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A Typology Proposal for Innovation Hubs

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Abstract

Innovation Hubs (IHs) catalyse open innovation and technology transfer within innovation ecosystems (IEs). IHs offer physical as well as virtual structures that enhance innovation. IHs around the world have different dynamics. They differ in terms of their characteristics, activities, and objectives, requiring distinctive forms of management and orchestration adapted to their realities. Thus, to subsidise universities, policy-makers and ecosystem orchestrators, we carried out a meta-synthesis, guided by the paradigm of Design Science Research, to identify IHs typologies. Recognising typologies and their dynamics reduces trial and error in the design, management and orchestration of IHs, increasing their performance. In this article, we present six typologies of IHs based on their dynamics and the class of priority problems they address: corporate, university, government, accelerators, co-working, and thematic. We also seek to explore connections between the typologies and the actors involved in the activities.

Keywords: innovation, open innovation, innovation hubs, scientific research.

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1 Introduction

Innovation ecosystems are comprised of a set of individuals, communities, organisations, material resources, norms, policies, and institutions. Universities, government entities, research institutes, laboratories, and small and large companies (Foguesatto et al., 2021; Malik et al., 2021) are frequently highlighted in the academic literature as essential actors within an ecosystem. The performance of an innovation ecosystem increases as it becomes possible to reconcile market dynamics and the knowledge society (Giudici et al., 2020). In this context, mutual opportunities for learning, services, business, and social events focused on innovation, are shared. These interactions add value to goods and services, drive economic development, and generate higher-quality jobs (Atiase et al., 2020; Kolade et al., 2021; Troisi et al., 2021).

Innovation ecosystems play a fundamental role in catalysing interest flows and promoting collaborative connections, as value aggregation is essential for economic development and becomes a competitive advantage for business investments (Friederici, 2018). Pooled connections, which expand the possibilities of open innovation in ecosystems, often occur in innovation hubs (Jiménez & Zheng, 2021; Remneland et al., 2019).

IHs can adopt various models and configurations, whether physical or virtual, with a local or global scope (Malik et al., 2021). They seek to experiment with more dynamic forms of governance and, as such, act not only as physical spaces, but as catalysts for open and collaborative innovation. To achieve this, they offer a structure that can include not only physical resources such as energy, pipelines, Internet, furniture, rooms, and secretarial services, but also virtual structures such as

stakeholder networks, shared knowledge, and access to human, financial, and social resources (Friederici, 2018; Rikap & Flacher, 2020).

The primary function of an IH can be understood as network orchestration. Orchestration is defined as a set of deliberate, purposeful actions performed by an IH or focal organisation seeking to create or extract value from a network, or initiate and manage innovation processes, thereby enabling network members to create or extract value from the network for itself (Hurmelinna-Laukkanen & Nätti, 2018). Thus, orchestration involves assembling and managing various actors in inter-organisational networks to promote collective innovation (Dhanaraj & Parkhe, 2006). IHs often occupy a central position (focal actor) in the network structure of a cluster, region or production chain, assuming leadership, influence, co-ordination, and articulation roles among network members to benefit innovation development within a production chain or arrangement (Ye et al., 2020).

IHs provide a space for sharing information, knowledge, and connections among companies, suppliers, competitors, universities, governments, etc. This enables collective gains in all aspects, as well as more excellent knowledge of the market and the current situation, forming collaborative networks that facilitate the capture and absorption of knowledge for innovation (Amitrano et al., 2018; Costa & Matias, 2020; Wu et al., 2021; Xu et al., 2020).

In this way, innovation ecosystems, including IHs, are dynamic entities that evolve in response to changes in social and economic needs, acting as catalysts for collaboration, knowledge exchange, and value creation. From this perspective and in a practical sense, Katz and Wagner (2014) described the emergence of innovation districts as a milestone in changing the spatial geography of innovation, promoting compact and accessible areas where leading institutions, companies, start-ups, and research facilities cluster. These districts not only foster open innovation, but also integrate work, housing and leisure, aligning with the principles of urban sustainability and quality of life. In turn, IHs, as elaborated by Davis et al. (2023), play a crucial role in facilitating collaborative innovation, acting as focal points for orchestrating networks and mediating knowledge transactions between incumbent companies and start-ups, as IHs have higher growth rates than adjacent commercial districts, outperforming other regions and commercial districts in economic, financial and social terms. In the most successful examples, the unifying and mission-oriented spaces that IHs create open new pathways for healthier, more diverse, and connected communities (Davis et al., 2023). In the context of sustainability and the development of smart cities, these hubs are essential for addressing urgent urban challenges, such as climate change and inequalities, contributing to effective solutions.

In other words, IHs mediate knowledge transactions and the search for new ideas, concepts, and technologies, acting as intermediaries between incumbent companies and start-ups. They are engines of renewal, creating bridges in innovative ecosystems where major organisations can collaborate to generate value through knowledge exchange (Amann et al., 2022), combining numerous possibilities for organisational arrangements.

Although several studies have already pointed out the benefits associated with the existence of IHs in ecosystems (Davis et al. 2023; Cotrino et al., 2021; Ford & Yoho, 2020; Malik et al., 2021; Mwantimwa et al., 2021; Remneland et al., 2022; Wikhamn & Styhre, 2019), and emphasised their role as network orchestrators (as in the studies by Hurmelinna-Laukkanen & Nätti, 2018, and Matos & Teixeira, 2022), little is known about the specific characteristics and models that innovation hubs are assuming, as well as their most recent trends.

From this perspective, this study aims to enhance related research, such as that of Davis et al. (2023), which proposed three categories of IH (districts, technological hubs, and ecosystems), outlining a manual with six crucial steps to guide innovation leaders. Clark et al. (2010), on the

other hand, presented a typology for innovation districts, categorising them into four distinct types (Marshallian; Districts dominated by large firms; Lesser Marshallian districts; University/Research Centre-anchored). More recently, the framework developed by Scholz et al. (2023) has offered a holistic approach to evaluating and improving the translation of research and innovation into impact, addressing aspects such as innovation, beneficiaries, socialisation, teams, and organisational support. Lähteenmäki and Töyli (2023) highlighted the importance of platform-based innovation ecosystems, proposing a configuration framework for these environments, emphasising value networks in managing these systems in an integrated manner.

In view of the above, the development of specific typologies or frameworks on innovation is crucial, as it helps identify patterns and opportunities, thus maximising proposals and solutions. These analytical tools organise complex information, facilitating the understanding and interpretation of data. Clark et al. (2010) argued that a clear, comprehensive typology allows for a better understanding of the various forms of innovation, anticipating patterns and trends. This not only facilitates the mapping of innovation spaces, but also supports policy-makers and other stakeholders in promoting sustainable economic development. Moreover, as pointed out by Scholz et al. (2023), the creation of frameworks can also help simplify and address complex problems faced by societies, which pose existential threats to our planet, making it more accessible and understandable for researchers, professionals, and other stakeholders interested in the subject under study. By establishing clear, comprehensive structures, we, the authors believe that it is possible to advance knowledge and promote a more informed, effective approach to addressing challenges, problems, and controversial matters.

Shen et al. (2024) highlighted that innovation is recognised as an essential practice for orchestrating ecosystems, adopted by companies to maintain their competitive advantage in the digital age. This suggests that companies are aware of the importance of innovation for success, and are directing investments towards innovative strategies to enhance their results, generating a growing demand for tools and methodologies in this field. Chatterjee et al. (2024) demonstrated in their research that innovation positively impacts organisational performance, especially when driven by a data-oriented culture and effective use of advanced business analysis tools. They argue that this approach promotes a competitive advantage for companies in the current business environment.

In the context of supporting, subsidising or formulating public policies, it is essential to understand the practical implications of these arrangements to better guide the development of effective strategies and policies. A recent example highlighted by Zeng et al. (2024) has illustrated this point, showing a movement that exhibits these characteristics and emphasises the importance of understanding and supporting initiatives of this nature. In the study conducted in emerging economies of the BRICS, the influence of foreign direct investment (FDI), technological innovation, green energy, and trade on carbon emissions, is investigated. The results of the study demonstrate that investments in innovation, green energy, and energy efficiency are crucial for improving environmental quality and reducing carbon emissions, highlighting the importance of public policies that promote sustainable development (Zeng et al., 2024). Furthermore, Pinheiro et al. (2024) showed that companies that invest more in research and development tend to have better environmental, social, and governance performance, which in turn is positively associated with the economic and financial performance of companies, while Clark et al. (2010) demonstrated that policies aimed at stimulating innovation in small businesses have broad benefits for regional economies. These studies provide important evidence for policy-makers and other stakeholders interested in promoting innovation and sustainable economic development, emphasising the need

for investments in innovation and ESG (Environmental, Social, and Governance) practices to ensure economic growth and environmental protection (Pinheiro et al., 2024).

When understanding the dynamics and unravelling the typologies of IHs, as proposed in similar articles that, as initially outlined by Clark et al. (2010, which suggest a typology for innovation districts, it becomes essential to meet the growing demand of companies and institutions for innovation, enabling them to visualise various options and paths to outline their own value aggregation competitiveness strategy (Chatterjee et al., 2024).

Consequently, practitioners lack relevant references on the implementation methods for IHs as artifacts to solve a problem (Dresch et al., 2015). In this scenario, aiming to support universities, public policy-makers and ecosystem orchestrators, we conducted a meta-synthesis guided by the Design Science Research paradigm to identify IH typologies. Recognising these typologies and their dynamics reduces trial and error in the conception, management, and orchestration of IHs, enhancing their performance. This article presents six IH typologies based on their dynamics and the priority problem class to which they are dedicated: corporate, university-based, governmental, accelerators, co-working, and thematic hubs.

2 Research Method

To fulfil the research objectives, we opted to conduct a meta-synthesis (Galvão & Ricarte, 2019; Hoon, 2013), focusing on concrete, significant, and recent case studies, aiming to present how IHs have been configured and applied concretely in order to generate a typology. Meta-synthesis allows drawing on an understanding of research synthesis as the interpretation of qualitative evidence from a post-positivist perspective. Meta-synthesis is "an exploratory, inductive research design to synthesize primary qualitative case studies to make contributions beyond those achieved in the original studies" (Hoon, 2013, p. 527). The meta-synthesis is a meta-study because it involves accumulating evidence from previous case studies, and, more specifically, its extraction, analysis and synthesis.

We followed the steps proposed by Hoon (2013) to conduct the meta-synthesis: a) framing the research question; b) locating relevant research; c) inclusion and exclusion criteria; d) extracting and codifying data; e) analysing on a case-specific level; f) synthesis of results; and g) presentation/discussion of results.

Thus, based on the guiding question of this meta-synthesis, which pertains to the current framework of IH configurations, the research question was defined based on the following specific objectives:

- Identify the different conceptions, characteristics, and models of innovation hubs in the literature.
- Characterise the variations in the formation of an IH.
- Propose a typology for IHs.

The definition of the research problem was also guided by the Design Science Research paradigm – seeking an understanding of problem classes (see Item 3.4) – as IHs are implemented/created precisely to solve problems, making this approach suitable for creating a typology.

In summary, we started our meta-synthesis by attempting to discover the IH typologies and the problems they are trying to solve.

2.1 Search procedures

We selected articles from two internationally recognised databases, Web of Science and Scopus.

The decision to use only the Web of Science and Scopus databases for this research was based on their broad coverage and reputation in the academic community. These platforms, along with PubliMed (a specialised database in the health field), are globally recognised as the largest databases of scientific works, both in terms of quantity and quality, ensuring the inclusion of peer-reviewed papers. Web of Science indexes more than 34,000 academic journals, while Scopus indexes over 24,000, positioning them as leaders in this aspect. Moreover, they are widely recognised as a standard in the academic community, and offer accessibility and ease of use. Given the limitations of resources and time, we chose to focus on these two databases, known for their reliability and data quality, to identify relevant works for the study in question.

In these databases, the following search terms and filters were applied in three search fields - title, abstract, and keywords (Table 1):

Table 1. Terms and filters applied

Search term	Filters applied
"Innovation" AND "HUB" OR "cluster" OR "living lab" AND "model" OR "element" OR "framework" OR "configuration" OR "structure"	- Full articles with open access; - Finalised articles; - Scientific articles; - Articles published in 2019 to 2022; - Articles in English or Portuguese.

It is worth noting that, before defining such search strategies, other search terms were combined and tested in eight scenarios, ranging from a return of 270 (and a more restricted configuration) to a return of 4,611, as described in Table 2.

Table 2. Boundary scenarios

Narrower scenario	Broader scenario
"Innovation" AND "HUB"	"Innovation" AND "HUB" OR "Network" OR "cluster" OR "living lab" AND "Structure" OR "Element" OR "configuration" OR "Model" OR "Method*" OR "development" OR "framework"
270 returns	4,611 returns

With such tests, it was observed that the terms "network," "method*" and "development" gave rise to discussions outside the scope of the theme "innovation." On the other hand, only searching for articles that referred directly to one IH removed the possibility of investigating other variations of content or just nomenclature, so, following the suggestions of the research team, the terms "cluster" and "living lab" were included.

2.2 Collection and consolidation of the database

In developing this study on IHs, we employed a rigorous data analysis methodology to ensure the accuracy and relevance of our findings. Content analysis was conducted through a process of marking and assimilation, where qualitative data collected from a variety of case studies were meticulously examined and tagged to identify emerging patterns and themes. We utilised thematic

analysis to organise and interpret the data, enabling a deeper understanding of the different IH typologies. Codifying the data was a crucial step in this process, where each relevant snippet of information was categorised under specific themes to facilitate detailed analysis.

To ensure the robustness of our findings, the analysis was triangulated, combining multiple perspectives and methodological approaches. Triangulation included correlating thematic analysis with the problem classes identified, as well as cross-validating the conclusions with existing theories and practices reported in the case studies. This multifaceted approach not only validated the results, but also provided a holistic view of IHs, highlighting both their unique features and common trends across different typologies. In summary, the methodology employed in this study ensured rigorous, comprehensive, reliable data analysis, essential for understanding the complexity and dynamics of IHs.

Table 1 was applied on 15th September, 2022, resulting in the first initial survey of the body of literature, according to the research protocol presented previously, resulting in Table 3.

Table 3. Publications extracted from the databases

	Web of Science	Scopus	Total
Extracted from databases	324	705	1029
DOI validated	293	640	933
Repeated in both databases			211
Result from 1st survey			722

DOI validation and exclusion of repeated articles were performed automatically using Mendeley software.

For the consolidation of the database, i.e., the definition of the portfolio of articles for full reading and analysis in the light of the meta-synthesis on screen, the exclusion and inclusion criteria defined in the research protocol were applied to the 722 articles from the first survey.

As the objective of this review was to derive a meta-synthesis of case studies from articles that discuss IH or similar artifacts, we searched the titles, keywords and abstracts for articles that mention the case study. As a result, 168 papers were returned.

In these works, a new screening was carried out manually with reading of the title and abstract of the remaining articles in order to detect repetitions or articles on topics outside the scope of innovation, such as articles that specifically discuss ecology or economic development in a broad way. These or ones that did not correctly speak of an IH, even considering their possible semantic variations (living lab or cluster), were excluded. Thus, we had another 116 exclusions, resulting in a new base (2nd survey) with 52 articles for full reading (Table 4).

Table 4. Body of literature for full reading

Status	Quantity
Articles mentioning a case study	168
Repeated articles	10
Do not deal with or are unrelated with an IH	97
Do not present models, characteristics, structures or configurations of an IH	9
2nd survey for full reading	52

Regarding the criteria to assess the quality of the studies, two were defined, namely:

- The journal in which the article was published has an SJR impact factor;
- Has empirical data.

3 Findings and Discussion

3.1 Consolidating the review portfolio

In the process of full reading and analysis of the database articles selected for this stage, new exclusions were necessary, totalling eight works that were outside the context of the present analysis, and one article from which it was not possible to obtain access to the full text.

3.2 Quality and typology of publications

Thus, as a result, we have 43 articles with quality factor SJR Best Quartile (Scimago et al. Rank – SJR, https://www.scimagojr.com/index.php) presented in Table 5.

It is observed that only five papers were published in journals that still need the SJR Quartile. In contrast, the Q1 factor with 26 papers is predominant, thus demonstrating the vital quality of the sample on screen.

Another question adopted to assess the quality of this database concerns the presentation of empirical data. Of the 43 articles studied, only two did not meet this criterion. However, as these same articles have an SJR impact factor, it was decided to include them in this analysis.

Table 5. Quality and typology of articles.

	Title	Typology	Factor	Reference
1	An assessment of the sustainability of Living Labs in Kenya	Living labs	none	(Ondiek & Moturi, 2019)
2	Applying a Living Lab Approach Within an eHealth Accelerator	Living labs	Q3	(Haukipuro et al., 2019)
3	Areas of innovation in cities: the evolution of 22@Barcelona	Innovation areas (innovation cluster)	Q4	(Pique et al., 2019)
4	Biopharmaceutical innovation ecosystems: a stakeholder model and the case of Lombardy	Hub as a stakeholder	none	(Bettanti et al., 2021)
5	Business model blueprints for the shared mobility hub network	Shared mobility hub	Q1	(Coenegrachts et al., 2021)
6	Clusters as institutional entrepreneurs: lessons from Russia	Cluster as a meta-organisation	Q1	(Lupova-Henry et al., 2021)
7	Co-creating service concepts for the built environment based on the end-user's daily activities analysis: Kth live-in-lab explorative case study	Live-in-Lab	Q1	(Malakhatka et al., 2021)
8	Collaborative innovation for sustainability in Nordic cities	Several cases	Q1	(Leminen et al., 2021)
9	Corporate hub as a governance structure for coupled open innovation in large firms	Corporate hub	Q1	(Remneland Wikhamn & Styhre, 2019)

	Title	Typology	Factor	Reference
10	Developing Methods to Assess and Monitor Cluster Structures: The Case of Digital Clusters	Digital Cluster	Q2	(Kudryavtseva et al., 2020)
11	Digital Innovation Hubs as a Tool for Boosting Biomass Valorisation in Regional Bioeconomies: Andalusian and Southeast Ireland (sic) Case Studies	Digital Innovation Hub	Q1	(Macias Aragonés et al., 2020)
12	Experimentation Platforms as Bridges to Urban Sustainability	Urban Living Labs	none	(Rehm et al., 2021)
13	Facing societal challenges in living labs: Towards a conceptual framework to facilitate transdisciplinary collaborations	Living labs	none	(Kalinauskaite et al., 2021)
14	Implementing agricultural living labs that renew actors' roles within existing innovation systems: A case study in France	Living labs	Q1	(Toffolini et al., 2021)
15	Industrial clusters in the developing economies: Insights from the Iranian carpet industry	Industrial cluster	Q1	(Saadatyar et al., 2020)
16	Innovation capability of clusters: understanding the innovation of geographic business networks	Cluster	Q2	(Bittencourt et al., 2019)
17	Innovation Management in Living Lab Projects: The Innovatrix Framework	Living labs	Q3	(Schuurman et al., 2019)
18	Inter-clustering as a network of knowledge and learning: Multiple case studies	Cluster grouping	Q3	(Franco & Esteves, 2020)
19	Living lab as a support to trust for co-creation of value: application to the consumer energy market	Living labs	Q1	(Dupont et al., 2019)
20	Living Lab as an Ecosystem for Development, Demonstration and Assessment of Autonomous Mobility Solutions	Living labs	Q3	(Pucihar et al., 2019)
21	Living Labs and user engagement for innovation and sustainability	Living labs	Q1	(Compagnucci et al., 2021)
22	Living Labs in University-Industry Cooperation as a Part of Innovation Ecosystem: Case Study of South Korea	Living labs	Q1	(Shvetsova & Lee, 2021)
23	Lombardy regional urgent reorganization for congenital cardiac patients following the Covid-19 pandemic	Services Hub	Q1	(Chessa et al., 2020)
24	Managing Organizational Tensions in Cross-Sector Collaboration: The Case of Mediapolis	Media Cluster	Q3	(Virta & Malmelin, 2022)

	Title	Typology	Factor	Reference
25	Network Impact Of Social Innovation Initiatives In Marginalised Rural Communities	Rural Hub	Q1	(Lombardi et al., 2020)
26	Network proximity and communities in innovation clusters across knowledge, business, and geography: Evidence from China	Innovation cluster	Q1	(Zhou et al., 2021)
27	On the resilience and the risk spillovers in innovation clusters	Innovation cluster	Q1	(Gudelytė, 2021)
28	Optimization of a physical internet based supply chain using reinforcement learning	Virtual Hub	Q3	(Puskás et al., 2020)
29	Regional Aspects of the Development of Clustering in the Dairy Branch	Agro-industrial cluster	Q1	(Novikov, 2019)
30	Scaling Innovation Hubs: Impact on knowledge, innovation and entrepreneurial ecosystems in Tanzania	Innovation Hub	Q1	(Mwantimwa et al., 2021)
31	Strategies For The Formation Of Entrepreneurship And Innovation Ecosystems: Conceptual Framework From Portuguese Cases	Living Lab and Innovation Habitat	Q3	(Alvares et al., 2020)
32	Successful Scaling in Social Franchising: The Case of Impact Hub	Social Franchising	Q1	(Giudici et al., 2020)
33	Synergetic effects of network interconnections in the conditions of virtual reality	Innovation-digital clusters and virtual reality cluster co-operation	none	(Kateryna et al., 2021)
34	Testing future societies? Developing a framework for test beds and living labs as instruments of innovation governance	Test benches, Living Labs	Q1	(Engels et al., 2019)
35	The business models of tech hubs in Africa: implications for viability and sustainability	Technology hub	Q2	(Kolade et al., 2021)
36	The different shades of innovation emergence in smart service systems: the case of Italian cluster for aerospace technology	Service cluster	Q1	(Troisi et al., 2021)
37	The emergence and strategy of tech hubs in Africa: Implications for knowledge production and value creation	DIY technology hubs	Q1	(Atiase et al., 2020)
38	The evolution of knowledge-intensive innovation ecosystems: co-evolving entrepreneurial activity and innovation policy in the West Swedish maritime system	Maritime cluster	Q1	(Gifford et al., 2021)

	Title	Typology	Factor	Reference
39	The Role of Managerial Cognitive Capability in Developing a Sustainable Innovation Ecosystem: A Case Study of Xiaomi	Hubs	Q1	(Cao et al., 2020)
40	The scope of regional innovation policy to realize transformative change - a case study of the chemicals industry in western Sweden	Industrial cluster	Q1	(Martin, 2020)
41	Universities as catalysts of social innovation in health systems in low- and middle-income countries: a multi-country case study	University HUBs network	Q1	(van Niekerk et al., 2020)
42	What impedes the success of late mover IT clusters despite economically favourable environments? A case study of an Indian IT cluster	IT cluster	Q3	(Mittal et al., 2020)
43	Who collects intellectual rents from knowledge and Innovation Hubs? questioning the sustainability of the Singapore model	IHs	Q1	(Rikap & Flacher, 2020)

3.3 Main features

The first finding of this research concerns the variations in nomenclature and formats that the IH can assume in concrete cases.

Generically, Table 6 shows that an IH can have the Innovation Cluster and the Living Lab as variants, and one paper explored multiple cases in the following proportions, as aggregated in Table 6:

Table 6. Hub Variations

Type of IH	Papers
Hub	14
Cluster	15
Living Lab	13
Multiple Cases	1
Total number of case studies	43

In contrast to single case studies, which concern almost all works, the study by Leminen et al. (2021) brought a panoramic approach to so-called "collaborative innovations" when investigating multiple cases. From a study in six Nordic cities, in the context of the search for sustainability through innovation, they found 49 cases covering co-working spaces, Fab labs, green public procurement, hackathons, hubs, maker spaces, participatory budgeting, and living labs. This study illustrated the variability of cases in innovation ecosystems or simply collaborative innovations (Leminen et al., 2021).

Thus, it is observed that it is possible to have various combinations, strictly speaking, artifacts of collaborative innovations, including concerning the denomination, form, and content of interactions

between non-living elements and stakeholders, as discussed by Foguesatto et al. (2021), which may be connected virtually or geographically to create an innovation ecosystem, Therefore, in the practical application of an IH, the two similar artifacts, known as Innovation Clusters and Living Lab (as indicated in Table 7), should also be considered.

Innovation Clusters, Living Labs and Innovation Hubs have in common the objective of being artifacts to catalyse and drive an innovation ecosystem. They are structures that aim to promote collaboration, knowledge sharing, the connection among different actors, and the development of joint solutions.

Each through a distinct pathway, these approaches seek to create an enabling environment for the emergence, experimentation, and implementation of innovative ideas. They recognise the importance of interaction among firms, research institutions, governments, entrepreneurs, and other actors to promote innovation more effectively.

While Innovation Clusters focus on bringing together companies and organisations from a particular geographical sector, Living Labs emphasises collaboration among companies, researchers, and end-users to improve products and services in a real-world context. IHs, on the other hand, are more comprehensive structures that can encompass different types of organisation and actors, promoting collaboration and knowledge exchange in various activity areas.

In the specific understanding of IHs, we have 14 studies (see Table 7) that reveal four main trends: creating companies as Hubs, aggregation of innovation services, implementation as public policy, and formation of Hubs by leading companies that aggregate start-ups. Each trend aims to boost innovation through collaboration among the various ecosystem actors, but each has a specific origin and motivation.

Table 7. IH trends

Trend	Paper	Reference
Company Hub	Successful Scaling in Social Franchising: The Case of Impact Hub	(Giudici et al., 2020)
	Network Impact Of Social Innovation Initiatives In Marginalised Rural Communities	(Lombardi et al., 2020)
	The business models of tech hubs in Africa: implications for viability and sustainability	(Kolade et al., 2021)
Services	Scaling Innovation Hubs: Impact on knowledge, innovation and entrepreneurial ecosystems in Tanzania	(Mwantimwa et al., 2021)
	Business model blueprints for the shared mobility hub network	(Coenegrachts et al., 2021)
	Lombardy regional urgent reorganization for congenital cardiac patients following the Covid-19 pandemic	(Chessa et al., 2020)
	Optimization of a physical internet based supply chain using reinforcement learning	(Puskás et al., 2020)
Development Policy	Digital Innovation Hubs as a Tool for Boosting Biomass Valorisation in Regional Bioeconomies: Andalusian and Southeast Ireland (sic) Case Studies	(Macias Aragonés et al., 2020)

Trend	Paper	Reference
	The emergence and strategy of tech hubs in Africa: Implications for knowledge production and value creation	(Atiase et al., 2020)
	Who collects intellectual rents from knowledge and Innovation Hubs? questioning the sustainability of the Singapore (sic) model	(Rikap & Flacher, 2020)
	Universities as catalysts of social innovation in health systems in low- and middle-income countries: a multi-country case study	(van Niekerk et al., 2020)
Leading Company	Corporate hub as a governance structure for coupled open innovation in large firms	(Remneland Wikhamn & Styhre, 2019)
	The Role of Managerial Cognitive Capability in Developing a Sustainable Innovation Ecosystem: A Case Study of Xiaomi	(Cao et al., 2020)
	Biopharmaceutical innovation ecosystems: a stakeholder model and the case of Lombardy	(Bettanti et al., 2021)

Considering the need to reconcile the duality (and specific problems) between the dynamics of the market economy and the knowledge society (Giudici et al., 2020), an inherent challenge for artifacts that seek to establish an innovation ecosystem, we can infer two forms of adjustment: one originating from the market, where elements of the knowledge society are situated, and the other in the reverse direction, as an initiative of the knowledge society seeking to incorporate market logic.

As a market-driven initiative, there are three IHs formed by a leading company (Bettanti et al., 2021; Cao et al., 2020; Remneland et al., 2019), and three IHs formed through the establishment of a company specifically to become an IH (Giudici et al., 2020; Lombardi et al., 2020; Mwantimwa et al., 2021).

From a perspective where societal flows toward knowledge are the initial driving force, without neglecting market logic, four studies highlighted IHs as service providers for local innovation (Chessa et al., 2020; Coenegrachts et al., 2021; Kolade et al., 2021; Puskás et al., 2020). These IHs aim to solve specific problems, focusing on the historical need to provide innovative health services and address procedures and treatments in response to the COVID-19 pandemic (Chessa et al., 2020). Additionally, they seek to drive socioeconomic development in historically marginalised regions of major global economies, mainly through local sustainability-oriented initiatives (Kolade et al., 2021).

Following this line, four other studies highlight IHs as outcomes of regional or national development policies, especially with the support of significant funding agencies such as the European Union (Macias Aragonés et al., 2020). Some IHs also emerge as a result of consortiums involving not only the EU, but also the United Nations Orgaisation and the World Bank, intending to support local innovations aligned with the United Nations Sustainable Development Goals (SDGs), particularly in combating poverty (Atiase et al., 2020). In other cases, such as Singapore, IHs are driven by the pursuit of good international integration into the global economy through knowledge (Rikap & Flacher, 2020). There are also examples of transnational collaborations of university-based IH networks motivated by adherence to the SDGs, especially in promoting universal healthcare networks (Van Niekerk et al., 2020).

On the other hand, clusters generally refer to the geographical articulation of companies through local entrepreneurial initiatives, forming an organising entity (Bittencourt et al., 2019).

They also exhibit considerable variability in their purposes and arrangements. However, they are included in this research because they bring the demand for innovation, favouring the formation of innovation ecosystems and IHs (Gifford et al., 2021).

Out of the 15 studies analysed, seven explicitly or centrally emphasise innovation's importance as an end. In contrast, others consider innovation to achieve other objectives, such as local development. These studies discuss the innovation capacity of a cluster (Bittencourt et al., 2019), the systemic risk faced by a cluster in its innovation processes (Gudelytė, 2021), and the distinction between geographical proximity and cognitive or affinity proximity in objectives (Zhou et al., 2021). In Barcelona, a cluster was formed based on geographical proximity and with a direct link to innovation in local urban infrastructure (Pique et al., 2019). A national aerospace technology cluster in Italy was established, promoting intelligent service systems (Troisi et al., 2021). In western Sweden, mediated by the regional government of Västra Götalandsregionen, it was decided that the region's economy would be independent of fossil resources by 2030, forming a cluster to transition the local energy matrix through the formation of an innovation ecosystem (Gifford et al., 2021).

In addition to these studies, there are examples of clusters in the dairy sector in Russia that follow a structure similar to that of a corporate IH. They are organised by a holding or parent company that sets the general goals of the cluster to achieve maximum economic results and promote innovation throughout the sector (Novikov, 2019). Another Russian cluster emerged from a government initiative comprising 63 companies in an association. A council co-ordinates this cluster and aims at regional development through import substitution and technological innovation in industry (Lupova-Henry et al., 2021). A similar case is observed in the carpet industry in Iran, where the central government plans and a semi-private company manages the cluster, aiming at local development and avoiding the loss of competitiveness due to technological lag (Saadatyar et al., 2020). In Portugal, a case study analyses an intraorganisational network of clusters organised through non-profit private associations. These clusters arise from the approval of a specific national legal framework, and are encouraged to share knowledge and collective learning for the country's development (Franco & Esteves, 2020).

In a digital format, there are four more cases of innovation clusters with a primary focus on a digital foundation organised by communication and information technologies. With government support, one study describes the Finnish media cluster, Mediapolis (Virta & Malmelin, 2022) as a "growing center and network for media companies and organizations' development." It is a hybrid organisation combining entities with different logic and organisational structures, including public entities and market-oriented organisations. This combination results in forming a collaborative company that organises the cluster, the Mediapolis Co-operative.

In Ukraine (Kateryna et al., 2021) and Russia (Kudryavtseva et al., 2020), an evaluation of the benefits of digital innovations is proposed from their clusters, which resemble a Hub of Innovation, especially concerning the class of problems common to both studies: co-operation and network economy.

In a study on the Gujarat region in India, Mittal et al. (2020) addressed the aspect of a cluster's success in the information technology (IT) sector, and highlighted the necessary endemic aspects of this sector, which is naturally dynamic. These aspects were present in other regions of India that achieved international importance in the IT markets, but were available in a different proportion in the Gujarat region. Some of these aspects include the historical concentration of innovative high-tech companies with IT demands, connections among local entrepreneurs and multinational companies, a robust entrepreneurial culture, good integration of research and development sectors,

IT companies with operational excellence that have achieved leadership in terms of cost, quality, security, and a global delivery model.

The initially successful states provide many more incentives than the states that followed, including an attractive work environment with adequate social infrastructure to bring up a family. Despite the economic vitality of the Gujarat region, it failed to achieve the same proportional integration into the IT markets due to the lack of these necessary endemic factors to drive the sector.

Out of the 13 studies on Living Labs mentioned in Table 7, three are related to forming innovation ecosystems for cities, approaching the trend toward smart cities. The first study examined three cases of innovation ecosystems linked to a city's territorial innovation in Portugal (Alvares et al., 2020). These cases included a technology park organised by a private non-profit association, resulting from collaboration among the public sector, a university and the market (triple helix model). The technology park aimed to expand traditional business incubation activities. Additionally, the study mentioned the Cova da Beira Living Lab, which promoted innovations related to housing, schools and other aspects of well-being and quality of life. The HABITAT program supports entrepreneurship and rural innovation in critical sectors such as agribusiness, clean energy, environmental services, tourism, and information technologies.

The second study addressed the concept of the city itself as an innovation ecosystem in the form of a Living Lab (Pucihar et al., 2019). In this case, advanced technologies, business models, and the latest services were tested with real users, focusing on an autonomous mobility project as a pilot demonstration.

The third study discussed the aspect of innovation ecosystems from the city's perspective. It proposed the Living Lab as a platform for urban experimentation (Rehm et al., 2021), especially in applying the United Nations' Agenda 2030 principles of sustainability to the municipalities.

Five other studies on Living Labs emphasised co-creation with the end user as a vital element of this approach. These studies highlighted the importance of building spaces facilitating explicit experimentation and learning through user participation and involvement.

In this context, one study addressed the use of multiple platforms for accelerated innovation in Living Labs (Malakhatka et al., 2021). It emphasised co-creation with the end user as a significant aspect of creating innovative solutions. Another study analysed three innovation cases in The Netherlands, and highlighted the transdisciplinary approach to solving specific problems, emphasising co-creation with end-users (Kalinauskaite et al., 2021). One study addressed the aspect of agroecological transition in French agriculture, and emphasised the importance of involving the end user in this context (Toffolini et al., 2021). Another study, also in France, emphasised the aspect of energy transition, and highlighted government induction in this process, but it also emphasised the importance of co-creation with the end user (Dupont et al., 2019). Finally, a broader study problematised the challenge of sustainability-oriented innovation from the European Community's perspective, highlighting the need for co-creation with end-users (Compagnucci et al., 2021).

The remaining three case studies on Living Labs focused mainly on development and sustainability, emphasising the interaction among government, industry and university as major actors rather than the end user. South Korea has strong government leadership in promoting the so-called fourth industrial revolution, driving development through Living Labs (Shvetsova & Lee, 2021). In Kenya, government leadership has been replaced by local and regional networks of Living Labs supported by multinational donors or funding agencies to promote sustainable development (Ondiek & Moturi, 2019). One study highlighted the importance of articulating technical and political/governance aspects in structuring and stimulating innovation through Living

Labs, projecting future possibilities of society through the experimentation of new socio-technical orders (Engels et al., 2019). In addition to these, there was a focus on a Living Lab in the health sector, with an emphasis on accelerating innovation (Haukipuro et al., 2019), and another that addressed a Living Lab project of a parent company called Innoatrix, whose focus was on innovation management (Schuurman et al., 2019).

In conclusion, considering these three main variations in the design of organised spaces for Innovation Ecosystems (IEs) - Innovation Hub, Innovation Cluster, and Living Lab - it can be stated that the adopted format is determined by the uniqueness of the specific IE, especially regarding the objectives and relationships established by the co-ordinating entity.

3.4 Classes of problems

Following the parameters of Design Science Research (Dresch et al., 2015), it is imperative to include the category of "problem classes," which are the generalisable elements of a specific artifact. In this case, an IH is considered an artifact from this theoretical perspective because it is a human, intentional element designed to solve a problem (Dresch et al., 2015). A problem class refers to generic elements that can be generalised through the inductive method from specific artifacts.

By identifying and grouping problems into a class (Table 9), researchers can develop generic solutions and design principles that apply to various problems within the same class, creating general and transferable solutions. This approach avoids ad hoc solutions for individual and recurring problems, providing significant gains in efficiency and time (Dresch et al., 2015).

Therefore, although all 42 analysed articles are situated in the context of innovation, we have inductively analysed one or more principal matters that each case presented (Table 8), which, potentially, may recur in similar contexts.

Table 8. Principal Matters

Paper	Matters	Helix	Reference
An assessment of the sustainability of Living Labs in Kenya	sustainability	quintuple	(Ondiek; Moturi, 2019)
Applying a Living Lab Approach Within an eHealth Accelerator	accelerating innovation	triple	(Haukipuro et al., 2019)
Areas of innovation in cities: the evolution of 22@Barcelona	knowledge economy	triple	(Pique; Miralles; Mirabent, 2019)
Biopharmaceutical innovation ecosystems: a stakeholder model and the case of Lombardy	Innovation; stakeholders	triple	(Bettanti; Lanati; Missoni, 2021)
Business model blueprints for the shared mobility hub network	network	triple	(Coenegrachts et al., 2021)
Clusters as institutional entrepreneurs: lessons from Russia	institutional barriers to innovation; development	triple	(Lupova-Henry; Blili; Dal Zotto, 2021)
Co-creating service concepts for the built environment based on the end-user daily activities analysis: Kth live-in-lab explorative case study	co-creation; end user	quintuple	(Malakhatka; Sopjani; Lundqvist, 2021)
Collaborative innovation for sustainability in Nordic cities	collaborative innovation; sustainability	quintuple	(Leminen et al., 2021)

Paper	Matters	Helix	Reference
Corporate hub as a governance structure for coupled open innovation in large firms	open innovation; governance	triple	(Remneland Wikhamn; Styhre, 2019)
Developing Methods to Assess and Monitor Cluster Structures: The Case of Digital Clusters	evaluation	quintuple	(Kudryavtseva Et Al., 2020)
Digital Innovation Hubs as a Tool for Boosting Biomass Valorisation in Regional Bioeconomies: Andalusian and Southeast Ireland (sic) Case Studies	digital innovation; bioeconomy; sustainability	quintuple	(Macias Aragonés et al., 2020)
Experimentation Platforms as Bridges to Urban Sustainability	Sustainability; cities	quintuple	(Rehm; McLoughlin; Maccani, 2021)
Facing societal challenges in living labs: Towards a conceptual framework to facilitate transdisciplinary collaborations	co-creation; end user	quintuple	(Kalinauskaite et al., 2021)
Implementing agricultural living labs that renew actors' roles within existing innovation systems: A case study in France	actors; end user	quadruple	(Toffolini et al., 2021)
Industrial clusters in the developing economies: Insights from the Iranian carpet industry	development	triple	(Saadatyar et al., 2020)
Innovation capability of clusters: understanding the innovation of geographic business networks	innovation capacity	triple	(Bittencourt; Zen; Prévot, 2019)
Innovation Management in Living Lab Projects: The Innovatrix Framework	innovation management	triple	(Schuurman et al., 2019)
Inter-clustering as a network of knowledge and learning: Multiple case studies	knowledge sharing; learning	triple	(Franco; Esteves, 2020)
Living lab as a support to trust for co-creation of value: application to the consumer energy market	trust; co-creation; end-user	quadruple	(Dupont et al., 2019)
Living Lab as an Ecosystem for Development, Demonstration and Assessment of Autonomous Mobility Solutions	mobility; cities	triple	(Pucihar et al., 2019)
Living Labs and user engagement for innovation and sustainability	sustainability; end user	quintuple	(Compagnucci et al., 2021)
Living Labs in University-Industry Co-operation as a Part of Innovation Ecosystem: Case Study of South Korea	innovation process; industry-university relationship	triple	(Shvetsova; Lee, 2021)
Lombardy regional urgent reorganization for congenital cardiac patients following the Covid-19 pandemic	improvement of health services; innovation; co-operation	triple	(Chessa et al., 2020)
Managing Organisational Tensions in Cross-Sector Collaboration: The Case of Mediapolis	public-private collaboration	triple	(Virta; Malmelin, 2022)

Paper	Matters	Helix	Reference
Network Impact of Social Innovation Initiatives In Marginalised Rural Communities	rural communities; evaluation	quintuple	(Lombardi et al., 2020)
Network proximity and communities in innovation clusters across knowledge, business, and geography: Evidence from China	network	triple	(Zhou et al., 2021)
On the resilience and the risk spillovers in innovation clusters	systemic risk	triple	(Gudelytė, 2021)
Optimization of a physical internet based supply chain using reinforcement learning	logistics	triple	(Puskás; Budai; Bohács, 2020)
Regional Aspects of the Development of Clustering in the Dairy Branch	regional development	triple	(Novikov, 2019)
Scaling Innovation Hubs: Impact on knowledge, innovation and entrepreneurial ecosystems in Tanzania	impact on innovation	triple	(Mwantimwa et al., 2021)
Strategies for the formation of entrepreneurship and innovation ecosystems: conceptual framework from Portuguese cases	territorial; cities	triple	(Alvares et al., 2020)
Successful Scaling in Social Franchising: The Case of Impact Hub	social value; tension between commercial and social objectives	triple	(Giudici et al., 2020)
Synergetic effects of network interconnections in the conditions of virtual reality	co-operation/network economy	triple	(Kateryna; Nataliia; Olena, 2021)
Testing future societies? Developing a framework for test beds and living labs as instruments of innovation governance	co-production; local testing; universal replication	triple	(Engels; Wentland; Pfotenhauer, 2019)
The business models of tech hubs in Africa: implications for viability and sustainability	viability; sustainability	quintuple	(Kolade et al., 2021)
The different shades of innovation emergence in smart service systems: the case of Italian cluster for aerospace technology	innovation patterns	triple	(Troisi; Visvizi; Grimaldi, 2021)
The emergence and strategy of tech hubs in Africa: Implications for knowledge production and value creation	knowledge economy	triple	(Atiase; Kolade; Liedong, 2020)
The evolution of knowledge-intensive innovation ecosystems: co-evolving entrepreneurial activity and innovation policy in the western Sweden maritime system	innovation governance; public-private collaboration; sustainability	quintuple	(Gifford; Mckelvey; Saemundsson, 2021)
The Role of Managerial Cognitive Capability in Developing a Sustainable Innovation Ecosystem: A Case Study of Xiaomi	managerial cognitive capacity	triple	(Cao et al., 2020)

Paper	Matters	Helix	Reference
The scope of regional innovation policy to realize transformative change - a case study of the chemicals industry in western Sweden	regional industrial development	triple	(Martin, 2020)
Universities as catalysts of social innovation in health systems in low- and middle-income countries: a multi-country case study	social innovation; health; development	triple	(Van Niekerk et al., 2020)
What impedes the success of late mover IT clusters despite economically favorable environments? A case study of an Indian IT cluster	success/failure of clusters	triple	(Mittal et al., 2020)
Who collects intellectual rents from knowledge and Innovation Hubs? Questioning the sustainability of the Singapore model	income	triple	(Rikap; Flacher, 2020)

To address the complexity of challenges faced by IHs, we employed an inductive methodology aimed at extracting generalisable elements from specific case studies (Pinheiro et al., 2023). This analytical approach seeks a meta-synthesis of results, identifying common patterns and challenges that permeate these innovation ecosystems (Silva et al., 2018). Before deriving the problem classes (Table 9), we assessed the nature of each challenge in relation to innovation, distinguishing between 'means' (operational) problems, which concern the internal operations and efficiency of IHs, and 'ends' (impact) problems, which reflect the broader outcomes and impacts of these entities in reality (Faccin et al., 2021). From the main problems identified in each specific and possibly recurring case, we inferred different problem classes representing thematic or conceptual groupings of challenges (Pinheiro et al., 2023). We used the methodology proposed by Dresch et al. (2015) to categorise the problems and infer the problem classes. The distinct categories, such as 'Governance and Strategy,' 'Capacity and Management,' and 'Development and Sustainability', among others, represent these problem classes, providing a more comprehensive view of the operational challenges and broader impacts faced by IHs (Silva et al., 2018).

Table 9. Identification of Problem Classes and their Connections

Nature of the Problem	Problem Class	Singular Problems	Occurrence
Operational Problems	Governance and Strategy	governance, institutional barriers to innovation, public-private interface, public-private collaboration, innovation governance	5
	Capacity and Management	innovation capacity, innovation management, managerial cognitive capacity, learning, trust	5
	Innovation Processes and Tools	digital innovation, open innovation, evaluation (2), innovation process, innovation (2)	7

Nature of the Problem	Problem Class	Singular Problems	Occurrence
	Connection and Networks	co-operation/network economy, network (2), systemic risk, logistics, co-operation, stakeholders, actors	8
	Development and Sustainability	sustainability (7), bioeconomy, development (3), regional industrial development, regional development, territorial, social value, tension among commercial and social objectives, rural communities	18
Impact Problems	Economic and Commercial Impact	knowledge economy (2), success/failure of clusters, income, viability, impact on innovation	6
	Health and Well-being	health (2), improvement of health services	3
	Social and Urban Impact	social innovation, cities (3), end user (4), local testing	8
	Innovation and Technology	accelerating innovation, innovation patterns	2
	Learning and Knowledge	knowledge sharing	1
	Mobility and Accessibility	Mobility	1
	Collaboration and Joint Creation	co-creation (4), collaborative innovation, co-production, universal replication	7
Total			71

In the context of theoretical production, the aspect of innovation encompasses a series of topics related to its functioning, such as the relationship among innovation and stakeholders, open innovation and its governance structures, innovation capacity, and innovation management. It also addresses aspects related to the purpose of innovation, such as sustainability, knowledge, and development. One emphasised aspect is the importance of the end user from the co-creation perspective.

By using the term, cloud technique to identify recurrences or patterns in theoretical production (Figure 1), themes such as the relationship among innovation and stakeholders (Bettanti et al., 2021), open innovation and its governance structures (Remneland Wikhamn & Styhre, 2019), innovation capacity (Bittencourt et al., 2019), innovation management (Schuurman et al., 2019), systemic risk in participatory innovation processes (Gudelytė, 2021), innovation governance, particularly in the public-private interface (Gifford et al., 2021), managerial cognitive capacity for innovation (Cao et al., 2020), sustainable innovation (Macias Aragonés et al., 2020; Ondiek & Moturi, 2019; Rehm et al., 2021), innovation in the context of knowledge (Atiase et al., 2020; Franco & Esteves, 2020; Pique et al., 2019), innovation in the context of development (Martin, 2020; Novikov, 2019; Saadatyar et al., 2020), and the importance of co-creation with the end user (Compagnucci et al., 2021; Dupont et al., 2019; Kalinauskaite et al., 2021; Malakhatka et al., 2021; Toffolini et al., 2021), are highlighted.

Figure 1. Recurring problem classes

Regarding the sectors participating in a Hub, also referred to as "helices" (Malik, 2021) as highlighted in Table 9, we can find situations of occasional connections among the business sector and the public sector, or with the academic sector, or situations where these three instances form constitutive components of a Hub, forming the so-called "triple helix." In addition to companies, governments, and the academic field, the community is included, either through direct involvement in the Hub or through the target audience of its innovations, constituting the so-called "quadruple helix" (Malik, 2021). Finally, we include the sustainability aspect as a sector when the Hub commits to and engages with the so-called ecological transition of society and the economy, thus forming a "quintuple helix" framework (Carayannis et al., 2012).

Therefore, it can be inferred that the constituent elements of an IH derive from a set of critical factors, namely the specificity of the location, the key aspect or problem that motivates the creation of an EI (Entrepreneurship Initiative), who the fundamental stakeholders are and who are potentially complementary partners, who took the initiative, who orchestrated the functioning, and who articulated the partnerships and collaboration networks. In the light of this, it is essential not to leave anyone out, considering the numerous possibilities of organisational combinations that an EI formed by an IH allows.

Based on the classes of problems and helices that can compose an IH, the following models can be inferred (Table 10):

Table 10. Models of IH

Models	Features	Class of Priority Aspects	References
Corporate hubs	Created by companies to stimulate internal innovation or collaborate with other companies and start-ups on specific projects.	Open innovation, governance structures	(Remneland Wikhamn; Styhre, 2019)
University hubs	Created by universities to connect students, professors and researchers with companies and investors, promoting technological innovation and entrepreneurship	Social innovation in health of medium and poor countries	(Van Niekerk et al., 2020)
Government hubs	Created by the government to boost regional economic development and encourage entrepreneurship and job creation through public policies focused on innovation.	Digital innovation, bioeconomy, sustainability	(Macias Aragonés et al., 2020)
Accelerator hubs	Focused on supporting start-ups, offering mentoring, training, connections with investors, and other resources to stimulate the rapid growth of companies.	Innovation acceleration	(Haukipuro et al., 2019)
Co-working services hubs	Shared spaces that bring together professionals from different fields for collaboration and networking, providing an environment conducive to the emergence of innovative ideas.	Feasibility and sustainability	(Kolade et al., 2021)
Thematic hubs	Focused on specific areas of interest, such as health, renewable energy and information technology, bringing together professionals and organisations with expertise in a particular sector.	Co-creation, end user	(Kalinauskaite et al., 2021)

Companies create corporate hubs to stimulate internal innovation or collaborate with other companies and start-ups on specific projects. They promote open innovation and are supported by efficient governance structures (Remneland Wikhamn; Styhre, 2019). On the other hand, university hubs are initiatives by these institutions to connect students, professors and researchers with companies and investors, focusing on promoting technological innovation and entrepreneurship. They particularly emphasise social innovation in healthcare in middle-income and poor countries (Van Niekerk et al., 2020). Additionally, hubs were established by the government to drive regional economic development, promote entrepreneurship, and create jobs through innovation-focused public policies. They cover digital innovation, bioeconomy and sustainability (Macias Aragonés et al., 2020).

Accelerator hubs support start-ups by providing mentoring, training, investor connections, and other resources to stimulate rapid company growth. Their primary focus is accelerating innovation (Haukipuro et al., 2019). On the other hand, co-working service hubs are shared spaces that bring together professionals from different fields for collaboration and networking, creating an

environment conducive to the emergence of innovative ideas. They emphasise the viability and sustainability of the projects developed (Kolade et al., 2021).

Lastly, thematic hubs focus on specific areas of interest, such as healthcare, renewable energy and information technology. They gather professionals and organisations with expertise in a particular sector, aiming at co-creation and meeting end-users' needs (Kalinauskaite et al., 2021). All these different hub models represent innovative strategies to promote collaboration, knowledge exchange, and the development of joint solutions, each with its specific characteristics and areas of operation.

These models are structured into three main segments - corporate, university and government - and unfold into three finalist axes - services, acceleration and thematic (Fig. 3), allowing for various combinations. For example, the case of Xiaomi (Cao et al., 2020) combined the architecture of a corporate innovation hub with a focus on accelerating innovation in the smartphone industry.

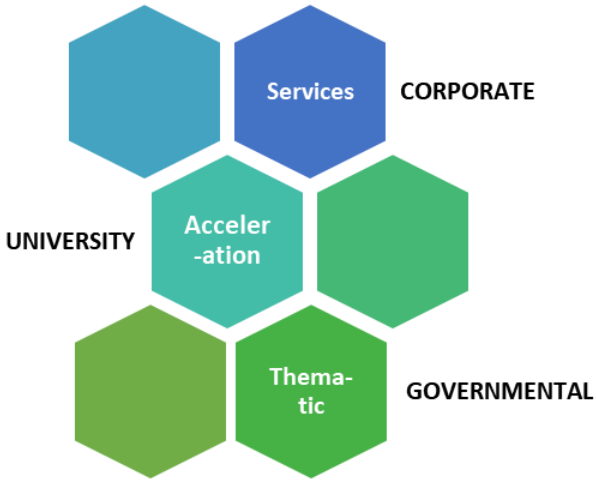

Figure 2. Connections among models

The above descriptions illustrate the diversity and specificity of the IHs, each with its own dynamics and objectives. This scenario is captured and explored in more depth in the Table 11, which provides an integrated analysis of the different types of IHs. It correlates the typologies with specific challenges, problem classes and performance expectations. This compilation is the result of a detailed synthesis of insights obtained from previous table proposals, as well as the incorporation of elements and findings from the current study. Aligning with the theoretical approaches of Carayannis et al. (2012) on innovation ecosystems and the performance analysis methodologies proposed by Dresch et al. (2015), the table examines each IH typology in relation to the problem classes identified in "Table 9. Identification of Problem Classes and their Connections." This reflects the importance of contextual analysis in innovation environments, as discussed by Ford & Yoho (2020) and Malik et al. (2021). The performance evaluation incorporated in the table also brings considerations about operational efficacy and efficiency, resonating with the discussions of Remneland Wikhamn & Styhre (2019) about governance and open innovation. This detailed analytical framework is crucial to assist managers, policy-makers and academics in understanding the complex challenges faced by IHs, as well as in identifying effective strategies to optimise the performance of these hubs, as recommended by Lupova-Henry et al. (2021) in the interaction

between institutions and innovation.

Table 11. Integrated Evaluation Matrix

Typology of IH	Expected Errors/Trials	Classes of Problems	Performance Analysis
Corporate hubs	Lack of internal and external collaboration; Strategic misalignment	Open Innovation, Governance, Evaluation and Risk; Collaboration and Co-creation	Performance evaluated by effectiveness in implementing governance structures and promoting collaborative innovation.
University hubs	Challenges in connecting academia and industry; Gaps in practical knowledge application	Industry-University Relationship; Sustainability and Bioeconomy	Performance measured by the ability to transform academic research into applicable innovations and drive social innovation.
Government hubs	Slowness in policy implementation; Ineffective policy implementation	Regional Development; Innovation and Economy of Knowledge	Performance reflected in the regional impact of innovation policies and the promotion of sustainable economic development.
Accelerator hubs	Ineffectiveness in selecting and supporting start-ups; Inadequate selection and unrealistic expectations	Accelerating Innovation, Evaluation; Innovation and Economy of Knowledge	Performance linked to the success of accelerated start-ups and their long-term growth.
Co-working hubs	Challenges in promoting collaboration; Underutilisation of networks	Co-operation/Network Economy; Sustainability and Bioeconomy; Collaboration	Performance associated with generating innovative synergies among professionals and the sustainability of initiatives.
Thematic hubs	Lack of focus in innovation efforts; Conflicts of interest and improper goal alignment	Co-creation, End-users; Knowledge, Learning and Confidence	Performance related to effectiveness in solving specific sector problems and engaging end-users in the innovation process.

4 Conclusion and Implications

4.1 Conclusion

In summary, the results demonstrate that IHs are physical or virtual spaces that aim to connect collaborative networks of stakeholders, focused on open innovation, in order to jointly and collaboratively pursue growth, innovation and network development through constant dialogue, interactions, collaboration and confluence.

The articles analysed primarily focused on specific cases, and by dissecting these cases into a set of variables and mapping the elements of how a hub can be constituted, it is inferred that there is a wide range of possible combinations that new policies or strategies for assembling innovation ecosystems through IHs can create or explore.

In the pursuit of innovation, the crucial element derived from the results is the numerous possibilities to create a conducive flow for the aggregation of knowledge, ideas and perceptions that materialise into innovation, which somewhat aligns with the constructal design methodology (Bejan & Lorente, 2008, 2009).

From this perspective, the studies analysed indicated some sensitive aspects in converging interests and knowledge for innovation in producing goods and services, and, therefore, for development. These aspects are identified within the classes of operational and interdependent problems, namely, the aspect of result-sharing (Rikap & Flacher, 2020), institutional barriers (Lupova-Henry et al., 2021; Mittal et al., 2020), systemic market risk (Gudelytė, 2021), the question of value in a network logic (Coenegrachts et al., 2021), the logistics challenge (Puskás et al., 2020; Zhou et al., 2021), and favourable or unfavourable local factors for open innovation (Mittal et al., 2020).

In conclusion, these aspects, together with the possibilities for innovation, serve as a reminder that collaboration should be fair and balanced, both in the co-ordination of efforts and in the distribution of gains or returns, creating practical institutional and cognitive sustainability for constant and continuously improving processes of creating knowledge-sharing environments, aligning objectives, and creating value as mutual property.

4.2 Limitations and suggestions for further research

Limitations

Although providing a recent overview of how IHs have been configured and identification of recurring characteristics, this study acknowledges its limitations. Caution should be exercised in generalising the findings, as each case studied arises from specific historical and geographical contexts unique to the IH under examination. Consequently, there exists a limitation in extrapolating the results to other similar situations. Additionally, another limitation of this study pertains to the methodological analysis. Although a comprehensive examination of IH characteristics and patterns was conducted, the complexity of these innovation environments may not have been fully captured. Changes in business environments, government policies and other external variables may impact IH dynamics in ways not fully accounted for in this study.

Suggestions for Further Research

To deepen the understanding of IHs, it is recommended to employ methodological proposals that consider both regular problem classes derived from past experience and the variable and critical elements of each specific context in IH constitution. This could be achieved through more detailed case studies, interviews with key stakeholders, and longitudinal analyses to capture IH evolution over time. Furthermore, exploring the theory of constructal design (Bejan & Lorente, 2008, 2009) as a theoretical framework may offer insights into the dynamics of constituent element flows within IHs. By applying this theory, researchers can examine how the interdependence of resource, knowledge, and human flows influences IHs' innovation capacity. Lastly, it is essential to consider the spatial dimension of IHs and how their geographical location may affect their effectiveness and interaction with other actors in the innovation ecosystem. Comparative studies among IHs located in different geographical regions can elucidate factors contributing to the success or failure of these innovation environments.

These suggestions aim to address some of the limitations identified in this study and provide directions for future research to expand and deepen our understanding of IHs and their contribution to fostering innovation and economic development.

Furthermore, for a consolidated view of this study's contributions, we present Table 12 below summarising the main conclusions of the article, as well as the advancements made in comparison to similar works

Table 12. Article Contributions Framework

Article Contribution	Detailed Description	Comparison with Similar Works
Identification of New Innovation Hub Typologies	This article expands the understanding of the different forms of IHs, introducing new typologies.	Advances beyond Carayannis et al. (2012) by detailing specific typologies, while Clark, Huang & Walsh (2010) offer a more generic view of 'innovation districts'.
Relationship between Hub Typologies and Problem Classes	Establishes unprecedented connections between IH typologies and specific problem classes.	Provides a more targeted practical application compared to Malik et al. (2021), while Davis et al. (2023) discuss the broader growth of innovation ecosystems.
Practical Implications for Managers and Policy Makers	Provides valuable insights into the management and strategies of IHs.	Uses research methodologies from Dresch et al. (2015) for practical guidance, going beyond Katz & Wagner (2014), who described the new geography of innovation.
Basis for Future Research and Theoretical Development	Identifies new areas of investigation and theoretical advancements regarding IHs.	Expands the research scope of Haukipuro et al. (2019) by exploring a wider variety of IHs, complementing Lähteenmäki & Töyli (2023) who discussed platform-based ecosystems.
Framework for Assessment and Improvement of Decision-making	Provides a framework for assessing and improving decision-making in the translation of research and innovation.	Advances beyond Scholz et al. (2023), detailing how the analysis of IH typologies can influence decision-making for impact.

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