capacity building. Network and processual infrastructures support formal knowledge-exchange networks, collaborative knowledge governance, interorganizational coordination, and structured processes for identifying knowledge needs, validating and matching knowledge, translating and transferring it, monitoring outcomes, and improving practices. Data and knowledge governance, organizational, financial–economic, physical, and cultural–discursive infrastructures complete this configuration by addressing enabling conditions that may be overlooked when brokerage is treated primarily as an individual, interpersonal, or technological activity. Another contribution is the analytical distinction between infrastructures, critical success factors, and drivers. Infrastructures are conceptualized as relatively stable enabling foundations for the emergence and continuity of knowledge brokerage; critical success factors influence its implementation and effectiveness, whereas drivers stimulate its development and change. This distinction clarifies that factors associated with brokerage do not necessarily perform the same theoretical function. The proposed framework therefore constitutes more than a static taxonomy of influential factors: it offers an infrastructural architecture for explaining the foundations and relationships through which ecosystem-level knowledge brokerage can emerge and be sustained. Overall, the findings extend knowledge-brokerage scholarship beyond the role and performance of individual brokers toward the systemic conditions that make brokerage possible and sustainable. Knowledge brokerage is conceptualized not merely as a link between knowledge producers and users, but as an ecosystem capability dependent on the coordinated functioning of institutional, organizational, human, technological, network, processual, financial–economic, physical, data and knowledge governance, and cultural–discursive infrastructures. This perspective explains why knowledge availability, advanced technologies, or competent brokers alone are insufficient to transform knowledge into innovation. Sustainable brokerage requires relationships, rules, capabilities, resources, processes, and knowledge infrastructures to operate in a coordinated and mutually reinforcing manner. The framework thus provides a theoretical basis for understanding how fragmented, person-dependent, and informal brokerage practices can develop into a sustainable and potentially scalable ecosystem-level capability, supporting knowledge flows, collective learning, innovation capacity, value creation, and the sustainable development of innovation ecosystems.

5.2. Theoretical and Practical Contributions

This study makes theoretical and practical contributions to the literature on knowledge brokerage and innovation ecosystems. Theoretically, the findings provide a more differentiated understanding of knowledge-brokerage infrastructures by showing that brokerage is supported by complementary

conditions operating across multiple domains and analytical levels. The identified infrastructures—including institutional, organizational, human, technological, network, processual, financial–economic, physical, data and knowledge governance, and cultural–discursive dimensions play distinct but interconnected roles in supporting knowledge brokerage across different ecosystem contexts. A further theoretical contribution concerns the linkage between knowledge, interaction, and action. The findings indicate that brokerage extends beyond the movement of knowledge between producers and users to processes through which knowledge needs and ideas are interpreted, translated into shared understandings and solutions, incorporated into joint decisions, and followed by implementation, feedback, and learning. The findings also show that the mere availability of infrastructural resources does not guarantee effective brokerage; their contribution depends on their accessibility, coordination, contextual appropriateness, and connection to processes through which knowledge needs and capabilities are matched and acted upon. Practically, the framework provides policymakers, ecosystem managers, universities, firms, intermediary organizations, and other ecosystem actors with a basis for assessing infrastructural gaps, identifying areas requiring development, and prioritizing interventions. The ten domains can inform the design of knowledge-matching mechanisms, collaboration arrangements, digital platforms, coordination structures, feedback mechanisms, and procedures for identifying, validating, translating, transferring, and monitoring knowledge. Rather than prescribing a uniform configuration, the framework allows brokerage arrangements to be adapted to differences in institutional conditions, actor capabilities, resources, technological maturity, and network structures. Overall, the study provides an empirically grounded basis for assessing, designing, prioritizing, and further validating knowledge-brokerage infrastructures. The framework can support evidence-based policy and investment decisions while providing a foundation for future research to examine the relationships, relative importance, and contextual variation of the identified infrastructural domains and their contribution to knowledge flows, innovation, and value creation.

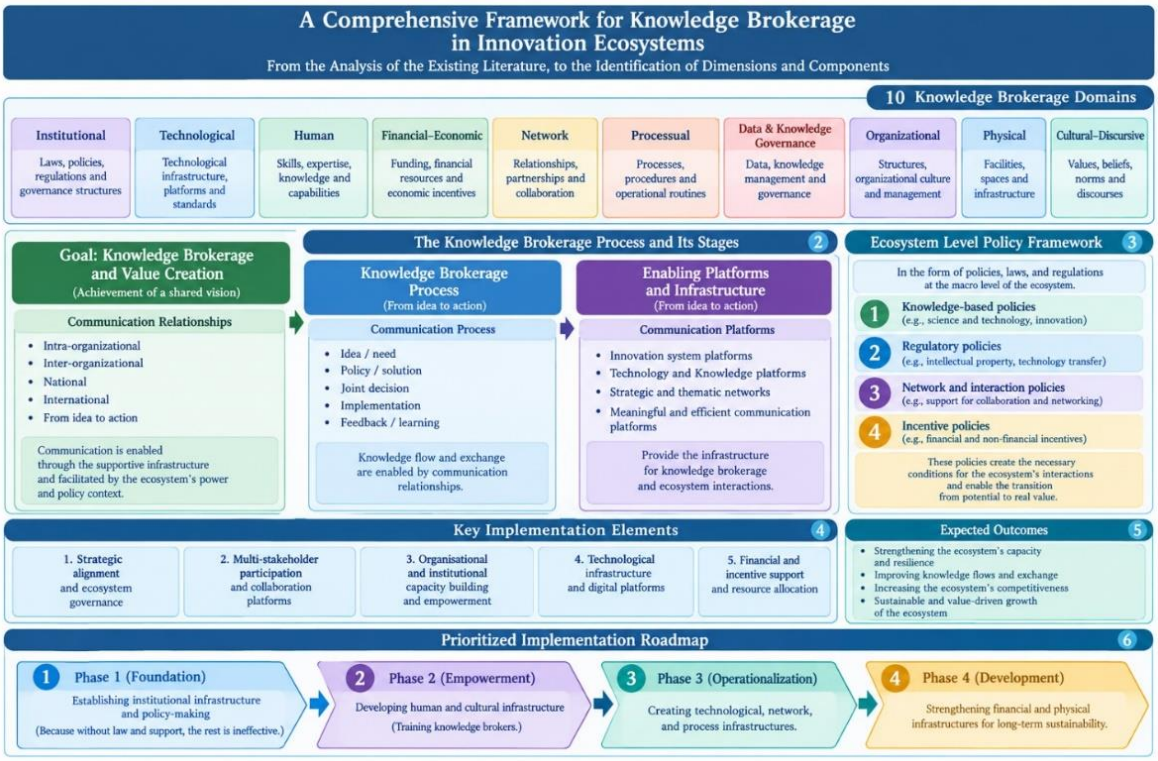


Figure 3. *Implementation Roadmap for Knowledge-Brokerage Infrastructure in the Innovation Ecosystem*

6. Conclusion

Innovation ecosystems require effective knowledge creation, circulation, and utilization to achieve sustainable innovation, value creation, and long-term competitiveness. Knowledge brokerage is therefore conceptualized not merely as knowledge transfer or an individual broker's activity, but as an ecosystem-level capability dependent on complementary infrastructures. While previous studies have primarily examined broker roles, knowledge transfer and translation processes, and factors influencing brokerage effectiveness, less attention has been paid to the infrastructures underpinning knowledge brokerage at the ecosystem level. Accordingly, this study adopts a systemic perspective to identify these infrastructures and examine their roles and interrelationships. The findings demonstrate that effective knowledge brokerage depends on the coordination of complementary infrastructures rather than the presence of any single infrastructure or capability. Comparison with national and international research reveals broad alignment with existing literature, while highlighting the study's contribution in integrating these infrastructures into a coherent, multidimensional framework. This framework provides a basis for assessing existing capacities, identifying infrastructural gaps, and informing future research and practical initiatives to strengthen knowledge brokerage in innovation ecosystems. Consistent with the findings of Tavassoli et al. (2023), Karimi and Iranzadeh (2016), and Ardalan et al. (2017), this study demonstrates that infrastructures do not generate value independently; rather, their effectiveness is realized through their interaction with managerial, organizational, and knowledge-related mechanisms. Likewise, the emphasis placed on the roles of human capital, collaborative networks, digital technologies, and institutional arrangements is consistent with the findings of Lee et al. (2023), Khan-Ahmadlou et al. (2020), McKillop et al. (2023), Kadouf et al. (2024), and Malin and Szucsak (2024), who conceptualize knowledge brokerage as a phenomenon grounded in interaction, trust, institutional capacity, and collaboration among ecosystem actors. Furthermore, the study highlights the critical roles of knowledge governance, data infrastructures, institutional legitimacy, collaborative culture, and financial sustainability, consistent with previous research emphasizing policymaking, networking, knowledge commercialization, and innovation ecosystems as key enablers of effective knowledge exchange and innovation. Nevertheless, the proposed model extends beyond these earlier studies by integrating these dimensions into a comprehensive systemic framework that explains how they collectively shape the effectiveness and sustainability of knowledge brokerage. A comparison with well-established international knowledge management models also reveals both substantial commonalities and important conceptual distinctions. For example, Nonaka and Takeuchi's SECI model emphasizes the continuous interaction between tacit and explicit knowledge and highlights the importance of organizational contexts in facilitating knowledge creation (Nonaka & Takeuchi, 1995). Similarly, Wiig's knowledge management model argues that effective knowledge management depends on the development of organizational infrastructures, human capital, and structured knowledge management processes (Wiig, 1993). The findings highlight the importance of human, organizational, processual, and technological infrastructures in supporting knowledge brokerage. The added value of the proposed framework lies in extending this perspective to the ecosystem level by integrating institutional, data governance, network, physical, and financial infrastructures into a coherent and complementary framework. This integration provides a more systematic understanding of the foundations required for the emergence and continuity of knowledge brokerage and constitutes a key theoretical contribution of the study. The framework is consistent with contemporary innovation ecosystem perspectives emphasizing university–industry–government interactions, collaborative networks, institutional conditions, and strategic investment

(European Commission, 2021; Organisation for Economic Co-operation and Development [OECD], 2023). The findings further indicate that knowledge-brokerage capacity depends on the coordinated interaction of complementary infrastructures rather than on individual components operating in isolation. Although the findings broadly align with previous studies, their principal distinction lies in the level of analysis and conceptualization of knowledge brokerage. Whereas much existing research has examined individual factors, including human capital, technology, organizational culture, networks, policies, and inter-actor relationships, this study indicates that no single component adequately explains brokerage effectiveness. Instead, effectiveness depends on the coordination, synergy, and interdependence of multiple infrastructures. Accordingly, whereas some previous approaches have confined knowledge brokerage to the organizational level, the broker's role, or knowledge-transfer processes, this study conceptualizes it as an ecosystem-level capability emerging from the ongoing interaction of complementary infrastructures. By integrating knowledge management, knowledge brokerage, and innovation ecosystem perspectives, the framework also extends conventional knowledge management approaches beyond knowledge-related capabilities to encompass the institutional, organizational, technological, processual, network, data governance, financial, physical, and cultural conditions supporting brokerage across organizational and ecosystem boundaries. Nevertheless, the framework should not be interpreted as a strictly linear or universal model or as establishing definitive causal relationships. Given the qualitative and exploratory nature of the study, determining the relative importance, direction, and strength of relationships among infrastructures requires quantitative testing and longitudinal research across diverse contexts. Future studies could also develop appropriate assessment indicators to examine these relationships and their contextual variation. From an implementation perspective, developing the ten infrastructures under resource constraints may encounter institutional fragmentation, policy misalignment, limited financial and human resources, weak trust and collaboration, policy–implementation gaps, and unequal access to technology and data. Implementation therefore requires a phased, context-sensitive approach, beginning with foundational capacities, followed by organizational and knowledge capabilities, networks and interactive platforms, and ultimately operational and value-creation capacities. Rather than prescribing a uniform configuration, the framework provides an analytical basis for identifying infrastructural interdependencies, diagnosing implementation gaps, prioritizing investments, and informing context-sensitive coordination and policy interventions across innovation ecosystems.

Practical and Policy Recommendations

1. Establish an ecosystem-level governance framework for knowledge brokerage: Policymakers and ecosystem authorities should establish a formal framework that defines the roles, responsibilities, and coordination mechanisms of knowledge-brokerage actors, enabling the systematic identification of knowledge needs, coordination of brokerage activities, and monitoring of performance.

2. Develop a digital architecture for knowledge demand–supply matching: Innovation ecosystem organizations should develop interoperable digital platforms for identifying knowledge needs and capabilities, matching knowledge supply and demand, facilitating knowledge exchange, and tracking brokerage interactions, supported by appropriate standards for interorganizational data exchange.

3. Develop a competency-based professional development system for knowledge brokers: Universities and innovation-support organizations should establish a competency framework for knowledge brokers covering areas such as knowledge assessment and translation, communication, networking, negotiation, and facilitating knowledge application, supported

by training, mentoring, and periodic competency assessment.

4. Embed knowledge brokerage within existing organizational processes: Organizations should integrate knowledge-brokerage functions into processes such as research–industry collaboration, technology transfer, innovation management, and commercialization, while establishing clear responsibilities and procedures for referring knowledge needs and opportunities.

5. Develop interorganizational knowledge-brokerage networks: Science and technology parks, universities, industry organizations, and innovation-support institutions should establish thematic or problem-oriented networks to facilitate connections among actors, knowledge exchange, referral of knowledge needs, and knowledge-based collaboration.

6. Establish dedicated and diversified financing mechanisms: Policymakers should develop dedicated funding instruments for knowledge-brokerage activities, including knowledge-transfer initiatives, digital brokerage services, and professional development, while linking resource allocation, where appropriate, to demonstrable knowledge-transfer and application outcomes.

7. Establish data and knowledge governance protocols: Participating organizations should develop shared standards for data and knowledge ownership, access, confidentiality, intellectual property, quality, documentation, and responsible sharing to strengthen the reliability and transparency of brokerage processes.

8. Establish a system for monitoring, evaluation, and continuous improvement: Ecosystem authorities should monitor knowledge-brokerage performance at the process, output, and outcome levels and use evaluation results to identify bottlenecks, improve processes, allocate resources, and adapt brokerage activities to changing ecosystem conditions.

Suggestions for Future Research

1. Conduct comparative studies on knowledge brokerage infrastructures across innovation ecosystems to identify contextualized and international patterns and models.
2. Examine the impact of emerging technologies, particularly generative artificial intelligence, on the transformation and evolution of knowledge brokerage infrastructures within innovation ecosystems.
3. Analyze the causal relationships and reciprocal effects among knowledge brokerage infrastructures within innovation ecosystems by employing advanced methods such as interpretive structural modeling (ISM), fuzzy cognitive mapping, and system dynamics approaches.
4. Investigate the relative importance and contribution of different knowledge brokerage infrastructures in enhancing innovation performance, knowledge commercialization, interorganizational learning, and competitiveness within innovation ecosystems.
5. Develop and validate measurement indicators and assessment tools for evaluating the maturity level of knowledge brokerage infrastructures in innovation ecosystems.
6. Develop an integrated governance model for knowledge brokerage infrastructures by emphasizing the synergistic alignment of institutional, human, technological, organizational, network, data-driven, financial, cultural, and environmental dimensions within innovation ecosystems.
7. Conduct comparative analyses of knowledge brokerage infrastructures in industrial innovation ecosystems versus academic innovation ecosystems.
8. Explore the impact of digital transformations and emerging technological disruptions (such as the rise of generative artificial intelligence) on the infrastructural requirements and evolving roles of knowledge brokers.
9. Empirical Validation of the Knowledge-Brokerage Infrastructure Framework and Elucidation of Relationships and Priorities among Its Infrastructures
10. Examining the Applicability and Transferability of the Knowledge-

Brokerage Infrastructure Framework across Innovation Ecosystems with Different Institutional, Organizational, and Technological Contexts

Limitations of the Study

This study has several limitations. First, the qualitative design and relatively small sample of 15 experts limit the statistical generalizability of the findings. However, the sample was appropriate for the exploratory nature of the study and was determined based on information adequacy and the relative stabilization of the thematic structure. Maximum-variation purposive sampling was used to incorporate perspectives from diverse stakeholder groups, including universities, knowledge-based and technology-oriented firms, government and policy organizations, science and technology parks, and knowledge-transfer and brokerage professionals.

Second, the findings are context-dependent and reflect the experiences and interpretations of experts with direct knowledge-brokerage experience. Therefore, the identified dimensions and their potential relationships may vary across institutional, organizational, national, and ecosystem contexts. The framework should consequently be adapted to differences in institutional arrangements, regulations, resources, technological conditions, and patterns of interaction among ecosystem actors.

Finally, the applicability and robustness of the proposed framework across different innovation ecosystems require further empirical validation. Future research should employ larger and more heterogeneous samples, comparative and longitudinal designs, and quantitative approaches to examine the relationships, relative importance, and contextual variation of the identified infrastructure dimensions.

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