Article

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Innovation Ecosystem: Evolution and Trends in Scientific Literature

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Abstract

Innovation ecosystems (IEs) have attracted growing interest from researchers, policymakers, and practitioners due to innovation's transformative role in socioeconomic reality. The objective of this article is to conduct a comprehensive mapping of the current state of research in IEs, analyzing its evolution and outlining trends. This analysis aims to provide researchers in the field with a comprehensive guide, offering a broad review of existing studies and establishing a solid foundation for future investigations. Utilizing data from WoS and Scopus, we adopted a systematic literature review methodology, grounded in a bibliometric analysis (415 documents), followed by analysis of the most significant works. The data were analyzed using CiteSpace and Bibliometrix software. This study identified cross-cutting themes for future studies that emerge in works from different authors, interconnecting various aspects of IEs. They are the following: strategic approach and performance; dynamics of relationships among actors; governance mechanisms and adaptive capacity; digital IE; responsible IE; and research and development. The study provided an overview of the conceptual development in the area, noting changes between historical studies and recent research on IEs. The categories that reveal these elements enable scholars concerned with strategy, entrepreneurship, and public policy to make decisions through consistent analyses.

Keywords: local development, innovation systems, innovation environments, relationship between actors, orchestration, bibliometrics.

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1 Introduction

Innovation Ecosystems (IEs) have attracted increasing interest from researchers, policymakers, and practitioners due to the transformative role that innovation plays in the socioeconomic reality (Zen et al., 2023). The term is rooted in the concept of business ecosystems introduced by Moore (1993) to refer to communities of economic actors who work cooperatively and competitively. IE became widely known after Adner's (2006) argument that information technologies have allowed IE to become a fundamental component in business growth strategies in various sectors, as well as significantly reducing coordination costs since ecosystems allow organizations to create more excellent collective value than a single organization could make individually.

Ecosystem approaches have been incorporated by diverse academic perspectives (Autio & Thomas, 2021). Their rapid adoption has contributed to a polysemy, often related to different socioeconomic contexts and organizations with different conceptions and objectives (Fischer et al., 2022; Gomes et al., 2018). For Ritala and Almapanopoulou (2017), IE refers to systems whose purpose is innovation involving the dynamics of interdependence and coevolution between actors in a spatial dimension. Preliminary, we adopted the concept of IE, defined by Adner as the "alignment structure of the multilateral set of partners that need to interact for a focal value proposition to materialize" (Adner, 2017, p. 40). This approach is based on four essential elements that structure ecosystems to materialize a value proposition: activities (actions), actors (entities), positions (location), and links (transfers) (Adner, 2017).

Previous studies presuppose IEs as a distinct field from other ecosystem approaches (entrepreneurship and business, for example). Different aspects and components of the structure of IEs are value creation and capture (Adner & Kapoor, 2010), open innovation and platforms (Gawer & Cusumano, 2002), modularity and complementarity (Jacobides et al., 2018), interdependence and actors (Adner, 2017). Literature reviews such as Granstrand & Holgersson (2020), Dedehayir, Mäkinen & Ortt (2018), and Yaghmaie & Vanhaverbeke (2020) have investigated the IE concept, actors' roles, and IE components. Others have applied systematic reviews to map scientific production and analyze the state of research (Gomes et al., 2018; Dias Sant' Ana et al., 2020; Gu et al., 2021; Zen et al., 2023).

The rise of IEs results from a shift in the paradigm of innovation processes, as they transcend organizational boundaries and incorporate collaboration among multiple entities, enhancing benefits for various stakeholders (Arena, Azzone & Piantoni, 2022). Additionally, the growing importance of these structures for collaboration among various entities encompasses other emerging transformations, such as those provoked by the coronavirus (COVID-19) pandemic, which, as pointed out by Boni and Gunn (2021), influenced the greater virtualization of relationships and digital collaboration. In this light, changes like these also impact the field of IE studies, incorporating new challenges and opportunities for research.

In this context, Chen (2006) highlights that emerging trends have the potential to instigate researchers to investigate a subject from innovative approaches, as they present new insights to be explored. Furthermore, "Detecting and understanding emerging trends and abrupt changes caused by such events in scientific disciplines can significantly improve the ability of scientists to deal with changes in a timely manner" (Chen, 2006, p. 2). Thus, the aim of this article is to conduct a comprehensive mapping of the current state of research in IEs, analyzing its evolution and outlining trends. This analysis aims to provide researchers in the field with a comprehensive guide, offering an extensive review of existing studies and establishing a solid foundation for future investigations.

The present bibliometrics study holds promise in uncovering novel insights into academic trends within the IE field, supporting researchers and practitioners through robust analyses of the knowledge landscape. Moreover, it serves as a tool for identifying emerging trends that can serve as focal points for future research endeavors. In this regard, our research showed that specific cross-cutting themes consistently appear in the works of different authors, each with a unique focus within the field of IEs. These aspects constitute a significant underlying thematic line that interconnects different facets of IEs.

We have written five sections. Next, we present a literature review on IEs and describe the methodological procedures adopted for the systematic literature review. Next, we present the results of the bibliometric and content analyses, pointing out future paths to improve understanding in this area of research. In the fifth section, we present the main conclusions of this research.

2 Literature Review

Although the definition of an IE is recent, its origin is related to already established theories. Since Schumpeter demonstrated innovation in 1942 as a driving force in the economy, new studies have emerged, and the use of the systemic approach developed in the 1980s and 1990s has intensified (Granstrand & Holgersson, 2020). In addition, the geographic concentration of organizations Michael Porter called clusters in 1998 introduced a new way of thinking about the relationship between localization, innovation, and business development (Suominen et al., 2019). The literature review revealed that researchers have investigated different aspects of IE.

Suominen et al. (2019) identified that previous studies have focused on elements such as dynamic capabilities, coopetitive work, and network creation, while contemporary studies have directed research toward the development, architecture, and design of IEs. Almpanopoulou et al. (2017) observed that, following Moore's seminal contribution (1993), studies have evolved around a systemic perspective of ecosystems, encompassing principles of shared environments, interdependence, coevolution, among others. The authors argued that earlier literature examined IEs in the context of a technological platform or a single focal actor, overlooking the importance of other partners, as well as the roles and influence they exert in these environments.

In this regard, Yaghmaie and Vanhaverbeke (2020) highlighted that, as actors within an IE create value by reconfiguring their various roles and interrelationships, all actors should be rewarded for the efforts and contributions invested in the ecosystem. According to the authors, the ecosystem approach brings together the perspective of all actors and requires the development of strategies that reflect the complexity of the existing interactions. Feng et al. (2021) suggested that resource sharing and information interaction drive innovation development and, in addition to enhancing the company's own business, create value for consumers and generate competitive advantage for the overall environment. Granstrand and Holgersson (2020) advocated the importance of dynamic balance between the creation and sharing of value among complements, complementors, competitors, and consumers to enable substitute artifacts and competing actors to integrate into an IE. In line with the studies of Dedehayir et al. (2018), the authors identified that research on IE often focuses on collaborating actors and much less on competition/substitution and artifacts.

Adner (2017) argues that while multilateral partnerships are valuable, rare, and inimitable, competitive advantage depends on both maintaining relationships and keeping rivals at bay. According to the author, the multitude of actors involved in an IE extends the issue of value creation and capture to include the distribution of value in the broader context of an ecosystem. This is because the advantages resulting from the traditional bilateral bargaining power between the focal company and its direct partners can be extended to partners who do not have direct relationships with the focal company. In this regard, Adner (2017) contends that alignment among the partners comprising an IE represents the essence of ecosystem strategy.

Despite efforts in recent studies, there is still much to comprehend regarding IE and the key elements that constitute these environments. In addition, the literature has only recently emphasized the flexibility of physical boundaries. Such circumstances reveal the need to understand the literature better about past and current learning trajectories, given that this impacts the direction of competitive strategies and the orientation of public policies.

3 Methodology

To achieve the proposed objective of the research, we adopted a systematic literature review methodology, based on a bibliometric analysis, followed by a content analysis of the most relevant

works. Bibliometric analysis is a well-established method for examining scientific production in a certain area, providing concise and comprehensible objective information (Filser et al., 2017). These approaches represent contemporary research methods for addressing the phenomenon of big data in the context of scientific discourses (Bragge et al., 2019). Bibliometrics applies quantitative techniques using mathematical and statistical tools (Prado et al., 2016), allowing for comments on characteristics and transforming something intangible (scientific quality) into a manageable entity (Li et al., 2019). Mukherjee et al. (2022) rightly points out that many bibliometric studies focus on quantitative descriptions, which may not meet the level of contribution required in high-level scientific debates. In line with their insights, we have gone beyond descriptive tables and plots, employing content analysis of relevant papers. This methodology has allowed us to offer a substantial analysis, define categories, and, importantly, reveal trends in the study field, thereby enhancing the robustness of our findings.

Thus, the application of bibliometric analyses enables the identification and anticipation of trends, as, by exploring a more comprehensive set of articles, it extends the investigation beyond historical and current states (Pigola et al., 2022). On the other hand, content analysis allows the researcher to put the obtained information in evidence, propose inferences, and make interpretations, considering the theoretical framework, or even identify new clues due to the theoretical dimensions that may emerge from reading the material (Minayo, 2000). In this perspective, combining bibliometric and content analyses enables the identification of trends and gaps in the literature, as well as the main themes and topics discussed (Gomes et al., 2018; Misra & Mention, 2022).

Our analyses identified that most bibliometric reviews in the field applied this technique in conjunction with content analysis, an approach in line with that adopted in our study, as exemplified by research such as Dias Sant´Ana et al. (2020), Foguesatto et al. (2021), Gomes et al. (2018), Suominen et al. (2018), and Zen et al. (2023). In this context, to complement the bibliometric analysis, content analysis was used to explore the central themes highlighted by bibliometrics. Additionally, aiming to outline directions for future research, the most recent articles from the sample were analyzed in their entirety.

Prado et al. (2016) emphasize that some limitations may occur in this type of research. To reduce bias, the authors developed a research framework (Figure 1). In addition, Iddy and Alon (2018) suggest that using software can mitigate bias in the selection and analysis of documents. Our preliminary analysis revealed growing interest in academia and the market, reflecting the relevance of IE acquired as economic and technological development drivers. Thus, we defined the objective of the study (procedure 1.1): mapping the research state of the IE issue as well as its evolution and future trends.

The data were collected from the Web of Science (WoS) and Scopus via Elsevier (procedure 1.2). These are considered the main sources of citation data and are commonly used in bibliometric analysis. In addition to Scopus being the largest bibliometric database and the WoS providing a complete range of scientific journals, these databases contain metadata that can be extracted and exported for bibliometric analysis (Filser et al., 2017). To perform a comprehensive literature review, the terms that represent the field (procedure 1.3) were delimited by IEs.

The search term "innovation ecosystem" was defined for the two databases, and the scope was delimited to locate the references only in the title of the articles (procedure 2.1). Initial research identified 823 documents at WoS and 45.870 at Scopus (Table 1). Subsequently, after underscoring the exact expressions of the term, it resulted in 484 documents at WoS and 1.065 documents at Scopus (procedure 2.2). From this initial sample, the database searches were filtered only by the type of peer-reviewed document: articles and reviews (procedure 2.3). Peer-reviewed

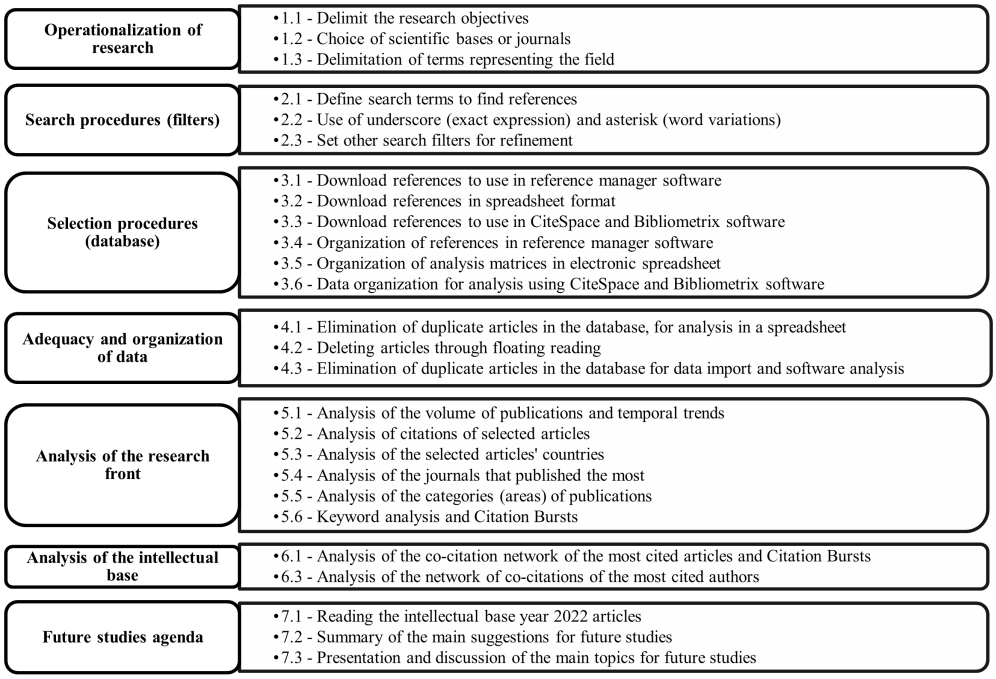


Figure 1. Research framework proposed for the review articles (Adapted from Prado et al., 2016)

documents are primary sources for new research results (Filser et al., 2017) and more reliable (Misra & Mention, 2022). In addition, these documents gather a more complex set of metadata to proceed with the bibliometric analysis (Gomes et al., 2018). Table 1 shows the steps and the results of the searches in the WoS and Scopus databases, performed on 08/21/2022.

Table 1. Research performed for bibliometric analysis.

Database	Research	Search terms	Results
WoS	P1	TI= Innovation Ecosystem	823
	P2	TI= Innovation Ecosystem*	484
	P3	**TI= Innovation Ecosystem* filtered by articles and review articles**	**295**
Scopus	P1	TITLE INNOVATION ECOSYSTEM	45.870
	P2	TITLE (INNOVATION ECOSYSTEM)	1.065
	P3	TITLE=(INNOVATION ECOSYSTEM*)	591
	P4	**TITLE(Innovation_Ecosystem*) filtered by articles and review articles**	**378**

Figure 2 demonstrates the count of articles identified in WoS and Scopus, as well as the intersection of articles present simultaneously in both databases. This analysis confirms the relevance of the search conducted in both databases, as no important article was excluded. After the searches, the metadata were selected and imported. The reference manager (procedure 3.1) was used to download and organize references, due to its ability to manage a large volume of data, direct connection with databases such as WoS and Scopus, efficient organization into folders, ease of citation according to academic standards, and support for sharing information with the team. Subsequently, the references were downloaded in spreadsheet format (procedure 3.2) and for use

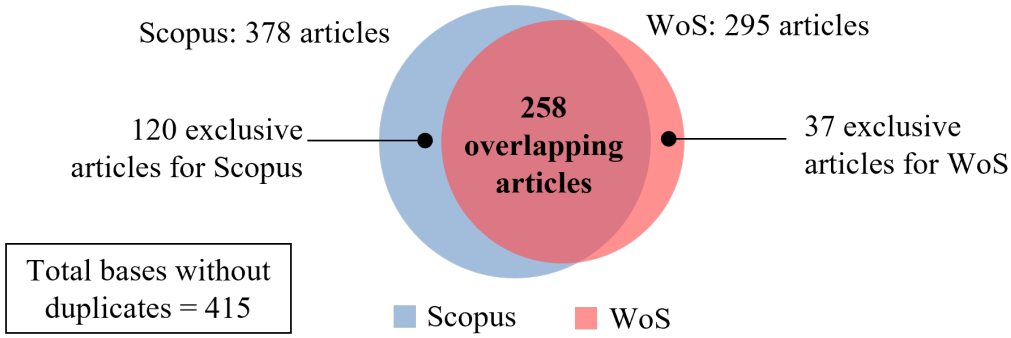


Figure 2. Articles on IE in Scopus and the WoS
Source: Prepared by the authors

in bibliometric software (procedure 3.3). In the second stage, the references were organized in the reference manager (procedure 3.4), and the matrices for analysis in a spreadsheet were organized and tabulated (procedure 3.5). Finally, the data were organized for analysis using the bibliometric analysis software CiteSpace (Chen, 2006) and Bibliometrix (Aria & Cuccurullo, 2017) (procedure 3.6).

We eliminated duplicate articles in the databases using Microsoft Excel spreadsheets (procedure 4.1) and through skim reading (procedure 4.2). We also excluded duplicate records from the Scopus database and converted the RIS file into a text file format (procedure 4.3). For this procedure, Microsoft Excel was used to identify the articles that were simultaneously indexed in the WoS and Scopus databases, enabling the removal of these studies from the Scopus metadata. This refinement was very important, as demonstrated in Figure 2, the elimination of 258 duplicate articles in the two databases was essential to avoid distortions in the analyses. Subsequently, we merged the data from the two databases (Scopus and WoS) for importation and analysis through the software. After all refinements, we obtained a sample of 415 articles.

To proceed with the analysis of the research front (procedure 5) and the intellectual base (procedure 6), we used Microsoft Excel, CiteSpace (Chen, 2006), Bibliometrix (Aria & Cuccurullo, 2017), and content analysis. In addition to the analysis through bibliometric software, tables and graphs were generated to represent the results, considering that the documents presented different citation counts in WoS and Scopus. Thus, the visual representations created with Microsoft Excel allowed for an individualized presentation of the data, facilitating comparative analysis (e.g. Figure 3). CiteSpace was chosen for its ability to integrally represent research fronts and intellectual bases, featuring a burst detection algorithm to identify concepts from the research fronts (Chen, 2006). Bibliometrix was used to highlight the social structure, being employed in the creation of the graph of articles produced in international co-authorship.

The analysis of the research front aims to identify the transitory nature of research concepts and understand the dynamics of how this transitory research modify the intellectual landscape of a scientific field (Chen, 2006). Such analysis is related to the sample and allows for identifying the state of the art of thinking in a field of research and detecting and monitoring emerging thematic trends and sudden changes related to a field of study (Chen, 2006). The analysis of the intellectual base allows us to identify the citation and co-citation networks of the references cited by the sample (Chen, 2006). The intellectual basis of a research front corresponds to the citation

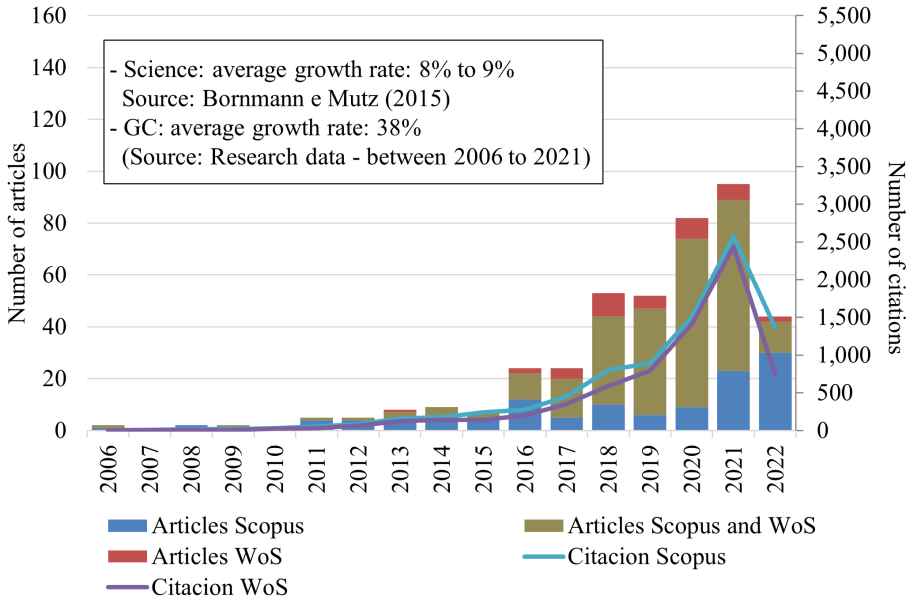


Figure 3. Number of articles and citation per year
Source: Prepared by the authors

and co-citation trails in the scientific literature; thus, what is cited by the research front forms its intellectual basis and highlights the nature of a research front (Chen, 2006). At the end of the analysis, we present the for future studies (proceeding 7). We chose to limit this analysis to articles published in 2022, taking for granted that proposals for future studies are still open.

4 Results of the library analysis and discussion

4.1 Analysis of the Research Front

Analysis of the volume of publications and temporal trends

Figure 3 shows the distribution of the 415 publications on IE over time and the number of citations received in the *Scopus* and *WoS* databases. The first article and significant influencer is from 2006 (Adner, 2006). The period between 2006 and 2015 comprises 9.88% of the sample, with 41 publications. From 2016, there was an increase in the number of publications and the volume of article citations, demonstrating an increase in the importance of the topic and suggesting a potential growth trend. In the last two years (2020 and 2021), we have 177 articles published, representing 42.65% of the sample. We searched in August 2022. Therefore, it does not represent the total number of publications throughout 2022.

The citation counts also showed similar growth. Between 2006 and 2016, the papers received 547 citations in the *WoS* and 778 in *Scopus*, representing 7.73% and 9.01% of the total, respectively. Between 2020 and 2021, the number of citations in the *WoS* accounted for 54.45%, with a total of 3.852 citations, and in *Scopus*, 47.21%, with 4.077 citations. Figure 3 indicates growing interest in the field in the coming years. We also highlight the average growth rate between 2006 and 2021 of 38% per year, demonstrating an exponential growth of the area in recent years. Compared with the average growth rate of science, which is approximately 8 to 9% per year, according to Bornann and Mutz (2015), this growth may indicate that the IE approach has implications for various sectors of the economy and is influencing relevant research fields.

Analyzing citations

Table 2 shows the ten most cited articles in the sample, their total citations, and classifications according to the citation counts in the two databases. Although the citation counts of *WoS* and *Scopus* are different, they are correlated, except in the fourth article by Oh et al. (2016), which appears only in the *WoS* database.

Table 2. Most cited articles.

Article title	Authors	Journals (ISSN)	Total citations		Average per year	
			WoS	Scopus	WoS	Scopus
Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations	Adner and Kapoor (2010)	Strategic Management Journal (0143-2095)	1.027	1.217	79	93,61
Match your innovation strategy to your innovation ecosystem	Adner (2006)	Harvard Business Review (00178-8012)	609	780	35,8	45,88
Mode 3' and 'Quadruple Helix': toward a 21st centry fractial innovation ecosystem	Carayannia and Campbell (2009)	International Journal of Technology Management (0267-5730)	560	756	40	50,4
Innovation ecosystems: A critical examination	Oh et al. (2016)	Technovation (0166-4972)	247	35,3		
Entrepreneurship in Innovation Ecosystems: Entrepreneurs' Self-Regulatory Processes and Their Implication for New Venture Success	Nambisan and Baron (2013)	Entrepreneurship: Theory and Practice (1042-2587)	236	267	23,6	26,7
Opening up for competitive advantage - How Deutsche Telekom creates an open innovation ecosystem	Rohrbeck, Hoelzle and Gemuenden (2009)	R&D Management (0033-6807)	216	252	15,4	19,38
Innovation ecosystems and the pace of substitution: Re-examining technology S-curves	Adner and Kapoor (2016)	Strategic Management Journal (0143-2095)	198	207	28,3	29,57
Unpacking the innovation ecosystem construct: Evolution, gaps and trends	Gomes et al. (2018)	Technological Forecasting and Social Change (0040-1625)	160	182	32	36,4

Article title	Authors	Journals (ISSN)	Total citations		Average per year	
			WoS	Scopus	WoS	Scopus
Innovation ecosystems: A conceptual review and a new definition	Granstrand and Holgersson (2020)	Technovation (0166-4972)	140	157	46,7	52,33
Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transition	Pigford, Hickey and Klerkx (2018)	Agricultural Systems (0308-521X)	127	139	25,4	27,8

The total number of citations of all the articles in the sample resulted in 7.075 citations in the WoS and 8.635 citations in Scopus. Thus, 1.48% of the sample (Table 2) is responsible for 49.75% of the total citations in the WoS and 45.82% in Scopus. The most cited articles addressed the following themes: Adner (2006) and Adner and Kapoor (2010; 2016) discussed business interdependence in Innovation Ecosystems (IEs), highlighting strategies to manage challenges and technological transitions. Nambisan and Baron (2013) focused on entrepreneurship and innovation in hub-based IEs. Rohrbeck, Hoelzle, and Gemuenden (2009) examined open innovation in IEs, while Pigford, Hickey, and Klerkx (2018) explored agricultural innovation and the creation of collective niches from the IEs approach. The Quadruple Helix interaction was discussed by Carayannis and Campbell (2009), advocating the role of academic research, knowledge quality, and innovation architecture.

Literature reviews on IEs also stood out among the most cited articles: Oh et al. (2016) emphasized the need for greater theoretical consistency, Gomes et al. (2018) analyzed the evolution of the theory and identified the transition in the use of the term business ecosystems to IEs, and Granstrand and Holgersson (2020) explored the definitions of IEs and related concepts.

Relevance by Country

Figure 4 shows the network of countries that have published works on the subject. Among the countries with the highest number of citations, China stands out with 194 articles, followed by the United States (98 publications), Brazil (77 publications) and the United Kingdom (73 publications).

In China, research began in 2014, and the most cited article was the work of Xu et al. (2018), with 73 citations. In the United States, the work of Adner and Kapoor (2010) was the most cited, with 1,090 citations in the sample. In Brazil, Gomes et al. (2018) stood out with 187 citations in the sample.

Another relevant data is the number of coauthors in the focal countries. Figure 4 shows the articles produced via coauthorship with scholars from other countries (MCP – light grey) and those produced only by authors in the same country (SCP – dark grey). China appears to have both the most significant volume of published articles (76 articles) and a percentage of (approximately) 28% of coauthorship with other countries (21 articles). In Brazil, only 6 of 34 articles present coauthorship with other countries. Among the countries with the most published articles in coauthorship with foreigners, the United Kingdom, Italy, and Finland have good international insertion. Analysis of the most cited countries reveals that the United States is in first place,

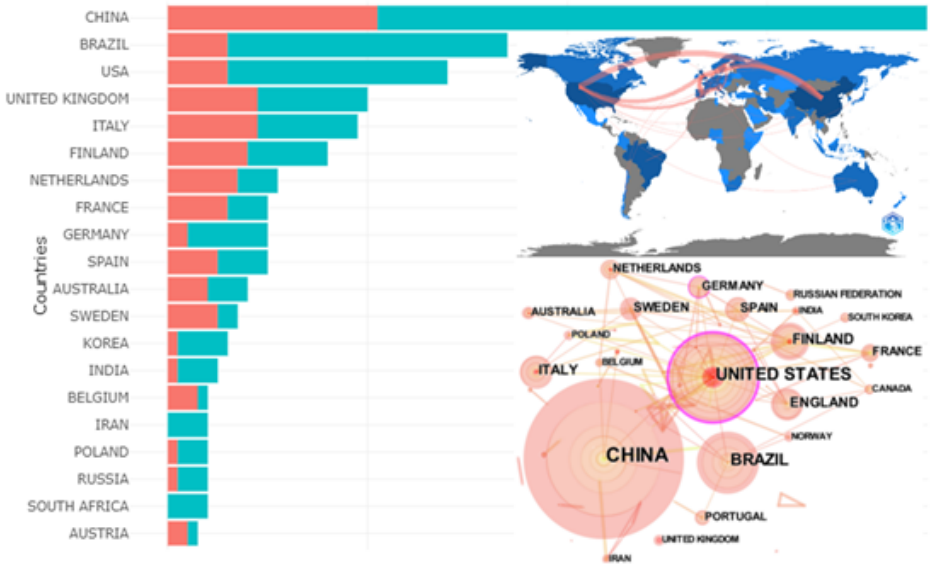


Figure 4. Analysis of the influence and relevance of countries Source: Prepared by the authors

with 2.673 citations; France in second place, with 933 citations; China in third place, with 876 citations; and Brazil in fourth place, with 508 citations.

Highlighted journals

Table 3 shows that of all articles collected, 10 journals are responsible for publishing 29% of them.

Table 3. Journals that publish the most works.

Journals	Frequency	Impact factor (2020)		Citation (sample)		
	N	%	SJR	JCR	Scopus	WoS
Sustainability	33	7,95%	0,612	3.251	360	295
Technological Forecasting and Social Change	29	6,99%	2.226	8.593	1.021	989
International Journal of Technology Management	10	2,41%	0,368	1667	891	806
Journal of Business Research	8	1,93%	2.049	7,55	130	113
European Planning Studies	7	1,69%	1.214	3.269	109	81
International Journal of Innovation and Technology Management	7	1,69%	0,324	-	42	26
Technovation	7	1,69%	2,3	6.606	180	507
IEEE Transactions on Engineering Management	6	1,45%	0,702	6.146	38	36
Journal of Cleaner Production	6	1,45%	1.937	9.267	80	92
Technology Innovation Management Review	6	1,45%	0,153	-	25	63

Figure 5. WoS categories
Source: Prepared by the authors using CiteSpace software

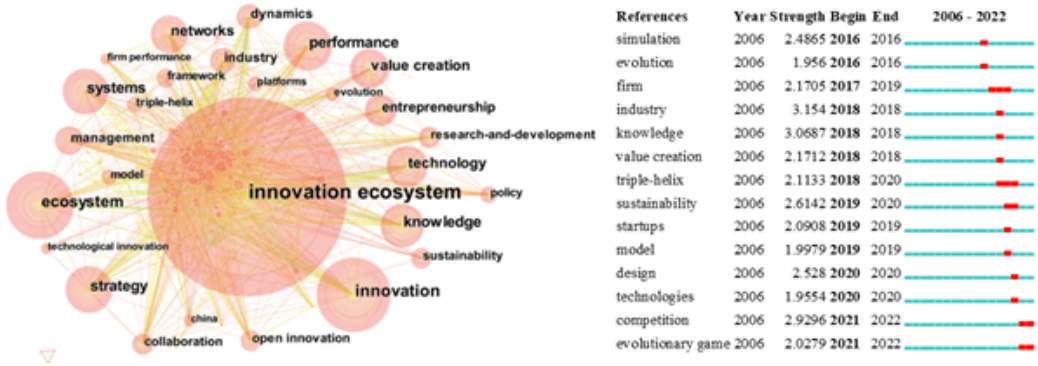


Figure 6. Network of keywords. Legend: Words with frequency greater than 15
Source: Prepared by the authors

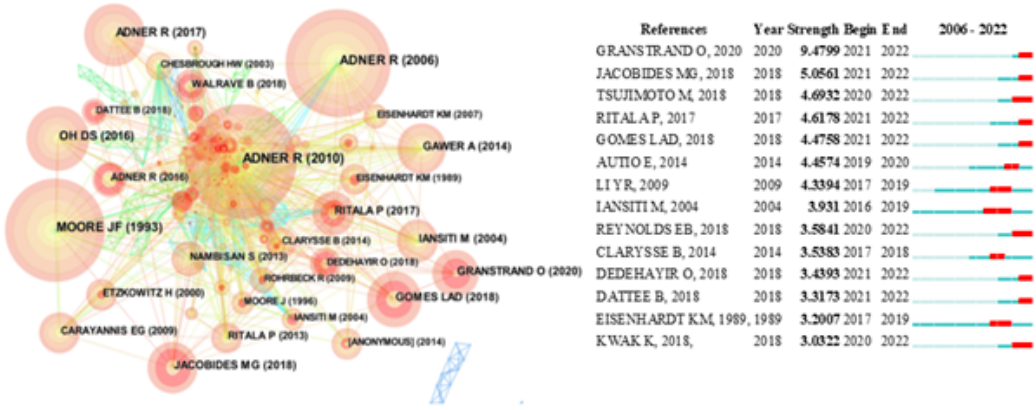
Analysis of the categories (areas) of publications

The best-ranked area is *Business & Economics*, with 159 articles, followed by *Social Science* (95), *Business* (57), *Environmental Sciences & Ecology* (58) and *Science & Technology* (53). In *Business & Economics*, the studies by Adner and Kapoor (2010) and Adner (2006) stand out. Carayannis and Campbell (2009) stand out in the *Social Science* and *Engineering* (45), with 560 citations. The other highlighted categories are *Green & Sustainable Science & Technology* (41), *Management Social Science* (40), *Public Administration* (39), and *Environmental Sciences* (34).

Keywords Analysis

As shown by the keyword network in Figure 6, *Innovation Ecosystem* presented the highest frequency (221 times), followed by *Innovation* (84), *Ecosystem* (77), *Performance* (56), *Strategy* (53), *Systems* (52), *Knowledge* (51), *Technology* (48), and *Value Creation* (46).

The term value creation has a strong connection with strategy. Knowledge and Technology are interconnected and among the main salient topics discussed. Figure 6 illustrates the explosion of the 14 references with the highest citation force. Among the keywords listed, those that showed the most significant explosion in citations were Knowledge (3.0687) and Industry (3.154) in 2018 and, subsequently, competition (2.9296) between 2021 and 2022. Chen (2006) explains that



References	Year	Strength	Begin	End	2006 - 2022
GRANSTRAND O, 2020	2020	9.4799	2021	2022	
JACOBIDES MG, 2018	2018	5.0561	2021	2022	
TSUJIMOTO M, 2018	2018	4.6932	2020	2022	
RITALA P, 2017	2017	4.6178	2021	2022	
GOMES LAD, 2018	2018	4.4758	2021	2022	
AUTIO E, 2014	2014	4.4574	2019	2020	
LI YR, 2009	2009	4.3394	2017	2019	
IANSITI M, 2004	2004	3.931	2016	2019	
REYNOLDS EB, 2018	2018	3.5841	2020	2022	
CLARYSSE B, 2014	2014	3.5383	2017	2018	
DEDEHAYIR O, 2018	2018	3.4393	2021	2022	
DATTEE B, 2018	2018	3.3173	2021	2022	
EISENHARDT KM, 1989	1989	3.2007	2017	2019	
KWAK K, 2018	2018	3.0322	2020	2022	

Figure 7. Network of cocitations among the most cited articles

explosion algorithms can identify emerging terms highlighting a new research front even before attracting sufficient citations. The keywords that showed a significant increase in interest in 2021 and 2022 were *competition* and *evolutionary game*. In 2020, the conceptually addressed themes were *design* and *technologies*.

4.2 Analysis of the Intellectual Base

Analysis of cocitations

Chen (2006) used co-citation analysis and burst detection to identify emerging trends and found that the most emerging clusters were associated with crucial articles that showed increased citation counts. Our results demonstrated that the work of Granstrand and Holgersson (2020) and Gomes et al. (2018) stood out, concomitantly, in three analyses: among the most cited articles in the sample, in the cocitation analysis of the most cited papers and among the references with the greatest citation strength. This analysis confirms the relevance of these studies for developing theory on IEs. Our analysis also identified that Ritala and Almapanopoulou (2017) and Jacobides, Cennamo and Gawer (2018) were evident both in the co-citation analysis and in detecting the citation explosion (Fig. 7).

Figure 7 also presents the top 14 references with higher citation strength that have attracted significant attention. Examining the documents with the highest citation strength between 2021 and 2022, we identified that the works referenced in this period demonstrated interest in presenting definitions for IE and identifying the attributes that make up the concept. An aspect of the articles is related to competitiveness and understanding its comparison to other ecosystems. Furthermore, some authors explored the context of the emergence of an IE: actors, roles, activities, and facilitating mechanisms, such as modularity and complementarity. From this perspective, the work of Granstrand and Holgersson (2020) stands out as the most influential. The authors analyzed the definitions of IEs and identified seven essential components: actors, artifacts, activities, institutions, complementary/ cooperative, substitute/competitive, and co-evolutionary nature of IEs. The authors argued that allowing substitute artifacts and competing actors in an IE is crucial for the competitiveness of an IE relative to other ecosystems. From this same perspective, Jacobides, Cennamo and Gawer (2018) suggested that competitive context connects to the dynamics between ecosystems. The authors investigated the mechanisms that influence the emergence of ecosystems, highlighting the role of modularity and types of complementarities as ecosystem actors interact around autonomous and interdependent activities.

Ritala and Almapanopoulou (2017) argued that the literature on IEs requires greater conceptual and empirical rigor. Gomes et al. (2018) analyzed the evolution of IE theory to clarify concepts and contribute to the development of theoretical consistency. They identified the turning point in the literature with the transition from business ecosystems to IEs. The authors proposed linking the IE concept with value creation and the business ecosystem with value capture. Dedehayir, Mäkinen and Ortt (2018) investigated four groups of roles considered by the authors as essential for the emergence of an IE - leadership, direct value creation, support for value creation, and entrepreneurial ecosystem - and identified the specific activities of each group. In line with Jacobides, Cennamo & Gawer (2018), the authors highlighted the importance of the complementarian's actions as a supplier of complementary products and services to extend the core offer of suppliers and assemblers. The interest in understanding the process of the emergence of ISIS encouraged Dattée, Alexy and Autio (2018) to conduct a multiple case study to know how actors commit to promoting the creation of an IE.

The influencing references between 2020 and 2022 concentrated efforts to understand aspects of IE management and the mechanisms for coordinating ecosystem relationships. Autio and Thomas (2014) attracted great attention among researchers between 2019 and 2020, but they deal with the same topic. Thus, Tsujimoto et al. (2018) identified that the essential meaning of IE relates to organic networks. For the authors, catching the principles that influence decision-making and the behavioral chains can provide relevant information about finding the patterns that can manifest spontaneously, generating involuntary results, exploiting the network, and impacting positively and negatively.

Reynolds and Uygun (2018) examine the links in the network of actors. In a study of an industrial IE, the authors identified an explicit capacity for innovation within each node of the system, but with weak interconnections, as communication and collaboration among the actors had limitations. Kwak, Kim and Park (2018) proposed a strategic alternative facilitating knowledge sharing and interaction between the IE actors and identified the multiplatform strategy's relevance with complementary resources interactions. Autio and Thomas (2014) focus on behavioral logic to extract insights into the management, structure, and coordination of IEs. The authors identified the following themes: value creation, network integration, and network management flow. The authors argued that the ecosystem concept has distinctive characteristics that refer to it as the only construct that can incorporate both upstream activities (production side) and downstream activities (user side).

Iansiti and Levien (2004) stood out as a reference between 2016 and 2019. The authors argue that management mechanisms are essential to maintain the stability of an ecosystem, which a company can lead with the support of a platform of services, tools, and technology. Eisenhardt (1989) is another reference for social science research with a significant time difference. Receiving many citations between 2017 and 2019, it describes the process of theory construction based on case studies. Li, Y. R. (2009) and Clarysse et al. (2014) are two influential case studies. The first carried out a case study on a successful company that used the mergers and acquisitions strategy. Clarysse et al. (2014) identified that knowledge and business ecosystems are disconnected, suggesting policymakers develop incentives and mechanisms for ecosystem links.

4.3 Implications for Future Studies

We considered the papers published in 2022 to analyze the trends concerning the literature gaps. We reduced the analysis to articles published in 2022 (83 papers), taking for granted that most proposals for future research are still open. Two documents were unavailable, and 19 lacked trend recommendations. Thus, we analyzed 62 articles, mapped in Table 4, and summarized in Figure

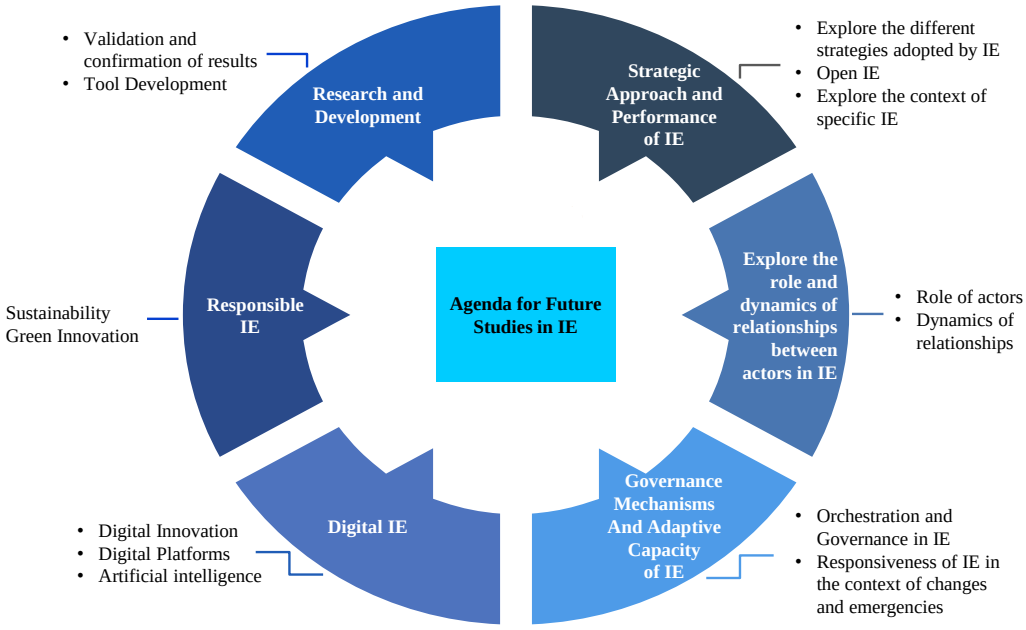


Figure 8. Future directions of research
Source: Prepared by the authors

8. We comprehensively read all the articles and identified 137 suggestions, which we grouped into 14 subcategories. Subsequently, we outlined these subcategories and grouped them into six main trends: strategic approach and performance, exploring the roles and dynamics of the relationships among actors, governance mechanisms and adaptive capacity, digital IE, responsible IE, and research and development.

Table 4. Trends of future studies.

Categories	Subcategories	Authors by subcategory
Strategic Approach and Performance of IE	Explore the different stategies adopted by IE	Arthur, Moizer and Lean (2022); Cukier et al. (2022); Klimas and Czakon (2022); Pushpananthan and Elmquist (2022); Sahasranamam and Soundararajan (2022); Santos, Zen and Bittencourt (2022); Steinbruch, Nascimento and Menezes (2022); Zheng and Cai (2022)
	Open IE	Li-Ying, Sofka and Tuertscher (2022); Remneland Wikhamn and Styhre (2022); Xiong et al. (2022)
	Explore the context of specific IE	Cukier et al. (2022); Gomes, Santos and Facin (2022); Klimas and Czakon (2022); Pasi, Mahajan and Rane (2022)

Categories	Subcategories	Authors by subcategory
Explore the role and dynamics of relationship between actors in IE	Role of actors	Arthur, Moizer and Lean (2022); Klimas and Czakon (2022); Ngongoni, Grobbelaar and Schutte (2022); Pushpananthan and Elmquist (2022)
	Dynamics of relationships	Burda and Gavrikova (2022); Jin et al. (2022); Klimas and Czakon (2022); Ngongoni, Grobbelaar and Schutte (2022); Song (2022); Steinbruch, Nascimento and Menezes (2022)
Governance Mechanisms and Adaptive Capacity of IE	Orchestration and Governance in IE	Burda and Gavrikova (2022); Li-Ying, Sofka and Tuertscher (2022); Santos, Zen and Bittencourt (2022); Song (2022)
	Responsiveness of IE in the context of changes and emergencies	Burda and Gavrikova (2022); Gomes, Santos and Facin (2022); Sahasranamam and Soundararajan (2022); Song (2022)
Digital IE	Digital Innovation	Cui et al. (2022); Li, Wang, Wang and Xie (2022)
	Digital Platforms	Li-Ying, Sofka and Tuertscher (2022); Xiong et al. (2022)
	Artificial intelligence	Sun, Xu, et al. (2022)
Responsible IE	Sustainability	Miranda et al. (2022); Zheng and Cai (2022)
	Green Innovation	Fan et al. (2022)
Research and Development	Validation and confirmation of results	Jin et al. (2022); Miranda et al. (2022); Ngongoni, Grobbelaar and Schutte (2022)
	Tool Development	Li, Wang, Wang and Xie (2022); Pasi, Mahajan and Rane (2022); Santos, Zen and Bittencourt (2022)

Considering the data, we observed the strategic approach and performance of IEs, addressing themes such as strategies adopted by IEs, open IEs, and exploring specific contexts. These perspectives concentrate on attributes that differentiate IEs (Klimas & Czakon, 2022), the institutional arrangements (Sahasranamam & Soundararajan, 2022), antecedents to the emergence of IEs (Pushpananthan & Elmquist, 2022), and policy (Zheng & Cai, 2022). Furthermore, some suggestions emphasize the importance of conducting empirical research and case studies to improve the understanding of IEs (Arthur et al., 2022; Santos et al., 2022). Open IE is concerned with

the interrelationships between complementarians, platforms, and communities and how these factors affect the diffusion of innovations (Xiong et al., 2022), the importance of ownership issues intellectual to knowledge partners (Li-Ying et al., 2022) and explore the perspectives of other stakeholders beyond key organizations (Remneland et al., 2022).

The third subcategory addresses indications for analyzing, reviewing, or exploring contexts or specific IEs about strategy and performance to deepen understanding of these contexts. Indications for research focus on Global IE (Gomes et al., 2022), Business (Klimas & Czakon, 2022), Entrepreneurship (Cukier et al., 2022), Industry 4.0 (Pasi et al., 2022), among others. Sahasranamam and Soundararajan (2022) argue that strategic agility can provide IE with adaptation and flexibility via its resources under dynamic and uncertain conditions. For authors, under these conditions, bottom-up development is the most appropriate model because it allows agility at the network level and informal coordination through institutional arrangements.

The second most significant trend concerns the role and dynamics of relationships between IE actors. Regarding the role of actors, trends point to the need for studies that investigate the level of interdependence from a holistic perspective on the roles and challenges faced by IE actors and contribute to consolidated definitions that enable comparability, generalization, and conditionality of empirical studies (Ngongoni et al., 2022). Furthermore, it is relevant to understanding actors' roles (Pushpananthan & Elmquist, 2022) and the relationships between IE actors. We highlight suggestions that explore the conditions, processes, and effects of interactions between actors (Jin et al., 2022), motivational aspects of collaboration (Burda & Gavrikova, 2022), and the influence of trust (Steinbruch et al., 2022).

The third trend directs studies toward governance mechanisms and adaptive capacity. Orchestration and governance in IE relate to studies that explore management, coordination, and how different governance mechanisms can affect the perception of IE participants (Burda & Gavrikova, 2022; Santos et al., 2022). Regarding response capacity in contexts of change and emergencies, research suggests studies on the ability of IEs to deal with uncertainty, dynamic changes, and emergencies, with an emphasis on uncertainty (Sahasranamam & Soundararajan, 2022; Gomes et al., 2022).

Digital IEs guided the fourth research stream and indicated research opportunities related to digital innovation, digital platforms, and artificial intelligence. The complexity and ambiguity of Digital IE result in several risks, potentially causing failures in digital innovation, such as resistance to changes and incompatibility with existing structures (Li et al., 2022). Future studies should comprehensively explore factors affecting network efficiency and security (Cui et al., 2022) and consider other aspects influencing stakeholders' collaboration strategies (Li et al., 2022). In the subcategory of digital platforms, researchers can analyze the diffusion phases on digital platforms and investigate how complementarity strategies between stakeholders and platform mechanisms influence the adoption of innovative products (Li-Ying et al., 2022). Research suggestions for the artificial intelligence subcategory refer to studies and research on the application, impact, and dynamics of artificial intelligence (AI) in digital IEs, including impacts on production processes, value co-creation, operation, and governance (Sun et al., 2022).

New technologies have played a crucial role in creating value generation opportunities through the development of innovative products, services, and business models (Granig & Hilgarter, 2022). In this context, Song (2022) emphasizes that the pandemic has pushed companies to exceed their traditional limits, and collaboration with external innovation entities can build a boundaryless, adaptive, and collaborative Innovation Ecosystem (IE). Li-Ying et al. (2022) highlighted the expansion of IE boundaries in relation to major scientific organizations, while Gomes et al. (2022) suggested a framework for managing uncertainties in global IEs, emphasizing the importance

of external partnerships and technological platforms for innovation and access to specialized knowledge. In this regard, Audy and Fiorin (2021) discussed how the pandemic, by challenging the replication of models in digital formats, offered the opportunity to expand relationship networks beyond geographical borders, leading to the emergence of hybrid IEs. The authors pointed out the challenges of conceiving spaces and physical and virtual presences, emphasizing the intensification of competition in the virtual environment and the promising possibilities of partnerships for creating joint spaces.

The fifth trend highlights research opportunities aimed at sustainability and green innovation. Future research may involve investigating actions related to the United Nations Sustainable Development Goals (SDGs) (Miranda et al., 2022), as well as the impact of sustainable policies and practices on IEs (Zheng & Cai, 2022). Finally, the sixth trend seeks to verify and validate the methods researchers use in other IE contexts and develop analytical tools, models, and simulations to measure the different factors that affect the performance of IEs. Considering this trend, we highlight the need for studies that develop a scale to measure the life cycle stage of IE and the corresponding level of coordination (Santos et al., 2022).

Fischer et al. (2022) state the need for advances in theoretical and empirical research, suggesting in-depth research on topics such as elaborating criteria and metrics to identify the relational essence of IEs. Unlike traditional organizational networks, ecosystems represent networks that generate a cohesive system-level outcome and represent a digital solution to the challenge of collective action, in which multiple stakeholders voluntarily come together to create a system-level output (Autio & Thomas, 2021). In this context, Gomes et al. (2022) described the IE as a unique phenomenon, akin to a meta-organization, and introduced the concept of ecosystem management as a function involving managing the co-evolution of multi-level configurations, regulating the ecosystem, and orchestrating progressive learning.

In parallel, Aarikka-Stenroos et al. (2021) argued that the transition from a linear economy to a circular economy will require the interaction of multiple actors, and the notion of the ecosystem becomes relevant for understanding how linear flows can become circular ones. Consequently, this transition will influence the configuration of ecosystems towards circularity and contribute to the development of a new field of research (Gomes et al., 2023). Additionally, considering the complexity of certain phenomena, Autio and Thomas (2021) argued that understanding how different types of ecosystems relate to each other and how competitive interactions occur represents a significant challenge for researchers.

5 Conclusion

This study confirmed the significance of (IEs) in scientific research by indicating the growth of studies in various countries and knowledge areas. Our objective was to map the research production on IEs, its evolution, and research trends. Therefore, this article presented the most relevant studies in this area through the analysis of the research front, highlighting the key articles, journals, countries, and categories that addressed this theme. Additionally, the analysis of the intellectual base enabled the identification of the most influential works and authors in this field of investigation.

In comparing the most cited countries, we highlighted the significance of research conducted in China, the United States, Brazil, and the United Kingdom, as well as the partnerships developed between these and other countries. The analysis also revealed that the ten most cited articles correspond to 1.48% of the sample but generate about 45% of the total citations, while the ten most frequent journals represent 29% of relevant publications. Additionally, the co-citation

analyses of the articles and references with the strongest citation impact allowed us to map the conceptual trajectory of the field, identifying the predominant themes and topics, as well as the periods when these references garnered the most attention from researchers.

The findings of this study point to promising directions for future research. We have identified six thematic streams that interconnect different aspects of Innovation Ecosystems (IEs): strategic approach and performance, dynamics of relationships among actors, governance mechanisms and adaptive capacity, digital IE, responsible IE, and research and development. In their studies, Suominen et al. (2019) suggested a shift in the focus of the scientific literature from when and why ecosystems emerge, as highlighted by Jacobides et al. (2018), to an investigation into the nature and functioning of ecosystems. Building on this, we noted that more recent studies emphasize the importance of exploring the relational essence of IEs (Fischer et al., 2022), broadening the perspective to understand the complex dynamics of influences and relationships among the diverse interdependent actors interacting in these environments.

Unlike previous bibliometric reviews that focused on a single database, our approach confirmed the importance of expanding the scope of analysis by including the bibliographic repositories of WoS and Scopus. However, despite having analyzed specific documents from each database, a limitation identified in our research was the exclusive focus on peer-reviewed articles. This results in the exclusion of contributions from conferences, books, and other potentially relevant sources that could provide additional insights into emerging themes in the field of Innovation Ecosystems (IEs) studies. Additionally, including other databases could provide additional sources and records.

In terms of contributions, we provide a comprehensive and detailed analysis of the research landscape on Innovation Ecosystems (IEs), highlighting the evolution of studies from historical approaches to contemporary trends in the field. We identified emerging thematic trends that should guide future advancements in this area, based on elements deemed critical by researchers. In the social context, IEs stimulate the development of new businesses and job creation, as well as the development of new technologies and innovative solutions for social and environmental problems.

Our study also provides significant implications for management within Innovation Ecosystems (IEs). The literature underscores the growing importance of managers in implementing effective coordination strategies that foster relational resources and competitive advantages within IEs. We identified the necessity of cultivating a culture of continuous innovation and adaptability, aligning sustainable practices with innovative objectives. Moreover, research emphasizes the crucial role of effective leadership and structured governance for the efficiency and sustainability of IEs. Therefore, this article effectively contributes to future research that aligns with the key theoretical and practical challenges that still need to be overcome to expand the knowledge of IEs.

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6 References

Aarikka-Stenroos, L., Ritala, P., & Thomas, L. D. (2021). *Circular economy ecosystems: A typology, definitions, and implications*.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem. *Harvard Business Review, 84*(4), 98-107.

Adner, R. (2017). Ecosystem as Structure. *Journal of Management, 43*(1), 39-58.

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal, 31*(3), 306-333.

Adner, R., & Kapoor, R. (2016). Innovation ecosystems and the pace of substitution: Re-examining technology S-curves. *Strategic Management Journal, 37*(4), 625-648.

Almpanopoulou, A., Bergman, J. P., Ahonen, T., Blomqvist, K., Ritala, P., Honkapuro, S., & Ahola, J. (2017). Emergence of energy services ecosystems: scenario method as a policy enabler. *Journal of Innovation Management, 5*(1), 58-77.

Arena, M., Azzone, G., & Piantoni, G. (2022). Uncovering value creation in innovation ecosystems: paths towards shared value. *European Journal of Innovation Management, 25*(6), 432-451.

Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics, 11*(4), 959-975.

Arthur, D., Moizer, J., & Lean, J. (2022). A systems approach to mapping UK regional innovation ecosystems for policy insight. *Industry and Higher Education, 0*(0), 1-15.

Audy, J., & Fiorin, F. (2021). Ressignificando os espaços dos ecossistemas de inovação: em direção ao modelo híbrido. In: Teixeira, C. S., & Depiné, A. *As cidades e a COVID-19: Necessidades, expectativas e tendências trazidas pela pandemia* (pp. 213-219).

Autio, E., & Thomas, L. D. W. (2014). Innovation Ecosystems: Implications for Innovation Management? In. M. Dodgson, D. M. Gann, & N. Phillips (Eds), *The Oxford Handbook of Innovation Management*. Oxford: Oxford University Press (pp. 204-288).

Autio, E., & Thomas, L. D. (2021). Researching ecosystems in innovation contexts. *Innovation & Management Review, 19*(1), 12-25.

Boni, A. A., & Gunn, M. (2021). Building and leveraging the innovation ecosystem and clusters: universities, startups, accelerators, alliances, and partnerships. *Journal of Commercial Biotechnology, 26*(1), 13-20.

Bornmann, L., & Mutz, R. (2015). Growth rates of modern science: A bibliometric analysis based on the number of publications and cited references. *Journal of the Association for Information Science and Technology, 66*(11), 2215–2222.

Bragge, J., Kauppi, K., Ahola, T., Aminoff, A., Kaipia, R., & Tanskanen, K. (2019). Unveiling the intellectual structure and evolution of external resource management research: Insights from a bibliometric study. *Journal of Business Research, 97*, 141-159.

Burda, E., & Gavrikova, E. (2022). Innovation ecosystems in developing markets: empirical evidence from Russian electric power industry. *Technology Analysis & Strategic Management, 36*(7), 1443–1460. https://doi.org/10.1080/09537325.2022.2099263

Carayannis, E. G., & Campbell, D. F. J. (2009). 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management, 46*(3-4), 201-234.

Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology, 57*(3), 359–377.

Clarysse, B., Wright, M., Bruneel, J., & Mahajan, A. (2014). Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. *Research Policy, 43*(7), 1164-1176.

Cui, Z., Liu, X., Qin, H., & Ji, H. (2022). Differential game analysis of enterprises investing in new infrastructure and maintaining social network security under the digital innovation ecosystem. *IEEE Access, 10*, 69577-69590.

Cukier, W., Gagnon, S., Dalziel, M., Grant, K., Laplume, A., Ozkazanc-Pan, B., & Saba, T. (2022). Women entrepreneurship: towards an inclusive innovation ecosystem. *Journal of Small Business & Entrepreneurship, 34*(5), 475-482.

Dattée, B., Alexy, O., & Autio, E. (2018). Maneuvering in poor visibility: How firms play the ecosystem game when uncertainty is high. *Academy of Management Journal, 61*(2), 466-498.

Dedehayir, O., Mäkinen, S. J., & Ortt, J. R. (2018). Roles during innovation ecosystem genesis: A literature review. *Technological Forecasting and Social Change, 136*, 18-29.

Dias Sant'Ana, T., Souza Bermejo, P. H., Moreira, M. F., & Souza, W. V. B. (2020). The structure of an innovation ecosystem: foundations for future research. *Management Decision, 58*(12), 2725-2742.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review, 14*(4), 532-550.

Fan, X., Shan, X., Day, S., & Shou, Y. (2022). Toward green innovation ecosystems: past research on green innovation and future opportunities from an ecosystem perspective. *Industrial Management & Data Systems, 122*(9), 2012-2044.

Feng, L. J., Lu, J. R., & Wang, J. F. (2021). A Systematic Review of Enterprise Innovation Ecosystems. *Sustainability, 13*(10), 26.

Filser, L. D., Silva, F. F., & Oliveira, O. J. (2017). State of research and future research tendencies in lean healthcare: a bibliometric analysis. *Scientometrics, 112*, 799–816.

Fischer, B., Gomes, L., Bernardes, R. C., & Facin, K. (2022). Guest editorial Innovation ecosystems: new perspectives and the way forward. *Innovation & Management Review, 19*(1), 2-11.

Foguesatto, C. R., Santini, M. A. F., Martins, B. V., Faccin, K., Mello, S. F., & Balestrin, A. (2021). What is going on recently in the innovation ecosystem field? A bibliometric and content-based analysis. *International Journal of Innovation Management, 25*(07), 1-39.

Gawer, A., & Cusumano, M. A. (2002). *Liderança de plataforma: como Intel, Microsoft e Cisco impulsionam Inovação da Indústria*. Harvard Business School Press.

Gomes, L. A. V., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. *Technological Forecasting and Social Change, 136*, 30-48.

Gomes, L. A. D. V., Santos, M. G., & Facin, A. L. F. (2022). Uncertainty management in global innovation ecosystems. *Technological Forecasting and Social Change, 182*, 121787.

Gomes, L. A. V., de Faria, A. M., Braz, A. C., de Mello, A. M., Borini, F. M., & Ometto, A. R. (2023). Circular ecosystem management: Orchestrating ecosystem value proposition and configuration. *International Journal of Production Economics, 256*, 108725.

Granig, P., Hilgarter, K. (2022). Management Perception of Digital Innovation: How Innovation Managers Perceive Digital Innovation in their Organizational Setting in Austria. *Journal of Innovation Management, 10*(3), 75-90. DOI: https://doi.org/10.24840/2183-0606_010.003_0004

Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation, 90-91*, 1-12.

Gu, Y., Hu, L., Zhang, H., & Hou, C. (2021). Innovation ecosystem research: emerging trends and future research. *Sustainability, 13*(20), 11458.

Iansiti, M., & Levien, R. (2004). *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Harvard Business School Press, Boston, Massachusetts.

Iddy, J. J., & Alon, I. (2019). Knowledge management in franchising: a research agenda. *Journal of Knowledge Management, 23*(4), 763-785.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal, 39*(8), 2255-2276.

Jin, Z., Zeng, S., Chen, H., & Shi, J. J. (2022). Creating value from diverse knowledge in megaproject innovation ecosystems. *International Journal of Project Management, 40*(6), 646-657.

Kwak, K., Kim, W., & Park, K. (2018). Complementary multiplatforms in the growing innovation ecosystem: Evidence from 3D printing technology. *Technological Forecasting and Social Change, 136*, 192-207.

Klimas, P., & Czakon, W. (2022). Gaming innovation ecosystem: actors, roles and co-innovation processes. *Review of Managerial Science*, 16, 2213–2259.

Li, Yan, He, M., Zou, Z., Bian, X., Huang, X., Yang, C., Wei, S., & Dai, S. (2019). Artificial liver research output and citations from 2004 to 2017: a bibliometric analysis. *PeerJ, 6*(6178), 1-22.

Li, Y. R. (2009). The technological roadmap of Cisco's business ecosystem. *Technovation, 29*(5), 379-386.

Li, Y. [Ying], Wang, Y., Wang, L., & Xie, J. (2022). Investigating the effects of stakeholder collaboration strategies on risk prevention performance in a digital innovation ecosystem. *Industrial Management & Data Systems, 122*(9), 2045-2071.

Li-Ying, J., Sofka, W., & Tuertscher, P. (2022). Managing innovation ecosystems around Big Science Organizations. *Technovation, 116*, 102523.

Miranda Junior, N. D., Viana, L. F. C., Carneiro, D. K. O., Filgueiras, R. C., & Goulart, G. S. (2022). Initial actions of the Brazilian regional innovation ecosystem against the COVID-19 pandemic. *International Journal of Innovation, 10*(2), 291-318.

Minayo, M. C. S. *O desafio do conhecimento: pesquisa qualitativa em saúde*. 7 ed. São Paulo: Hucitec; Rio de Janeiro: Abrasco, p. 197-211, 2000.

Misra, A., & Mention, A. L. (2022). Exploring the food value chain using open innovation: A bibliometric review of the literature. *British Food Journal, 124*(6), 1810-1837.

Moore, J. F. (1993). Predators and Prey: A New Ecology of Competition. *Havard Business Review*.

Mukherjee, D., Lim, W. M., Kumar, S., & Donthu, N. (2022). Guidelines for advancing theory and practice through bibliometric research. *Journal of Business Research*, *148*, 101-115.

Nambisan, S., & Baron, R. A. (2013). Entrepreneurship in Innovation Ecosystems: Entrepreneurs' Self–Regulatory Processes and Their Implications for New Venture Success. *Entrepreneurship Theory and Practice, 37*(5), 1071-1097.

Ngongoni, C. N., Grobbelaar, S., & Schutte, C. S. (2022). Making Sense of the Unknown: Using Change Attractors to Explain Innovation Ecosystem Emergence. *Systemic Practice and Action Research, 35*(2), 227-252.

Oh, D.-S., Phillips, F., Park, S., Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation, 54*, 1-6.

Ojaghi, H., Mohammadi, M., & Yazdani, H. R. (2019). A synthesized framework for the formation of startups' innovation ecosystem A systematic literature review. *Journal of Science and Technology Policy Management, 10*(5), 1063-1097.

Pasi, B. N., Mahajan, S. K., & Rane, S. B. (2022). Development of innovation ecosystem framework for successful adoption of industry 4.0 enabling technologies in Indian manufacturing industries. *Journal of Science and Technology Policy Management, 13*(1), 154-185.

Pedrinho, G. C., Carvalho, D. N., Teixeira, C. S., & Lezana, A. G. R. (2020). Universidade e o Ecossistema de Inovação: Revisão Estruturada de Literatura. *NAVUS - Revista de Gestão e Tecnologia, 10*(1), 1-223.

Pigford, A. A. E., Hickey, G. M., & Klerkx, L. (2018). Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions. *Agricultural Systems, 164*, 116-121.

Pigola, A., Costa, P. R., Porto, G., & Mazieri, M. R. (2022). Towards a comprehensive conceptualization of relational capabilities: An innovation management perspective. *Journal of Innovation Management, 10*(4), 1-25. DOI: https://doi.org/10.24840/2183-0606_010.004_0001

Prado, J. W., Alcântara, V. C., Carvalho, F. M., Vieira, K. C., Machado, L. K. C., & Tonelli, D. F. (2016). Multivariate analysis of credit risk and bankruptcy research data: a bibliometric study involving different knowledge fields (1968-2014). *Scientometrics, 106*, 1007-1029.

Pushpananthan, G., & Elmquist, M. (2022). Joining forces to create value: The emergence of an innovation ecosystem. *Technovation, 115*, 1-15.

Remneland Wikhamn, B., & Styhre, A. (2022). Open innovation ecosystem organizing from a process view: a longitudinal study in the making of an innovation hub. *R&D Management*.

Reynolds, E. B., & Uygun, Y. (2018). Strengthening advanced manufacturing innovation ecosystems: The case of Massachusetts. *Technological Forecasting and Social Change, 136*, 178-191.

Ritala, P., & Almpanopoulou, A. (2017). In defense of 'eco' in innovation ecosystem. *Technovation, 60-61*, 39-42.

Rohrbeck, R., Holzle, K., & Gemunden, H. G. (2009). Opening up for competitive advantage - How Deutsche Telekom creates an open innovation ecosystem. *R&D Management, 39*(4), 420-430.

Sahasranamam, S., & Soundararajan, V. (2022). Innovation Ecosystems: What Makes them Responsive during Emergencies? *British Journal of Management, 33*(1), 369-389.

Santos, D. A. G., Zen, A., & Bittencourt, B. A. (2022). From governance to choreography: coordination of innovation ecosystems. *Innovation and Management Review, 19*(1), 26-38.

Song, Y. (2022). How do Chinese SMEs enhance technological innovation capability? From the perspective of innovation ecosystem. *European Journal of Innovation Management, ahead-of-print*(ahead-of-print).

Steinbruch, F. K., Nascimento, L. D., & de Menezes, D. C. (2022). The role of trust in innovation ecosystems. *Journal of Business & Industrial Marketing, 37*(1), 195-208.

Sun, Yu, Xu, X., Yu, H., & Wang, H. (2022). Impact of value co-creation in the artificial intelligence innovation ecosystem on competitive advantage and innovation intelligibility. *Systems Research and Behavioral Science, 39*(3), 474-488.

Suominen, A., Seppänen, M., & Dedehayir, O. (2019). A bibliometric review on innovation systems and ecosystems: a research agenda. *European Journal of Innovation Management, 22*(2), 335-360.

Thomas, L. D. W., & Autio, E. (2020). *Innovation ecosystems in management: An organizing typology*. Oxford Encyclopedia of Business and Management, Oxford University Press, Oxford.

Tsujimoto, M., Kajikawa. Y., Tomita, J., & Matsumoto, Y. (2018). A review of the ecosystem concept - Towards coherent ecosystem design. *Technological Forecasting and Social Change, 136*, 49-58.

Xiong, B., Kuan Lim, E.T., Tan, C.-W., Zhao, Z., & Yu, Y. (2022). Towards an evolutionary view of innovation diffusion in open innovation ecosystems. *Industrial Management & Data Systems, 122*(8), 1757-1786.

Xu, G., Wu, Y., Minshall, T., & Zhou, Y. (2018). Exploring innovation ecosystems across science, technology, and business: A case of 3D printing in China. *Technological Forecasting and Social Change, 136*, 208-221.

Yaghmaie, P., & Vanhaverbeke, W. (2020). Identifying and describing constituents of innovation ecosystems A systematic review of the literature. *EuroMed Journal of Business, 15*(3), 283-314.

Yu, X., Qi, Y., Yu, L., & He, Y. (2022). Temporal and Spatial Evolution of Coupling Coordination Degree of Industrial Innovation Ecosystem-From the Perspective of Green Transformation. *Sustainability, 14*(7), 1-18.

Zen, A. C., Santos, C. A. F. D., Santos, D. A. G. D., da Rosa, J. R., & Spindler, E. D. S. (2023). Exploring the theoretical foundations of innovation ecosystems between 2006 and 2020: an analysis at the different approaches. *International Journal of Innovation Science*.

Zheng, X. R., & Cai, Y. Z. (2022). Transforming Innovation Systems into Innovation Ecosystems: The Role of Public Policy. *Sustainability, 14*(12), 26.

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