DESIGN AND MANAGEMENT OF TECHNOLOGY ECOSYSTEMS: IMPLICATIONS AND BEST PRACTICES FOR COLLABORATION, INNOVATION AND SUSTAINABILITY

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Abstract
A documentary review was carried out on the production and publication of research papers related to the study of the variables of Technology Ecosystems, Innovation, and Sustainability. The purpose of the bibliometric analysis proposed in this document was to know the main characteristics of the volume of publications registered in the Scopus database during the period 2017-2022 achieving the identification of 172 publications. The information provided by the said platform was organized by employing figures and tables categorizing the information by Year of Publication, Country of Origin, Area of Knowledge, and Type of Publication. Once these characteristics had been described, a qualitative analysis was used to refer to the position of different authors on the proposed topic. Among the main findings of this research, it is found that China, with 32 publications, was the country with the highest scientific production registered in the name of authors affiliated with institutions of that country. The Area of Knowledge that made the greatest contribution to the construction of bibliographic material referring to the study of Technological Ecosystems, Innovation, and Sustainability was Environmental Sciences with 81 published documents, and the type of publication most used during the period mentioned above was Journal Articles with 59% of the total scientific production.
Keywords*: Technology Ecosystems, Innovation and Sustainability.*

1. INTRODUCTION

In today's fast-paced and interconnected world, innovation is the driving force behind the success and success of companies and organizations. Rapid technological development has created a complex and dynamic landscape where traditional moderate innovations are no longer sufficient. To succeed in this competitive environment, companies must take a holistic and collaborative approach to building and managing technology ecosystems.

A technology ecosystem can be defined as a network of interconnected entities that include people, companies, technologies, and resources that work together to create innovative solutions to real-world problems. These ecosystems encourage cross-pollination of ideas, foster creativity, and enable the effective sharing of information and resources. Effective planning and management of technology ecosystems are critical to achieving sustainable and disruptive innovation. This requires organizations to take a cross-boundary view and build partnerships with external stakeholders such as start-ups, academic institutions, suppliers, and customers. By leveraging the expertise and diverse perspectives

of these partners, companies can gain a competitive advantage and deliver solutions that impact the marketplace.

One of the biggest challenges in building technology ecosystems is finding the right balance between collaboration and competition. While collaboration fosters innovation, healthy competition fosters continuous improvement and ensures that everyone involved is doing their best. Therefore, effective management of these ecosystems requires fostering an environment of trust, openness, and mutual benefit among all stakeholders.

In the search for best practices in innovation, technology ecosystems can act as catalysts for research and development, enabling companies to pool resources and share the risks associated with new projects. In addition, these ecosystems facilitate rapid prototyping, testing, and validation of ideas, shortening the time to market for innovative products and services. In addition, designing and managing technology ecosystems requires a deep understanding of emerging technologies and market trends. As technologies evolve, ecosystems must adapt and reconfigure, encouraging the integration of cutting-edge advances into existing frameworks. For this reason, this article seeks to describe the main characteristics of the compendium of publications indexed in the Scopus database related to the variables Technology Ecosystems, Innovation and Sustainability, as follows. As the description of the position of certain authors affiliated with institutions, during the period between the years 2017 and 2022.

2. GENERAL OBJECTIVE

To analyze from a bibliometric and bibliographic perspective, the elaboration and publication of research papers in high-impact journals indexed in the Scopus database on the variables of Technological Ecosystems, Innovation and Sustainability, during the period 2017-2022.

3. METHODOLOGY

This article is based on a mixed research approach combining quantitative and qualitative methods. On the one hand, a quantitative analysis of the information selected in Scopus is carried out under a bibliometric approach of the scientific production corresponding to the study of Technological Ecosystems, Innovation and Sustainability.

With a qualitative perspective, examples of some studies published in the area of knowledge are indicated above, starting from a bibliographic approach that allows describing the position of different authors facing the proposed topic. It is important to highlight that the entire search was carried out through Scopus, establishing the parameters referenced in Figure 1.

3.1. Methodological design

Figura 1. Diseño metodológico
Source: Own elaboration

3.1.1 Phase 1: Data collection

The data collection was executed from the Scopus web page search tool, where 172 publications were obtained by choosing the following filters:

- TITLE-ABS-KEY (technological AND ecosystems, AND innovation, AND sustainability) AND PUBYEAR > 2016 AND PUBYEAR < 2023
- Published documents whose study variables are related to the study of Technological Ecosystems, Innovation and Sustainability.
- Limited to years 2017-2022.
- Without distinction of country of origin.
- Without distinction of the area of knowledge.
- Without distinction of the type of publication.

3.1.2 Phase 2: Construction of analysis material

The data collected in Scopus during the previous phase is organized and then classified through figures, graphs, and tables as follows:

- Cooccurrence of words.
- Year of publication.
- Country of origin of publication.
- Knowledge area.
- Type of publication.

3.1.3 Phase 3: Drafting of conclusions and final document

In this phase, the results previously obtained are analyzed, resulting in the determination of conclusions and, consequently, in obtaining the final document.

4. Results

4.1 Cooccurrence of words

Figure 2 shows the co-occurrence of keywords found in the publications identified in the Scopus database.

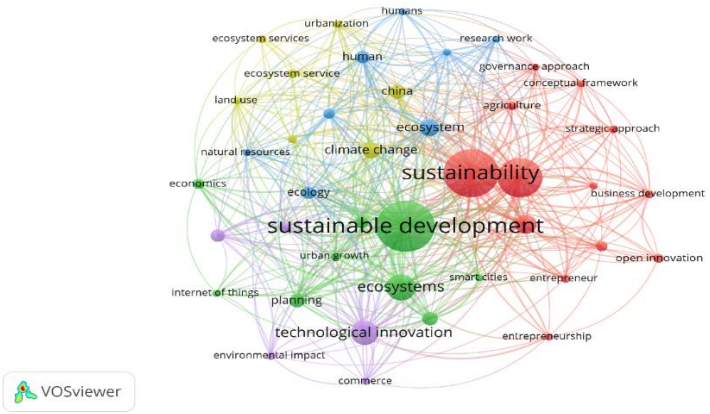

Figure 2. Co-occurrence of words

Source: Own elaboration (2023); based on data exported from Scopus.

Sustainable Development was the keyword used most frequently in the studies identified through the execution of Phase 1 of the Methodological Design proposed for the development of this article. Ecosystems are also among the most frequently used variables, associated with variables such as Innovation and Technology, Sustainability, Ecology, Climate Change, and Trade. From the above, it is striking that the design and management of technological ecosystems is a transformative force that can revolutionize industries and improve the quality of life of people around the world. By fostering collaboration, enabling innovation, and harnessing new technologies, these ecosystems can unlock unprecedented opportunities and advance development in ways that were previously unimaginable. As this journey of exploration and advancement is embarked upon, continuous improvement in innovation practices will create a brighter technology-driven future.

4.2 Distribution of scientific production by year of publication

Figure 3 shows the distribution of scientific production by year of publication.

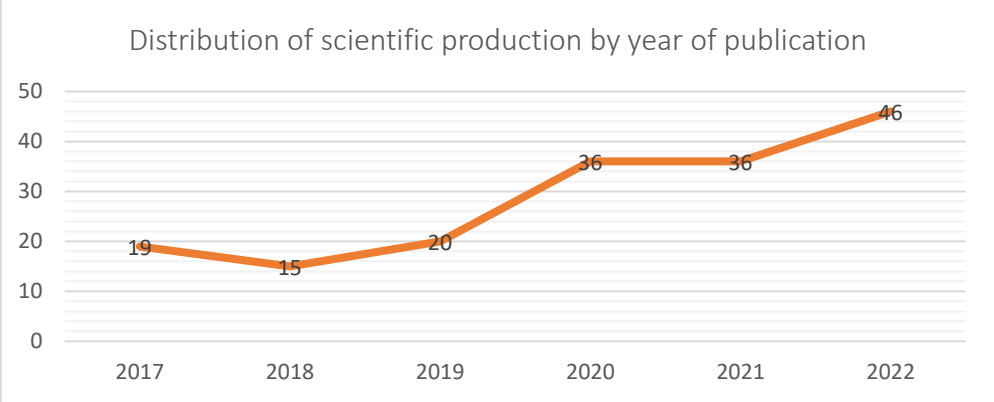

Figure 3. Distribution of scientific production by year of publication.
Source: Own elaboration (2023); based on data exported from Scopus.

Among the main characteristics evidenced through the distribution of scientific production by year of publication, a level of number of publications registered in Scopus was noted in 2022, reaching a total of 46 documents published in journals indexed in that platform. The above can be explained by articles such as "Orchestrating frugal eco-innovation: the plethora of challenges and diagnostics in lean startups in emerging economies" (Abbas, 2022) the present article aims to explore the challenges faced by startups in resource-scarce economies and innovative ways to address these challenges. Design/methodology/approach: Data for the study were collected through 17 semi-structured interviews taken with startup owners and industry experts based in Pakistan and Bangladesh. The transcribed data were coded through NVivo 12 and themes were generated by merging 47 open and 14 axial codes. Findings: The findings show that lack of government support and lack of organizational readiness and motivation significantly affect the frugal eco-innovation of startups. Empirical evidence reveals problems related to the entrepreneurial ecosystem, and internal organizational problems also contribute to the challenges faced by startups in achieving a competitive position in the industry. Research limitations/implications: the study findings suggested that leveraging dynamic capabilities can help lean startups in frugal eco-innovation. In addition, organizational cohesion, entrepreneurial ecosystem, government regulations and aiding organizational mismanagement, and market realization are determinants in the competitive position of startups in emerging economies.

4.3 Distribution of scientific production by country of origin

Figure 4 shows the distribution of scientific production according to the country of origin of the institutions with which the authors are affiliated.

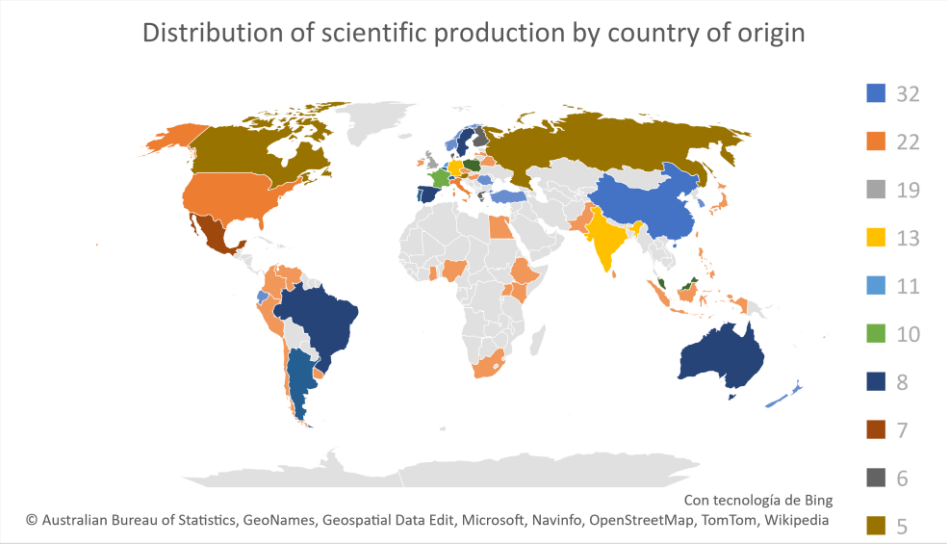

Figure 4. Distribution of scientific production by country of origin.
Source: Own elaboration (2023); based on data provided by Scopus.

Within the distribution of scientific production by country of origin, the records coming from institutions were taken into account, establishing China, as the country of that community, with the highest number of publications indexed in Scopus during the period 2017- 2022, with a total of 32 publications. In second place, the United States, with 22 scientific papers, and the United Kingdom occupies the third place presenting to the scientific community, with a total of 19 papers among which is the article entitled "Multifunctionality of urban agriculture and its characteristics in Latvia" (Dobele, 2022). This research aims to identify the main functions of urban agriculture and to assess its importance in Latvia. The following tasks were set to achieve the objective: 1) to identify and classify the functions of urban agriculture, and 2) to analyze the performance and importance of the functions in Latvia. Several methods were used to perform the tasks and achieve the objective: monographic and descriptive methods to make a theoretical discussion; methods of analysis, synthesis, and deduction for obtaining information, systematization, and classification of functions; a structured interview with experts to qualify and classify the functions and identify interactions between them. The research identified 14 functions of urban agriculture, which were classified into 5 groups: political, economic, social, environmental, and technological. The most significant functions of urban agriculture in Latvia are social (promotion of social cohesion and public health, education, and maintenance of traditions and values) and technological innovations. There are interactions between all functions, with support for urban sustainability, education, provision of ecosystem services, and technological innovations having the greatest impact on other functions. The interactions of functions demonstrated the multifunctionality of urban agriculture, which could be an important support tool to contribute to sustainable urban development.

4.4 Distribution of scientific production by area of knowledge

Figure 5 shows the distribution of scientific publications according to the area of knowledge through which the different research methodologies are implemented.

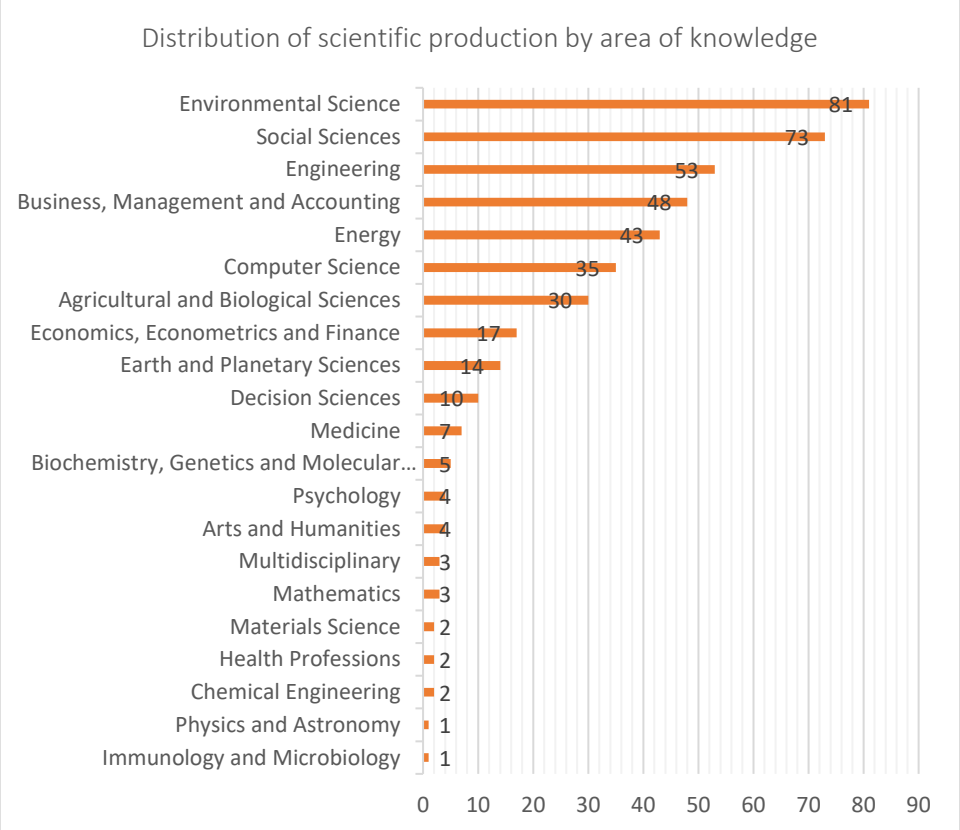

Figure 5. Distribution of scientific production by area of knowledge.
Source: Own elaboration (2023); based on data provided by Scopus

Environmental Science was the area of knowledge with the highest number of publications registered in Scopus with a total of 81 documents that have based their methodologies on Technological Ecosystems, Innovation and Sustainability. In second place, Social Sciences with 73 articles, and Engineering in third place with 53. The above can be explained thanks to the contribution and study of different branches, the article with the highest impact was registered by the area of Environmental Science entitled "Natural resource management and technological innovation in the EKC framework: a ray of hope for a sustainable environment in newly industrialized countries" (Chen, 2022) whose scope of study examines the dynamic association between natural resources, technological innovation, and environmental sustainability using annual data from newly industrialized countries (NIC) from 1990 to 2019. This study is based on a panel co-integration estimator and examines the long-run association between natural resources and technological innovations with environmental sustainability. The long-run results of the cross-sectional ARDL estimator indicate that natural resource rent constrains environmental sustainability, while green technological advances help reduce ecological deterioration. Similar results are observed in the short run; however, the magnitudes of the coefficients are larger in the long run. Furthermore, the validity of the Environmental Kuznets Curve (EKC) hypothesis is also confirmed in IAS. These results are consistent with robust alternative estimators and emphasize the importance of appropriate policies for the efficient management of natural resources through technological innovations and the achievement of sustainable development objectives.

4.5 Type of publication

The following figure shows the distribution of the bibliographic findings according to the type of publication made by each of the authors found in Scopus.

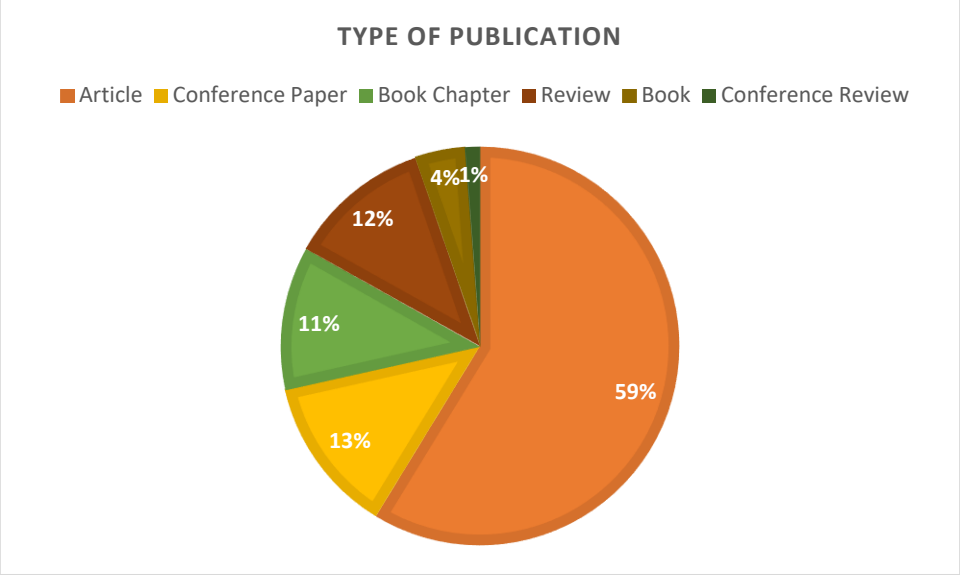

Figure 6. Type of publication.
Source: Own elaboration (2023); based on data provided by Scopus.

The type of publication most frequently used by the researchers referenced in the body of this document was the one entitled Journal Articles, with 59% of the total production identified for analysis, followed by Session Paper with 13%. Book Chapters are part of this classification, representing 11% of the research papers published during the period 2017-2022 in journals indexed in Scopus. In the latter category, the one entitled "Innovation Strategy for green development and carbon neutralization in Guizhou: an overview" (Yan, 2022) stands out. This paper summarizes and analyzes ecological restoration and negative carbon emissions in karst areas. The paper includes water-energy-carbon coupling, energy saving, and emission reduction technologies; industrial energy saving and emission reduction technologies in karst areas; and CCUS technology for carbon dioxide capture, utilization, and storage. On this basis, the trend and orientation of green development in Guizhou are studied and judged, and countermeasures such as adhering to clean and efficient

utilization with low carbon emissions, strengthening research and development of carbon emission reduction technology, and implementing carbon sink capacity are taken. buildings are proposed. Innovation in key basic technology research and development is recommended to establish a low-carbon science and technology innovation system. Energy efficiency, resource recycling, negative emissions, and other strategies should be promoted. Specific suggestions, such as accelerating the transformation and application of green and low-carbon scientific and technological achievements, are also put forward.

5. CONCLUSIONS

Through the bibliometric analysis carried out in this research, it was possible to establish that China was the country with the highest number of published records regarding the variables Technological Ecosystems, Innovation and Sustainability, with a total of 32 publications in the Scopus database. Similarly, it was established that the application of theories framed in the area of Environmental Sciences was the most frequently used in the impact generated by the implementation of the design and management of technological ecosystems, since they have become a force for change, driving innovation and shaping industries around the world.

These dynamic networks connect diverse stakeholders, technologies, and resources, creating fertile ground for collaboration to innovate and drive progress. A key point of the exploration of this exciting field is that improving innovation practices in these ecosystems is not only necessary but key to unlocking unprecedented opportunities for growth and development. One of the main points in the study of technology ecosystems is the power of collaboration.

By breaking down traditional barriers and fostering a culture of shared knowledge and expertise, these ecosystems enable participants to leverage each other's strengths, leading to breakthroughs and new opportunities. The synergy between startups, established companies, research institutes, investors, and governments fosters a collective approach to problem-solving, where innovation becomes a collaborative rather than a siloed effort. Agility and adaptability are important characteristics that result from the effective design and management of technology ecosystems. The ability to respond quickly to market changes and customer demands gives ecosystem-based entities a competitive advantage. Smaller companies benefit from the resources and market access provided by larger partners, which levels the playing field and promotes healthy competition. The fluidity and flexibility of these ecosystems foster continuous improvement and ensure continued relevance in an ever-changing technology environment.

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