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Worldwide Innovation and Technology Environments: Research and Future Trends Involving Open Innovation

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Abstract: Innovation environments are places where open innovation and technology are boosted. The purpose of this paper is to present the evolution of innovation and technology environments through the most covered topics in the scientific literature. In this sense, technology transfer has been the subject of research since 1975; however, in the period from 2006–2021, the focus shifted to innovation. It was possible to observe an exponential growth of the term, "innovation", but it is no longer the central theme and is linked to different terms related to different ways of innovating, characterizing open innovation variables. In this article, 4650 academic studies involving innovation environments were reviewed. The analysis identified the nomenclatures that characterized innovation environments and the particularities of these environments. The contributions, such as which countries developed more research in this area, and the analysis of which environments were more common in these countries were also presented. Additionally, some methodological and theoretical gaps in the current research were identified, providing pathways to support future research and practices seeking a better understanding and development of innovation environments. This article can also serve as a basis for a consultation for members of the quadruple helix, who wish to install or create environments for innovation and attract companies or investments to develop any open innovation activity.

Keywords: innovation environment; technology transfer; innovation ecosystem; open innovation

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1. Introduction

Innovation environments are places where technology and innovation are boosted and encouraged among companies [1]. These spaces for research and development aim to sustain the character of "public good", uniting and creating compatible public policies and scientific studies [2]. A region with a better innovation environment can provide companies with a better infrastructure, better human capital, and greater knowledge resources [3]. The companies seeking innovation environments must rely on capabilities based on the technologies transmitted and supported by larger companies geographically placed in prominent clusters [4]. An innovation environment focusing on dynamics and co-evolution is considered as one of the main drivers of open innovation and subsequent technology transfer [5].

Due to risk and uncertainty [6], it is difficult to predict the achievements of innovation initiatives [7]. Seeking help in an innovation environment best suited to a particular type of innovation can aid the development of different types of open innovation, increasing the positive impacts and reducing risks and uncertainty [6]. On the other hand, managers have doubts about how to achieve higher levels of industrial performance through the correct use of technologies generated by open innovation processes [8], which can be accelerated by technology transfer. The technology transfer process allows the actors of the quadruple helix to access new manufacturing methods, technologies, or specific knowledge [9]. This expands the access to scientific and technological innovations and, to this end, allows the creation of new products, services, materials, and applications [10].

Given the adherence of contextualized themes, and based on the literature, innovation and technology transfer are stimulated in innovation environments, but these environments must be dynamic, entrepreneurial, and be integrated with academic and scientific research. Over the years, different studies have characterized innovation environments, encompassing different research areas and regions into different clusters. The data from European countries show that countries that are leaders in innovation perform better economically than countries with low levels of investment in innovation activities and technology transfer [11]. Analyzing the level of development and the characteristics of innovation environments in different countries with relationship networks, can aid in setting a future trend for research that helps emerging countries, as well as countries that are looking to expand their research and public policies of innovation environments [12]. In this sense, the purpose of this paper is to present the evolution of the innovation and technology environment through the most covered topics in the scientific literature. To achieve this goal, five research questions (RQ) will be answered: RQ1—What is the evolution of studies related to the innovation and technology environments over time?; RQ2—Which research areas have the greatest connection to the development of the innovation and technology environments?; RQ3—Studies related to the innovation and technology environments are most prominent in which countries?; RQ4—In the innovation and technology environments, is there evidence of cross-country specifications?; RQ5—What is the trend for open innovation and future research related to innovation and technology environments?

To answer these questions, a bibliometric review was developed, which presented an analysis of all the research conducted over the years involving innovation and technology environments. This study indicates opportunities for developing research focused on the most widespread environments, showing which countries stand out in this theme, showing the future trends, and indicating in which environments company managers can seek support.

2. Materials and Methods

In this section, we present a brief review of the literature on open innovation and then present the methodology of the scientific research.

2.1. Literature Review of Open Innovation

The challenges introduced by global competition force companies to grow and lead innovation initiatives [13]. Therefore, innovation has become the goal for companies interested in expanding business, involves different types of change, and depends on the organization's resources, capabilities, strategies, and requirements [14]. The Organization for Economic Cooperation and Development [15] classifies innovation into product, service, process, management, and marketing innovations [16,17]. Open innovation covers many areas, such as the development of new products, services, methods, processes, raw materials, markets, marketing, and organizational structures [18,19]. According to [20], different types of innovation influence companies' overall performance, generating risk, and uncertainty that may hinder organizations' decision-making processes [21,22].

So, it is important to explore different types of innovation and digital processes [23], as well as studying the impact that innovation can have in academic and practical spheres [24,25]. Thus, during this study of different types of innovation, the process of open innovation emerges and is adapted according to companies' needs [26]. Open innovation is cyclical and follows a quadruple helix, composed of actors from the industry, government, universities, and society [27]. A critical part of the open innovation process involves the knowledge management required to achieve higher levels of industrial performance through the correct use of technologies [8]. Innovation is a cutting-edge goal for companies interested in expanding their businesses, involves different types of change and depends on an organization's resources, capabilities, strategies, and requirements [25]. As a result, customer attraction and company performance are influenced by innovative strategies and activities [27]. For [8], the dynamics of innovation are cyclical and follow a quadruple helix, composed of actors from the industry, government, and universities, and could be leveraged in innovation environments. Without the need of developers, companies manage to keep up-to-date through research and creations developed mainly by universities, startups, and professional specialists [28]. In general, companies tend to innovate to react to a market opportunity [29], where cooperative agreements between governments and companies, induced by the innovation environment, can generate the effective production of innovation [30].

2.2. Methodology of Scientific Research

This study uses the bibliometric review method (keyword co-occurrence and conceptual thematic mapping) to explore the research questions, being a transparent and reproducible study and review, increasing the reliability of the results [31]. Bibliometric review techniques were based on a quantitative approach designed to identify, describe and evaluate the existing research [32]. The steps followed in the bibliometric review are presented in Figure 1.

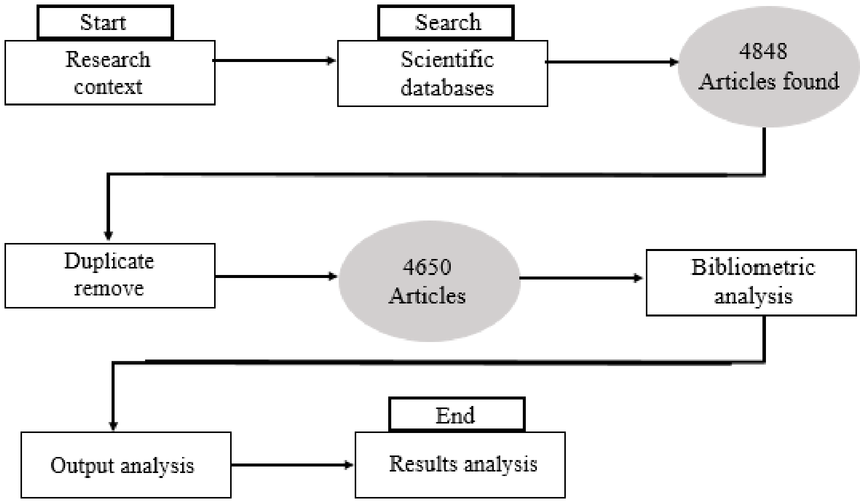

Figure 1. Bibliometric analysis steps.

The basis for this review is a collection of bibliographic data available in databases. The two main bibliographic databases used are Web of Science (WoS) and Scopus [33]. The WoS database has more restricted coverage than Scopus. The Scopus database has more than 20,000 peer-reviewed journals, while Web of Science includes only ISI-indexed journals and is limited to 12,000 journals [34]. As the article seeks to investigate worldwide innovation and technology environments, the keywords searched were "technology park" OR "innovation ecosystem" OR "innovation environment" OR "agro-technology park" OR "science and technology parks" OR "Technoparks" OR "Technological pole" OR "agricultural technology park" OR "technological cluster" OR "business incubators" OR "Technology incubators" OR "agritech". The keywords searched were defined according to [35], which explains the main innovation and technology environments, according to a literature review, and how companies benefit from these environments. No additional filters were added, so the searches include articles from all areas that have some keywords in the title, abstract, keywords, or topics, from 1975 to 2021. The only exclusion criterion was the removal of duplicate articles.

To perform the bibliometric analysis, we used the VOSviewer software, as it can adjust and customize different graphical representations of bibliometric maps [36]. It offers a high degree of flexibility for sorting, building, and modifying network maps, selecting and adjusting different combinations to create keyword maps based on the strength of the co-occurrence data. This flexibility builds multiple network maps of our large dataset to obtain meaningful insights into the publishing behavior and performance of the innovation and technology environment search domain, which would not be feasible using manual methods [37]. To aid in the analysis, the multivariate analysis technique PCA (Principal Component Analysis) procedure using ChemoStat® software was used. Through the PCA procedure, we organized the most predominant characteristics in each innovation environment [38].

3. Results

In this section, the results found through the analysis of the current literature were presented, with a bibliometric analysis of the chronological scheme of changing the meaning of the basic terms and main research theme depending on three periods under consideration, the environmental characteristics and, finally, the analyses of the countries.

3.1. Bibliometric Analysis

A total of 4848 studies were found, which, after removing the duplicates, resulted in a final sample of 4650 studies. Figure 2 shows the evolution of studies involving the innovation and technology environment, from 1975 to the present day.

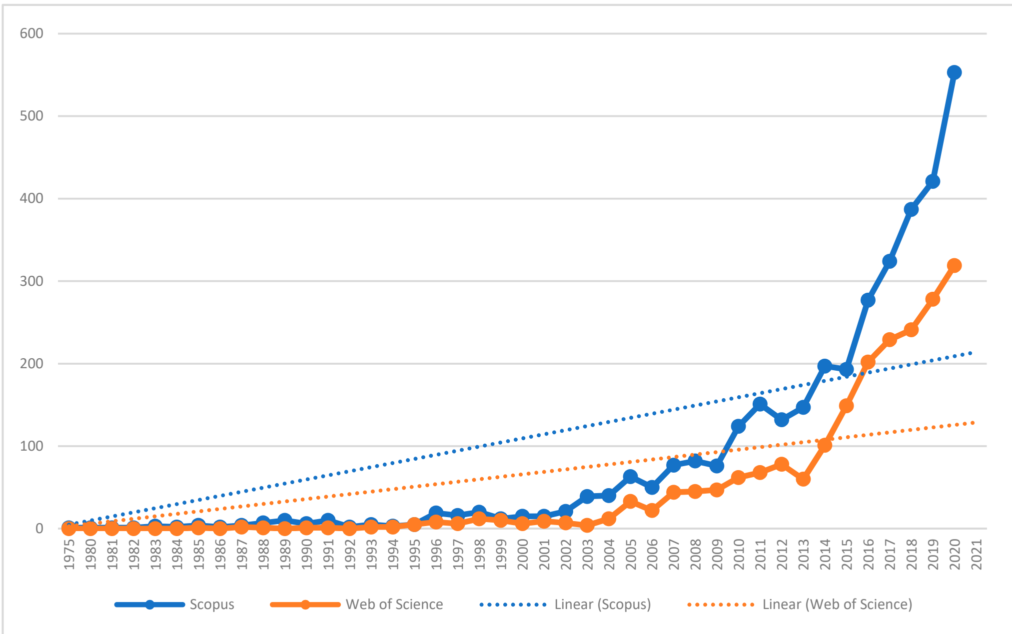

Figure 2. Evolution of studies involving innovation environment over the years.

The figure with the evolution of the studies shows the behavior of the number of studies, and the trend line helps to show how the studies will behave in the coming years. The trend line indicates that, until 2015, the number of studies was below average, but in 2016 there was a considerable increase, which is predicted to continue increasing in the coming years. However, to indicate the trend for the coming years, it is first necessary to understand how the studies have evolved since 1975 and why there was an exponential growth in 2016.

To understand the study's evolution, bibliometric performance analyzes were performed over the periods with the help of the VOSviewer software. VOSviewer also used distance-based mapping instead of graphics-based maps. Distance-based mapping is best suited for mapping the performance, networks, and knowledge structure of the domain being surveyed, and they are represented as colored circles in the network. The size of the circle reflects the size of the entity, and the closer the two entities are to each other on the map, the more closely they are related to each other in reality. The colors represent groups of strongly linked entities [39]. When two entities in a network are directly connected, VOSviewer will draw a line between them to show this [37]. For the analysis, all 4650 studies were included in VOSviewer, and then analyzed using the following parameters: (i) type of analysis: co-occurrence of keywords; (ii) minimum number of co-occurrence of a keyword: 10; (iii) number of keywords to be selected: 423; (iv) verify selected keywords. In the latter step, a manual analysis of each of the identified keywords was performed, and similar keywords such as "business incubator" and "business incubators" were gathered in the same cluster.

For a better analysis, the studies were divided into five periods, from 1975 to 1999, from 2000 to 2005, from 2006 to 2010, from 2011 to 2015, and from 2016 to the present day. The period-by-period analyses answer RQ1—What is the evolution of studies related to the innovation and technology environments over time? Each of these periods is marked by some advancement or world event related to technology or innovation, which are explained in the following sections.

3.1.1. Bibliometric Performance of 1975 to 1999

The first period is from 1975 to 1999, characterized by the consistency of studies, but with few representations (158 papers), as shown in Figure 3.

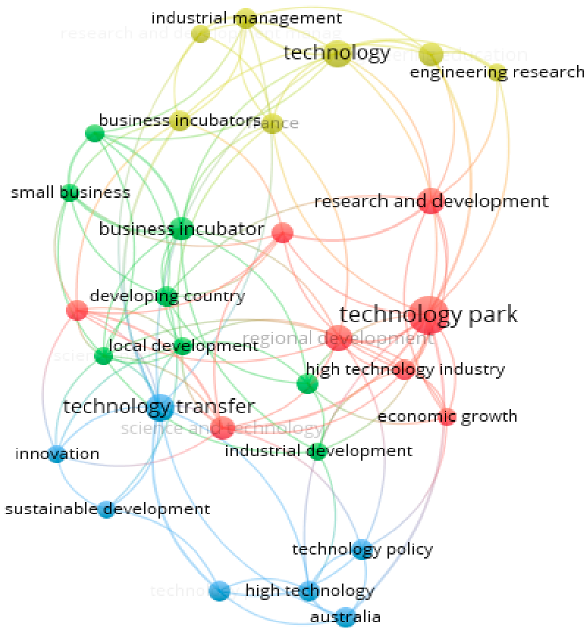

Figure 3. Cluster map 1975–1999.

The 1975–1999 period has four clusters: blue cluster, red cluster, green cluster, and yellow cluster. Figure 3 shows that the keywords do not have strong relationships with each other. Nevertheless, the technology park cluster stands out among the others.

The red cluster has the largest number of studies and "technology park" is the main keyword used. In [40], a technology park is conceptualized as an "enterprise-generating enterprise" that assists businesses during the start-up and take-off stages. The definition of a technology park is similar to the definition of the keyword "business incubator" that represents the green cluster, which also offers assistance to early-stage companies [11]. Nevertheless, the two clusters relate to words with different characteristics. A technology park relates to research development, the high technology industry, and economic growth. On the other hand, a business incubator is related to keywords that refer to the development of a specific space, represented by a developing country and local development. The keyword "small business" is also related to the green cluster, demonstrating the influence of business incubators on small businesses [41].

Regarding the red cluster, "research and development" is the keyword that most closely relates to the technology park, proving the link between institutions that stimulate research for the development of organizations. In the historical context, [42] cites the industrial policy changes in Japan in the late 1970s and early 1980s, a time that represented the country's recovery from the damage of World War II. The authors point out that, among these changes, the proximity between research associations and industrial organizations increased, resulting in the creation of knowledge and collaboration in the development of industries in the country.

The blue cluster and yellow cluster present as main keywords: "technology transfer" and "technology". According to [43], technology transfer involves the transfusion of knowledge between educational and research institutions and industrial environments and emphasizes the importance of business incubators. The authors state that the know-how is the indispensable component for this process, representing the ability to mold talent, technology, and capital to expand companies.

The analysis of this period showed the concern and attention to research related to technology. Among the main keywords of the four clusters, three presented the word "technology". The keyword "innovation" did not stand out and was connected to the technology transfer concept.

3.1.2. Bibliometric Performance of 2000 to 2005

In the period from 2000 to 2005, there was an increase in studies, but not to the level of later studies, with 226 published papers. The technology transfer reached higher levels in the scientific literature, while the relevance of topics involving innovation and business incubators increased. Figure 4 shows the period cluster map.

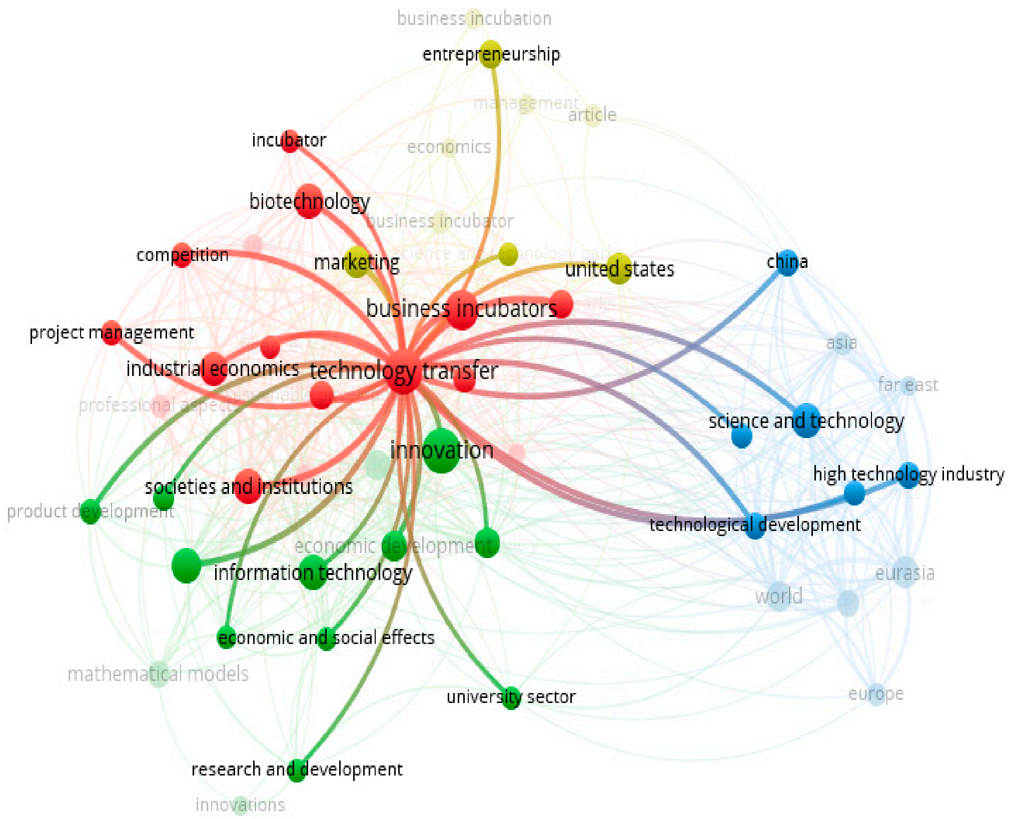

Figure 4. Cluster map 2000–2005.

The period from 2000–2005 also has four clusters. Technology transfer is the central research theme, but with an increase in the research of innovation compared to the previous period. "Technology transfer" (red cluster) presents a connection to all the other keywords. The keyword defines the transfer of technologies, techniques, or knowledge that were developed in one organization and then adopted by another institution [44]. In the early 2000s, the expansion of telecommunication technologies occurred [45], which may have generated an influence on the themes related to the exchange of knowledge and technologies between organizations.

The keyword "innovation" (green cluster) is relevant in the scientific scenario. The emergence of startups in the early 2000s [45], may be a factor that explains the beginning of the increase in studies related to the innovation of organizations. The startups stood out by using technologies and innovations to transform businesses into scalable and replicable organizations [46]. The startups demonstrated an organizational concept that uses innovation as a basis for business structure, demonstrating a transformation of the industrial environment. With the emergence of startups, the concept of open innovation also began to emerge, bringing the possibility of developing new businesses and new solutions in the most diverse areas, as shown in Figure 4.

The yellow and blue clusters appear with less expressions. The yellow cluster presents, for the first time, the keyword "entrepreneurship", still with little relevance to studies, associated with the keywords "marketing", as well as the country of the United States. The blue cluster presents keywords related to the development of technology in the industry. The keyword "science and technology" has the greatest relevance, associated with the country of China.

3.1.3. Bibliometric Performance of 2006 to 2015

The period from 2006 to 2015 confirmed the rise and consolidation of innovation as the main research theme concerning technological development environments. Figure 5 shows the period cluster map.

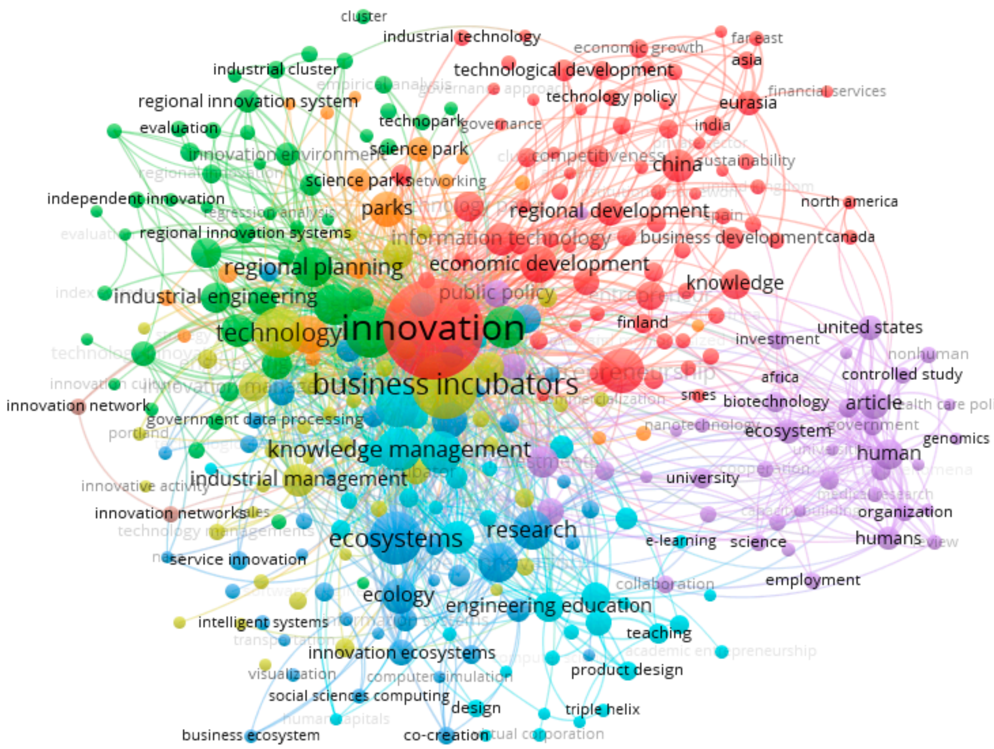

Figure 5. Cluster map 2006–2015.

In the period from 2006 to 2015, there was also a significant increase in studies related to the research themes, representing 1571 papers. "Innovation" represented the main keyword of the period, was present as the central theme, and linked to a large network of terms used in the research. With the growth of startups in the industrial environment, the activities of technology accelerators and incubators were required, and themes related to innovation received much attention [47]. Innovation was the central theme of the research, showing that most of the studies analyzed bring some kind of innovation. Although not appearing as the predominant keyword, the increase in the number of studies and the large volume of secondary keywords showed that open innovation and the different ways of innovating received increasing attention over the years.

"Business incubators", which had already been prominent in previous periods, received great attention from researchers in the 2006–2015 period, representing the top keyword after "innovation". Other innovation environments also began to emerge during this period. Figure 3 demonstrates the emergence of studies involving technology parks and science and technology parks, and keywords referring to the creation of a context for technology development began to gain prominence, such as "ecosystems," "regional planning," and "economic development". Innovation environments are also called innovation ecosystems in some studies, which approached universities to accelerate innovation processes.

During this period, studies began to spread to different countries and regions, involving regional development and public policies. Studies became more widespread and were observed from different points of view, becoming increasingly specific to different industry and research contexts.

From this period, an exponential growth in studies began, marked by the emergence of the concept of Industry 4.0, an initiative of the German government, in partnership with universities and the private sector, to boost the long-term competitiveness of the manufacturing industry through the digitization of processes, which aroused the interest of the international academic community [48].

The great marker of this period is the beginning of research involving Industry 4.0. In addition to the opportunities that new forms of management and the use of technologies brought, Industry 4.0 presented the need to build collaborative networks involving government agencies, research institutions, consulting firms, non-profit institutions, and startups [49]. The interest of the academic community in how to internationally expand this concept and apply it to the day-to-day activities of companies has motivated many subsequent studies.

3.1.4. Bibliometric Performance of 2016 to 2021

From 2016 to 2021, the focus of research began to change. As of 2016, there is a worldwide growth in public policies aimed at open innovation and technological development. In emerging countries, such as Brazil, in 2016, the National Innovation Policy was launched [50]. In China, also in 2016, the government became a subsidiary in research and development [51]. During this same period, the United States also started to develop a National Innovation System, encouraging research in this area [52]. Both technology and industry are evolving to a high level, which may explain this change in the research trend. Figure 6 shows the cluster map of the studies from 2016–2021.

The period from 2016 to 2021 is the most representative period since 1975 in terms of the number of studies, which can be represented by four clusters. This period stands out due to the relationship among the clusters identified, demonstrating an increase in the connections between studies, as well as a great number of keywords, based on 2695 papers published in this period (2016–2021).

The keyword "innovation" (green cluster) still appears prominently, but no longer represents the central cluster, evidencing that it is no longer the driving theme, but is always related to the other research themes and the concept of the emerging open innovation, and therefore remains a representative cluster. In this period, a new phase of industrial maturity emerges, characterized by the need for connectivity and the use of digital technologies and how these can be applied in practice [53] As it occurs in many ways, open innovation is linked to the issues discussed by researchers and represents the basis for the development of a technological ecosystem.

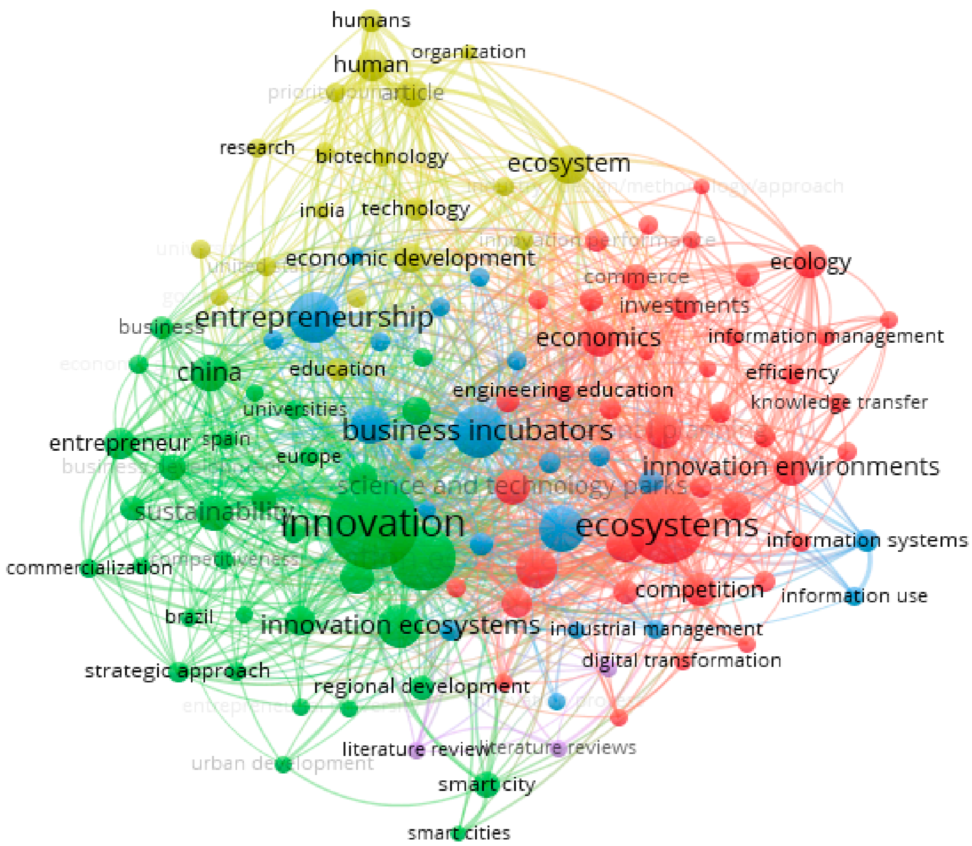

Figure 6. Cluster map 2016 to 2021.

According to [54], innovation activities are currently oriented toward the development of knowledge that seeks technical and scientific advancements. Due to this rapid evolution of technologies, the management of these activities is a challenge. Nevertheless, according to the authors, open innovation and technological development increasingly need to be shared by a network involving various actors in an ecosystem to find opportunities for the industry. Understanding the importance of different authors to the technological and innovative diffusion present in this period reveals the growth of studies related to the "ecosystem" and "innovation environment" (red cluster).

The blue cluster reveals the strengthening of studies regarding its main keyword "entrepreneurship" in the period from 2016–2021. The need for a greater understanding of new technologies and their applicability in different areas of knowledge are key search criteria that involve entrepreneurship, being directly linked with "business incubators" [55]. According to [56], entrepreneurship is connected to innovation and technology, with the new generation of entrepreneurs who have grown up in the Internet age and are accompanied by rapid "economic development", represented in the yellow cluster. Thus, an increasing number of entrepreneurs need to be aware of new trends involving technology development and innovation.

The period from 2016–2021 highlights elements related to ecosystems that achieved a great representation in the research. The red cluster had a great representation of the keyword "ecosystems", while the yellow cluster had a great representation of the variant of the same word: "ecosystem". Additionally, in the red cluster, "innovation environments" drew attention and, in the green cluster, "innovation ecosystems" was the second most cited word (the first was "innovation").

As the authors of [57] describe, the innovation ecosystem involves the creation, diffusion, and use of technologies when organizations, companies, research centers, and policymakers interact. Thus, research related to the different ways of using technology and open innovation in the sector grew due to the insertion of different actors in the technological context, causing a considerable relationship between the different themes.

3.2. Environments Characteristics

Based on the analysis in Section 3.1, the evolution of search terms over the periods was studied, analyzing the characteristics of each one over the years.

In this article, PCA was used to analyze the interrelationships between the characteristics of each innovation environment and explain these environments in terms of the inherent characteristics, generating a cluster. The cluster analysis consisterd of transforming a set of heterogeneous into homogeneous groups, according to the characteristics of the environments [58]. The graphic visualization was completed using the biplot methodology, which made it possible to observe the multivariate relationship between the variables, in addition to selecting the environments according to the characteristics with which they were correlated [59]. The analysis was performed using the Chemostat software and the results are shown in Figure 7.

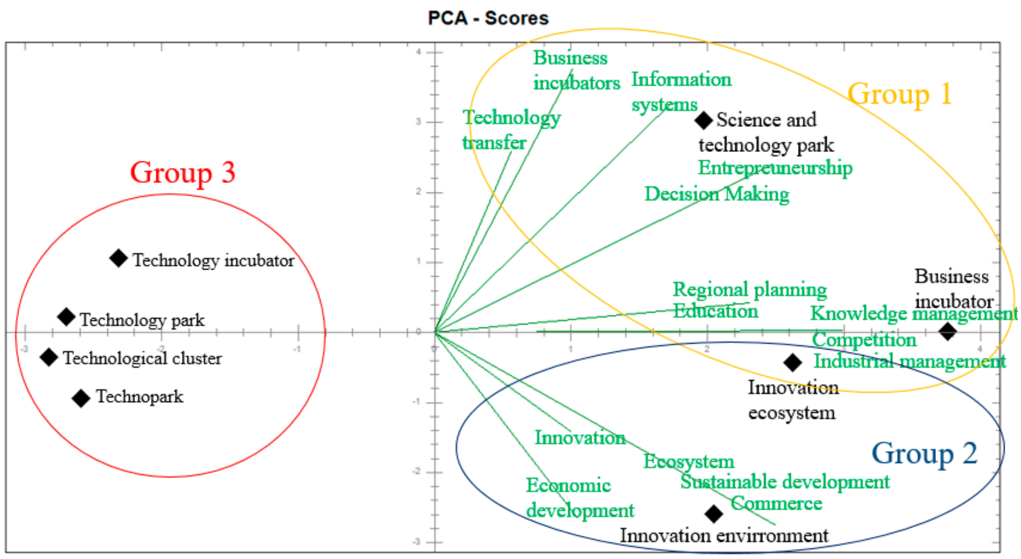

Figure 7. Biplot PCA Scores.

Through the PCA analysis, twelve innovation and technology environments were initially searched: technology park, innovation ecosystem, innovation environment, science and technology parks, technoparks, technological pole, technological cluster, business incubators, and technology incubators. These environments were more developed, presenting interrelationships and having specific or common characteristics. The agro and agricultural environments did not present consolidated research and therefore did not generate any interrelationships with the other environments. This shows how studies have evolved over the years.

In addition to the evolution of the studies, some are related as they demonstrate the same characteristics, while others have different characteristics and end up becoming more isolated in the graphs. The analysis of the PCA graph in Figure 7 is based on theory, where the green lines, which are in the same quadrant and do not have angles between them greater than 90°, are positively related. Lines that have an angle greater than 90° are negatively related. Thus, the characteristics that are positively related to a given environment originate from three groups: Group 1—science and technology parks and business incubators. These group environments are characterized by research in the areas of technology transfer, business incubators, knowledge management, industrial management, information systems, regional planning, education, entrepreneurship, decision making, and competition. Group 2—innovation ecosystems and innovation environments. The environments that are part of Group 2 are interrelated as they are the focus of research on innovation, economic development, ecosystems, sustainable development, and commerce. Group 3—technology incubator, technology parks, technological clusters, and technoparks. These four environments are not directly linked to any specific research area.

By analyzing Figure 7, RQ2 can be answered. These groups have distinct research areas, which indicate that some types of research can be more easily developed in each of these environments. Group 1, composed of science and technology parks and business incubators, is the most representative, as it is directly linked to ten different research areas. The term Business Incubators also appears as a research area related to science and technology parks. Since the business incubator environment can be located within science and technology parks, they can be considered a macro environment, which unfolds in several areas of research. This is a dynamic environment and is intended for different purposes: industry (industrial management, entrepreneurship, competition, decision making); public policies (regional planning and education); and technology (technology transfer and knowledge management).

Group 2 is composed of innovation ecosystem and innovation environment. These are environments that develop innovation as a major area of research but have a great focus on research related to economics, especially in economic development, ecosystem, sustainable development, and commerce.

Group 3, composed of technology incubators, technology parks, technological clusters, and technoparks, was not linked to any specific research area. Figure 6 showed no relationship between these environments and any research area. This implied that, according to the databases, these environments were important, but did not have an action or research focus.

Open innovation is characterized by showing that innovation can be completed in various ways, have different characteristics, be applied to different domains, and can still be enhanced or developed in a more favorable innovation environment. These analyses contribute to understanding what each of these environments develops, and they can help to develop new projects. Regarding the research and solutions involving industry, public policy, and technology, science and technology parks emerge as the most favorable environment, as they are historically the environment that has the most research and findings. Regarding the economy, innovation ecosystem and innovation environments emerge, which can contribute to the economic development of specific countries.

3.3. Countries Analysis

In the graphics generated by the VOSviewer, some countries appear prominent and, for this reason, a deeper analysis was conducted for these countries, seeking to identify which were the most developed research areas in each country and also if there were any similarities between these countries concerning the research areas. To analyze the countries, the PCA was used to analyze the main search terms which were related to each country and if there was an interrelation between the search terms and the countries. The analysis was performed using the Chemostat software and the results are shown in Figure 8.

Based on the PCA analysis in Figure 8, some countries stand out more than others in research related to innovation environments, namely: China, Spain, the United States, Germany, Canada, Portugal, Brazil, and the United Kingdom, and so answer RQ3. These countries not only present research related to innovation environments but also present the largest volume of research published in the studied databases. The PCA graph shows the relationships between the countries, according to the most developed search terms in each, answering RQ4. After the PCA analysis, it was observed that all countries had the characteristic of research related to the term "innovation," with Brazil, Germany, the United Kingdom, Canada, and Portugal presenting only innovation as a central research theme, without being specific as to the purpose, i.e., what kind of innovation was researched and the associated organizational or academic gains. Because these countries have this characteristic in common, they are grouped in the PCA graph.

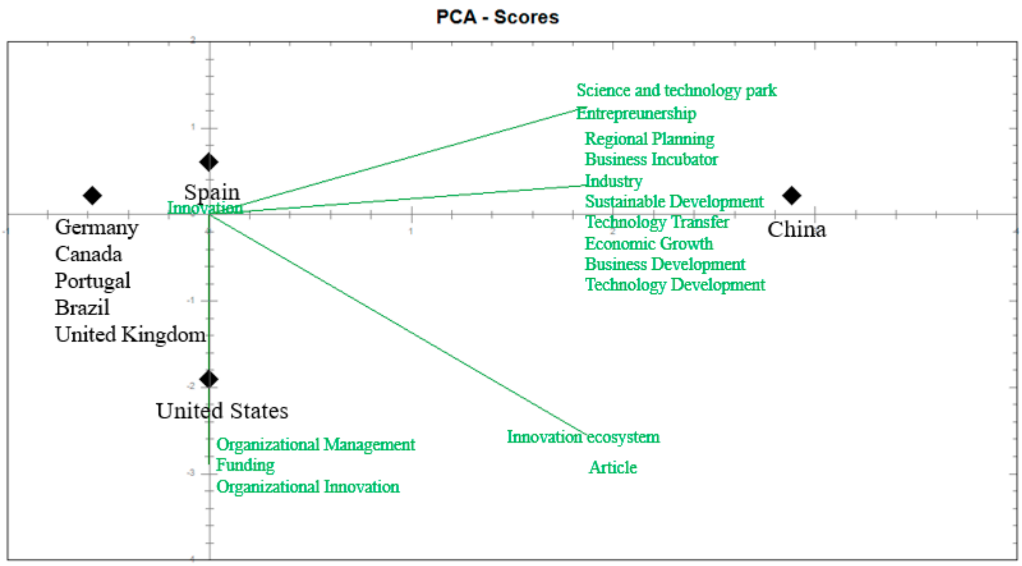

Figure 8. Countries Biplot PCA Scores.

Spain also stands out, which has major research focused on innovation, but the search terms indicate that Spain concentrates its efforts on science and technology parks and searches for research related to entrepreneurship. This demonstrates that the concept of science and technology parks is widespread in Spain and that they are searching for people or companies focused on innovation and entrepreneurship.

Even in the opposite clusters, the United States also has a large representation of research involving innovation, indicating research that is aimed at industry, with organizational management and organizational innovation. The term "funding" is also represented in the United States and is related to the study of innovations that can be part of new public policies to encourage innovation, also stimulating the creation of innovation ecosystems. The term "study" still appears linked to research in the United States, showing the importance given to research in the country.

China presented the greatest diversity of studies related to innovation environments. Section 3.3 discussed how science and technology parks were a macro environment, which unfolded in several areas of research. This becomes clearer when examining Figure 8. Yet, China has the most widespread research on science and technology parks, according to the published research in the country, with research also focused in areas such as entrepreneurship, technology transfer; economic growth; business development; technology development and regional planning, which have an impact on the industry as a whole, in addition to having a research sector that seeks innovations in the area of sustainable development.

From the graphical representation, it is easy to visualize that China and the United States emerge as the major players in the research related to international innovation environments. On the one hand, China, increasingly encourages entrepreneurship and innovation in different research areas; therefore, Chinese business incubators are expanding rapidly [60,61]. With this incentive, the generation of research in innovation and technology projects occurs, even at an international level [62–64]. In this way, innovation environments have become an important element of China's entrepreneurial ecosystem to support start-up customers as a key component of social and economic development [60,65]. The United States, in turn, pioneered the creation of a science and technology park, the Cummings Research Park, whose main objective is to be a collaborative and connected environment [66]. Being pioneers, the United States has incentive policies to promote innovation and support new technology-based companies through a portfolio of innovation services [67,68].

4. Worldwide Innovation Environment, and Open Innovation

Investments in open innovation can be a competitive advantage to companies but can also generate risks and uncertainties that may hinder organizations' decision-making processes [21,22]. The knowledge produced in innovation environments can be the answers or solutions to current problems, enabling companies, organized societies, and public authorities to apply them, generating and capturing value [25]. This highlights how these environments must be dynamic to develop different types of innovation and solutions, spreading the concept of open innovation [69]. The innovation and technology environments, aside from potentiating open innovation in different areas, also create a collaborative network between universities and companies [64]. Countries that have public policies focused on open innovation, with environments dedicated to research and development stand out more than others, such as China and the United States [60,61,63]. The development of open innovation in innovation environments also contributes to public policies, creating a competitive identity for countries and potentiating the development of emerging technologies [70,71]. Innovation environments also help in the process of disseminating the culture of open innovation [72], thus promoting business acceleration [73] and also increasing the productivity of the academic research [74–76], since these environments have specific knowledge and tools for the development and application of research.

5. Conclusions

This article presented in an original way, that no previous research had demonstrated, the evolution and trend of the scientific literature regarding the innovation and technology environments related to open innovation. Given the expansion of the theme, different focuses and characteristics of the studies stood out over time, highlighting the open innovation transformations addressed by the literature and developed in the industrial context. This study demonstrated how the literature addressed the evolution of innovation and technology environments over the years, presenting the most recurrent themes that guided the scientific literature.

The study used search terms conceptualized by the current literature, seeking to identify the maximum amount of research, referring to the theme of open innovation and technology in the industry. The scientific research from 1975 (the year in which the first search terms were found) to 2021 was covered. The analyses were developed based on graphics developed by the software VOSviewer and Chemostat, in addition to the investigation of historical facts that influenced the context of innovation and technology environments.

The results of the article demonstrated that, over the years, scientific research developed in different areas of the open innovation and technological context. In the early years that were studied, the focus was on the development and transfer of technologies. As of 2006, guided by the expansion of startups, innovation has become the central theme of scientific studies, emphasizing other related subjects, such as the innovation incubators responsible for the development of startups and technology companies.

5.1. Theoretical Implications

The evolution of studies shows that world facts directly interfere with research themes. In 2006, there was an exponential growth of studies, because this was when the first startups were created, causing the themes related to open innovation and different innovation areas to receive much attention. A few years later, studies emerged from the concept of Industry 4.0, which even today motivates research to identify opportunities, new forms of management, and the use of technologies involving government agencies, research institutions, consulting firms, non-profit institutions, and startups. This shows that research must seek solutions or innovations for the problems and needs of the current society. The search for solutions and innovations that meet the needs of the market is a basic characteristic of open innovation.

The main theoretical contribution of this paper was to seek evidence to identify the most evolved open innovation research areas in each innovation environment, so that this could serve as a guide for future research and that these studies could generate increasingly robust results in the sense of presenting gains to organizations. Figure 7 presents evidence that there are innovation environments with a higher concentration of research, demonstrating that efforts are being concentrated on delivering different solutions and open innovation. Figure 8 shows that China, the United States, and Spain are leading the research in this area. Figure 7 shows the most developed research in each environment, while Figure 8 highlights the United States and China as world leaders in the research and development of innovation environments.

Through the analyses, it was possible to answer all the RQs, showing the evolution of studies related to innovation environments, which research areas were more developed in each environment and which countries stood out in the research in this area, as well as showing which countries had research efforts in the same area. Through these responses, RQ5 is answered, pointing out the trend for future research in innovation environments.

5.2. Managerial Implications

The research involving innovation environments has increased since 2006, and is predicted to maintain an increasingly trend for the coming years. This trend indicates that innovation continues to be a central theme of research, but one must pay attention to which types of open innovation the market or organizations seek. To help in the selection of innovation projects, the concept of open innovation also needs to be widespread in these environments. For this to occur, the choice of the innovation environment that favors the development of a certain open innovation type or research is essential, where the choice for an inadequate environment can make the research development more time-consuming or even lead to failure.

For example, according to Figure 7, a company that wants to develop research or an open innovation project involving information systems can use science and technology parks as a reference, which, according to published research, is the place which presents the most research in this area. The same happens with the other research areas, which are presented in Section 3.2 and divided into three groups and can guide managers before looking for a suitable place to develop the projects.

The groups presented in Section 3.2 can also serve as a basis for a consultation with policymakers and universities, who wish to install or create innovation environments and attract companies or investments. In this way, the companies attracted will be more focused on developing projects and research focused on technology and innovation, central themes of the research. It presents, for example, that a science and technology park has installed companies that do not generate gains or innovation but only provide services that do not add value to academia and industry.

5.3. Limitations and Future Trends

The results demonstrate a trend for future studies involving open innovation, answering RQ5: What is the trend for open innovation and future research related to the innovation and technology environments? The scientific literature shows a trend to develop various means of expanding knowledge regarding open innovation and technology. The trend is that scientific research is not limited to technology development and transfer, but should also investigate how an innovation environment develops different types of innovation and technologies, encompassing terms used in various areas of industry and covering diverse environments.

To demonstrate the relevant aspects for future research and business managers, the study identified aspects that characterized the evolution of scientific research in innovative and technological environments. In addition to the evolution and trends, the study identified the areas that presented the greatest connection with the development of the innovation and technology environment. The countries that developed more research on the subject were also identified, as well as the evidence of specifications. By having a greater knowledge of the characteristics of each environment and which countries stand out, new research can be conducted, including the creation of a network for knowledge exchange.

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