Technological Adoption in the Business Sector: Origin, Evolution, and Research Trends

Pedro Duque*
Sergio Díaz**

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Abstract

Objective: This article presents an exhaustive analysis of the origin, evolution, and current research trends in technological adoption in the business sector. It introduces an innovative methodology to map the field, and the integration of the two major global databases enhances the understanding of trends and research evolution in this domain. **Methodology:** To perform a bibliometric analysis of global research on technological adoption in the business sector literature, searching through the Scopus and Web of Science (wos) databases from 2000 to 2022. The literature is classified and analyzed using the metaphorical scheme of the science tree, employing bibliometric techniques and tools such as Bibliometrix, Gephi, and Terms of Service. **Key finding:** Four main clusters were identified that frame current research on technological adoption in the business sector: Knowledge Management, The Human Factor in Technological Adoption, Innovation and Competitiveness, and New Technologies for Organizations. **Conclusions:** This article contributes to the topic by mapping it and establishing its current and future research directions. Additionally, it confirms the close relationship between elements like technology and competitiveness and the human factor as a catalyzing element among them.

Keywords: Research; development; innovation; competitiveness; knowledge transfer; digital transformation; knowledge management.

* Ph.D. and master's in Management. Business Manager. Teacher Assistant, Faculty of Legal and Social Sciences, Universidad de Caldas, Colombia. Email: pedro.duque@ucaldas.edu.co

** Student of a master's in management, specialist in finances. Public Manager. Universidad Católica Luis Amigó. Email: sergio.diazco@amigo.edu.co

Adopción tecnológica en el sector empresarial: origen, evolución y tendencias de investigación

Resumen

Objetivo: Este artículo presenta un análisis exhaustivo del origen, la evolución y las tendencias actuales de investigación en la adopción tecnológica en el sector empresarial. Introduce una metodología innovadora para mapear el campo, y la integración de las dos principales bases de datos globales mejora la comprensión de las tendencias y la evolución de la investigación en este dominio. **Metodología:** realizar un análisis bibliométrico de la investigación global sobre la adopción tecnológica en la literatura del sector empresarial, buscando a través de las bases de datos de Scopus y Web of Science (wos) desde el año 2000 hasta el 2022. La literatura se clasifica y analiza utilizando el esquema metafórico del árbol de la ciencia, empleando técnicas bibliométricas y herramientas como Bibliometrix, Gephi y Terms of Service. **Resultados:** se identificaron cuatro principales grupos que enmarcan la investigación actual sobre la adopción tecnológica en el sector empresarial: gestión del conocimiento, el factor humano en la adopción tecnológica, innovación y competitividad, y nuevas tecnologías para las organizaciones. **Conclusiones:** Este artículo contribuye al tema mapeando y estableciendo sus direcciones actuales y futuras de investigación. Además, confirma la estrecha relación entre elementos como la tecnología y la competitividad y el factor humano como elemento catalizador entre ellos.

Palabras clave: investigación; desarrollo; innovación; competitividad; transferencia de conocimiento; transformación digital; gestión del conocimiento.

Adoção tecnológica no setor empresarial: origem, evolução e tendências de pesquisa

Resumo

Objetivo: este artigo apresenta uma análise abrangente da origem, evolução e tendências atuais de pesquisa em adoção tecnológica no setor empresarial. Introduz uma metodologia inovadora para mapear a área, e a integração das duas principais bases de dados globais melhora a compreensão das tendências e da evolução da investigação neste domínio. **Metodologia:** realizar uma análise bibliométrica de pesquisas globais sobre adoção de tecnologia na literatura do setor empresarial, pesquisando nas bases de dados Scopus e WoS de 2000 a 2022. A literatura é classificada e analisada utilizando o esquema de árvore metafórica da ciência, utilizando técnicas e ferramentas bibliométricas como Bibliometrix, Gephi y Terms of Service. **Resultados:** foram identificados quatro grupos principais que enquadram a investigação atual sobre a adoção tecnológica no setor empresarial: Gestão do Conhecimento, O Fator Humano na Adoção Tecnológica, Inovação e Competitividade e Novas Tecnologias para as Organizações. **Conclusões:** este artigo contribui com o tema mapeando-o e estabelecendo seus rumos de pesquisa atuais e futuros. Além disso, confirma a estreita relação entre elementos como a tecnologia, a competitividade e o fator humano como elemento catalisador entre eles.

Palavras-chave: pesquisa; desenvolvimento; inovação; competitividade; transferência de conhecimento; transformação digital; gestão do conhecimento.

Introduction

Different studies suggest that to achieve greater competitiveness, improve product quality, reduce costs, and achieve greater customer satisfaction, organizations must encourage the adoption of new technologies (Rambe & Khaola, 2021; Wei et al., 2022). To do this, they can acquire or develop new technologies, or implement changes to existing ones (Bolatan et al., 2022). Additionally, the ability to innovate has a positive impact on a company's performance, as it enables them to achieve sustainable performance and a competitive advantage in the market (Jalil et al., 2021).

Although the adoption of new technologies is crucial to drive economic growth for businesses, government policies and regulations can limit their implementation (Hooks et al., 2022). Therefore, to achieve greater economic growth through innovation, countries must commit to globalization to drive technological development and implementation, as well as knowledge transfer (Skare & Riberio Soriano, 2021). For this, the government, industrial community, and productive community must collaborate in developing programs that promote industry-focused education to drive innovation and technological development (Karuppiah et al., 2022).

Currently, Cloud Computing, Big Data, and Blockchain are tools that offer potential possibilities for technological management in organizations (Morawiec & Sołtysik-Piorunkiewicz, 2022). As an example, implementing Blockchain technology can greatly enhance several operations within organizations, including the prevention of counterfeit products and supply chain fraud, cost reduction, and efficiency improvement (Han & Rani, 2022). Additionally, this technology's influence extends to various aspects such as business, ethics, corporate governance, and sustainability due to its ability to establish a decentralized, transparent, and traceable system (Ronaghi & Mosakhani, 2022). However, the adoption of Blockchain can present challenges that can complicate its implementation, so organizations must establish an appropriate framework for it, according to the characteristics of the business (Taherdoost, 2022).

Despite the relevance of technological adoption in the business sector, there has not been an article to date that presents an analysis of the origin, evolution, and research trends in this field. However, some works that approach the topic have been identified.

For example, a review was conducted on the additive manufacturing technology adoption for supply chain resilience (Naghshineh & Carvalho, 2022). A systematic literature review on Blockchain Acceptance Models (Taherdoost, 2022). A survey of breakthroughs in blockchain technology (Sanka et al., 2021). A systematic review of drivers and barriers to the adoption of Industry 4.0 technology (Ghobakhloo et al., 2022). A meta-analysis of research on the adoption of sustainable technologies (Neves et al., 2022).

Facing the identified knowledge gap, this study aims to conduct a bibliometric analysis of global research on technological adoption in the business sector, through publications recorded in the Scopus and Web of Science (WOS) databases, published between 2000 and 2022. To achieve this, tools such as Bibliometrix, Gephi, and Tree of Science (TOS) were used. Thus, through a network analysis, the most relevant documents, authors, and countries on the subject were identified, and the most important documents were categorized using the metaphorical framework of the science tree. Finally, using clustering techniques, the main research approaches adopted globally on technological adoption in the business sector were established.

This document is divided into four sections. The first section presents the theoretical foundation, where the main elements and associated themes, as well as related concepts, are analyzed. The second section analyzes the methodology used to select and analyze articles related to the research objective. The third section presents scientific mapping and bibliometric analysis. Finally, the fourth section presents the results of the network analysis, a discussion of the findings, and describes the conclusions and suggestions for future research.

Theoretical Foundation

To analyze and understand technological adoption in companies, it is essential to reflect on fundamental concepts and review the literary contributions of different authors and their research. One of the reference works in this field is Rogers et al. (2010), who established that innovation is constantly occurring in organizations and follows a sequence of five stages divided into two moments: Initiation (1. Agenda Setting, 2. Matching) and

Implementation (3. Redefining / Restructuring, 4. Clarifying, and 5. Routinizing). However, they warn that one of the main limitations in these processes is the establishment of overly high goals, as this can lead to neglecting important stages in the innovation process and failing in the implementation objective.

To understand the current situation regarding technological adoption in companies, it is necessary to evaluate the development of innovation since the 1960s. During this decade, Rothwell (1992) exposes that the evolution of technology was sequential, as explained by the "technology-push" and "need-pull" theories. Likewise, this author indicates that in the early 1970s, a shift towards a more interactive coupling model occurred, which was dominant until the early 1980s. During this latter period, emphasis was placed on integrating the Research and Development (R&D) interface, suggesting that it should directly involve public policy. This is necessary because financial constraints limit the use of creative inputs and innovation in organizations (Aghion & Tirole, 1994). Furthermore, it is essential to strengthen R&D policies and practices to maintain progress and competitiveness in any business sector (Cresswell & Sheikh, 2013).

Innovation must be analyzed from various perspectives, considering that depending on the type of innovation, unique and sophisticated development strategies may be required that involve greater risk. However, moderately innovative products do not have as much success as highly innovative products (García & Calantone, 2002). Therefore, it cannot be ignored that the development of innovation and the adoption of new technologies are complex processes that involve inherent risks and are subject to social development and contextual limitations. That is, achieving people's understanding, adoption, and learning of technology is a critical factor (Straub, 2009). All of this requires an open stance from all involved in these processes, as their role can generate different contributions from multiple perspectives. For example, workers, from their perspective, have information that managers do not have, which allows them to interpret situations differently (Rogers et al., 2010).

From the above, it is essential to understand organizations as stable systems of individuals who collaborate to achieve common goals (Rogers et al., 2010). Consequently, innovation processes must identify the factors that motivate people to get involved and persuade others to follow a different course of action, as well as understand particular behaviors in specific contexts (Ajzen, 1991). Therefore, it is necessary to refer to the theory

of planned behavior, as the implementation and use of technology are based on individual acceptance, motivation, and behavior (Venkatesh et al., 2003). It is important to note that perceived usefulness is a key determinant for people to adopt different technological tools and, essentially, these tools cannot help organizations if they are not used (Davis et al., 1989).

Hence, technological adoption in organizations should not only focus on the implementation process but also on how people understand, accept, and learn about the technology. This is why adoption models often focus on specific characteristics of the context, the individual, and the innovation to predict its future use (Straub, 2009). It is essential to expand knowledge about the adoption of innovation practices in organizations to improve and leverage their potential (Cresswell & Sheikh, 2013). In this sense, individuals must understand that companies can benefit from incorporating technology into their processes, but at the same time, they themselves can also benefit (Zhang & Dhaliwal, 2009).

However, the challenge for organizations is not limited to individual acceptance of technological adoption but is also affected by financial constraints that limit the use of creative and innovative inputs (Aghion & Tirole, 1994). Furthermore, there exists a structural problem in the global economy, evidenced by marked inequalities in certain regions, as Freeman (1987) recognized when he indicated that "Third World" countries have faced difficulties in adopting and developing new technological tools, despite the potential advantages they could provide in terms of competitiveness. Nevertheless, addressing this problem would require a radical modification of trade, industrial, and governmental policies (Asheim & Gertler, 2006), something that has not been achieved to date.

Methodology

This paper was developed based on the concept of science mapping, through which scientometric tools and bibliometric tracking are used to visualize the intellectual structure, patterns, and trends of a knowledge area (Chen, 2017; Leydesdorff, 1987; Noyons et al., 1999). Different methods, frequently employed for this type of analysis, are used for this

purpose, as suggested by Zupic & Čater (2015): author co-citations analysis (Chen, 1999; White & McCain, 1998), document co-citation analysis (Small, 1973), co-word analysis (Callon et al., 1983). Likewise, techniques for network visualization (Herman et al., 2000), relevant indicators and metrics, including citation counts (Garfield, 1955) and the h-index (Hirsch, 2005), are employed.

Data Selection

To conduct the scientific mapping of research on technological adoption in the business sector, a search was done on Web of Science (WoS) and Scopus, which are considered the main databases worldwide (Bar-Ilan, 2008; Martín-Martín et al., 2018; Mongeon & Paul-Hus, 2016; Pranckutė, 2021). Comprehensive analysis through both tools allows for a broader overview of knowledge in a specific research area (Echchakoui, 2020; Zhu & Liu, 2020). In the search process, the following terms were used as references: "technology adoption" AND "firm*" or "industr*" or "enterprise*" or "organization*" or "business", considering publications registered between 2000 and 2022. This search generated 1264 records in Scopus and 601 in WoS (consultation date 01/15/2023), which were compared to establish duplicate data (469 records) and thus purify the data source, which in this case was consolidated into 1396 records.

Visualization and analysis

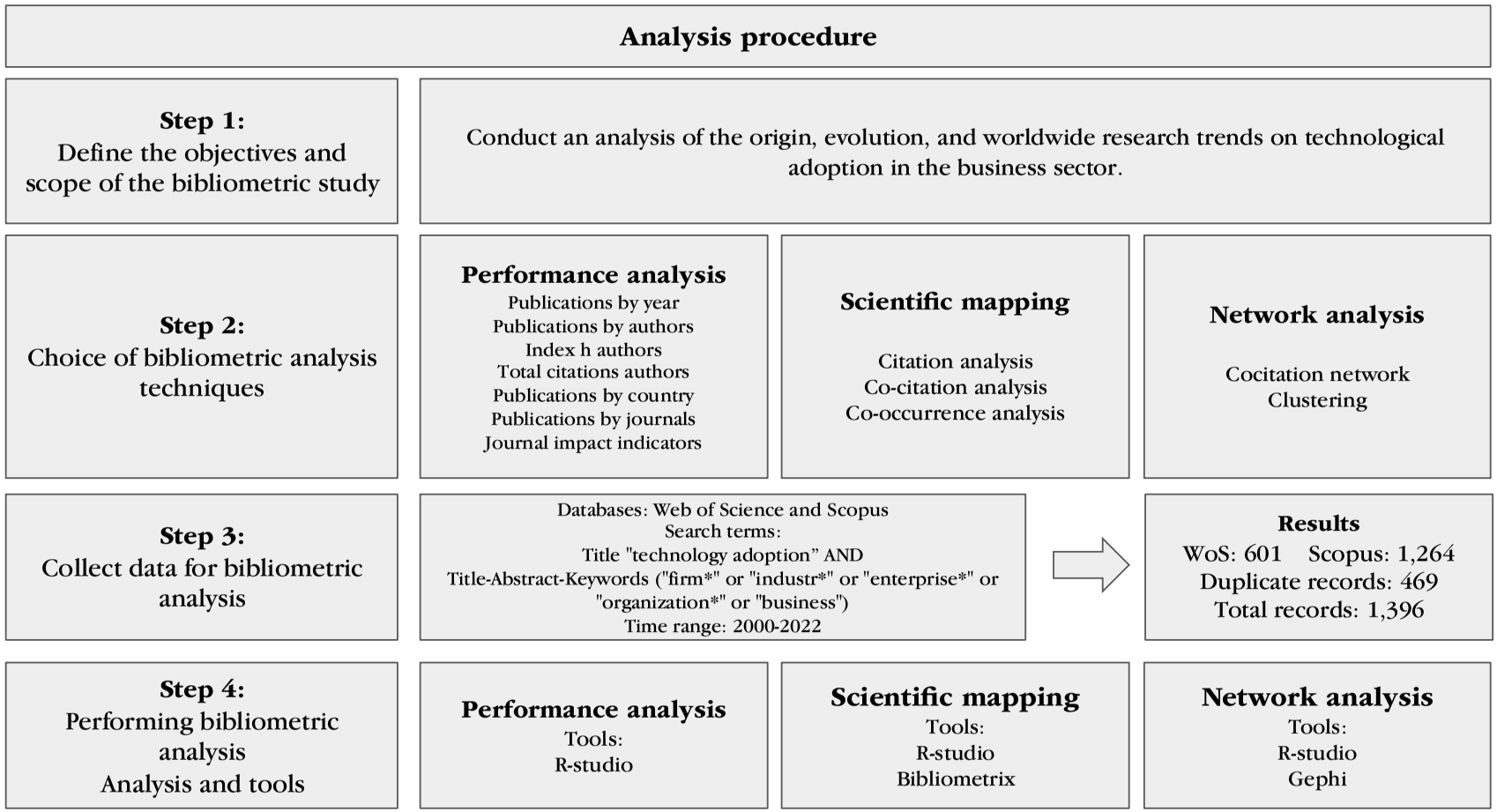
The tools Bibliometrix (Aria & Cuccurullo, 2017) and Gephi (Mathieu et al., 2009) were used for data analysis and visualization. Bibliometrix version 3.1 was employed, which is a free open-access tool with functionalities that allow bibliometric studies, including author co-citation analysis, collaboration network analysis, document co-citation and co-word analysis, as well as facilitating work with different databases (Aria et al., 2020). This tool has been used in various studies (Derviş, 2020; di Vaio et al., 2021; Duque & Oliva, 2022; Homolak et al., 2020; Queiroz et al., 2020), generating reliability in its results. Subsequently, the documents were classified using the metaphorical Tree of Science (ToS) scheme through the ToS tool (Robledo et al., 2022; Valencia-Hernandez et al., 2020; Zuluaga et al., 2022). The scheme has three categories: Seminal documents representing the roots, structural documents representing the trunk, and clusters (current perspectives) representing the branches (Figure 5), allowing for visualization of this field's theoretical evolution.

As for the Gephi software, version 0.9.4 was used, which is a tool for network analysis that allows for a detailed visualization of how the different components of the co-citation network are interconnected, it also allows for the identification of indicators for each element in the network. This application has been used in accordance with previous studies (Donato, 2017; Donthu et al., 2020; Ferguson, 2012; Hurtado & Ortiz, 2022; Jacomy et al., 2014; Meier, 2020; Pineda Guerrero et al., 2021).

The network obtained from the documents found in the databases was divided into clusters, using the clustering algorithm proposed by Blondel et al. (2008), which allows documents to be classified into groups through co-citation analysis, thus establishing the main research fronts in this area (Chen, 2017). Subsequently, impact and relationship metrics such as Indegree (Wallis, 2007), Betweenness Centrality (Freeman, 1977), and PageRank (Page et al., 1999), were calculated for each document. The PageRank identifies the most representative and highest quality documents in each group, considering the citations received from other highly cited documents (Ding et al., 2009; Yan et al., 2010). Finally, using text mining programmed in R with the WordCloud package (Ohri, 2012), the titles and keywords of each work that integrates each cluster were taken to generate the word clouds that facilitate the identification of the topics they contain.

Based on the above, it is important to indicate that the methodological procedure used in this research is based on the structure suggested by Donthu et al. (2021), whose implementation is developed in four (4) stages, which are described in Figure 1. It has also been used in previous studies (Barrera et al., 2022; Castellanos et al., 2022; Duque et al., 2020, 2021; Hoyos et al., 2023; Loaiza et al., 2022; Restrepo et al., 2023; Robledo et al., 2023).

Figure 1. Research Methodology



Results

Performance Analysis and Scientific Mapping

The results presented in Figure 2 show the trend in publications since 2000, segmented by database and calculated as a total after merging the records from the Scopus and WOS databases, considering the removal of duplicates. The trend reflects a steady increase in publications on innovation and technological adoption over the past two decades. This is evidenced by the average number of publications between 2000 and 2023, which has even reached up to 220 publications per year. The acceleration in the trend occurred after 2016, with an average of 111 publications between that year and 2022. Furthermore, approximately one in every two papers was published between 2018 and 2022. These results reflect the relevance of the topic and its current importance, indicating that the scientific and academic community is interested in expanding research in this important area.

Figure 3 graphically displays the journals with the highest number of publications in the field of innovation and technological adoption in organizations. This exercise provides a contrast between the Scopus and WOS databases, as their impact indicators are not homologous. Therefore, it is pertinent to present the individual impact indicators for each journal to provide a more comprehensive and complete view of their impact. The impact indicators of the journals are associated with the JIF (Journal Impact Factor) based on the data indexed in Web of Science Core Collection, the SJR (SCImago Journal Rank) calculated through the information reflected in the Scopus database, as well as the quartile in which they are classified in each database.

Based on the exercise previously described, it can be determined that the journal with the highest number of publications in the field is the North American journal *Sustainability*, with a total of 19 records. It is also classified in quartile 1 of both JIF and SJR indices, making it a highly impactful editorial. It is followed by *Technological Forecasting and Social Change* (a specialized journal in environment and technological factors) with 14 publications. In addition to these two journals, the other eight on the list are renowned journals, as 9 of them are classified in quartile 1 of the SCImago Journal Rank, making them reference journals in global research on innovation and technological adoption.

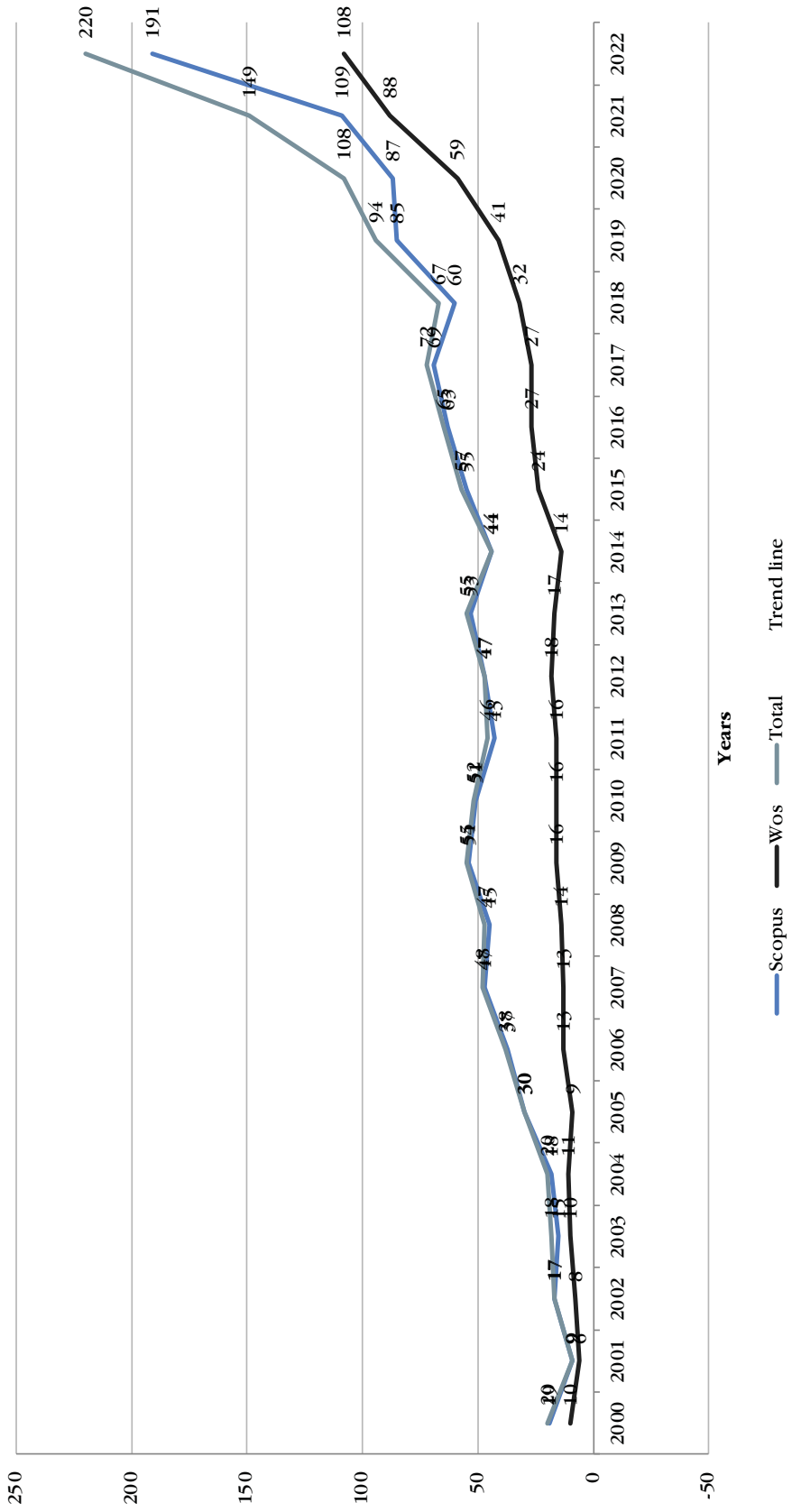


Figure 2. Publication Trends

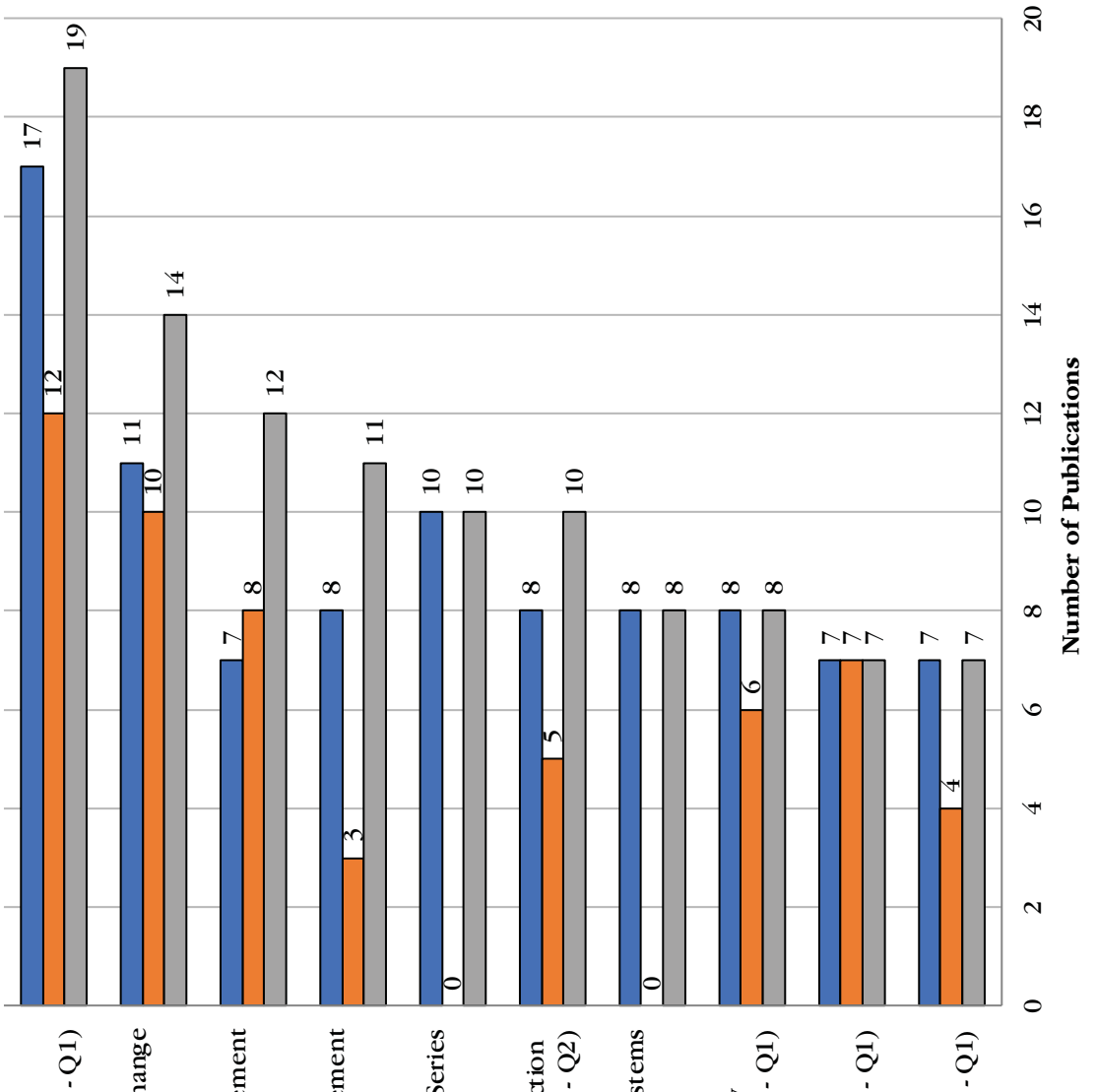


Figure 3. Publications by Journals

Table 1 shows the countries with the highest contribution to the field of innovation and technological adoption. Researchers from the United States contribute 393 publications, representing approximately 35.63% of the global production in the field, followed by China with 132 publications, representing 11.97%. These two nations are the main powers in the field, and when relating the top 10 most relevant journals in the field (Figure 3) with the country, it is established that 4 are from the United States and 6 from China. This list reveals that contributions to global research on innovation and technological adoption mainly come from these countries. Additionally, other nations such as the United Kingdom, India, Australia, Malaysia, Canada, Indonesia, Italy, and Taiwan contribute to a lesser extent but significantly on a global level.

Based on the country collaboration network tool, it can be explained why researchers from the United States and China are the most prolific in terms of scientific production on innovation and technological adoption. This is because the support and collaboration between them are the strongest, with 4 out of every 10 articles published on the topic being authored by researchers from these regions. However, researchers from the United States have the highest number of co-authors from other countries, meaning they have a wider research network, which boosts their production.

Table 1. Publications by Countries

Countries	Number of publications			Country Collaboration Network
	Scopus	WoS	Total	
United States	346	185	393	
China	112	85	132	
United Kingdom	113	58	121	
India	91	33	103	
Australia	93	34	96	
Malaysia	66	20	70	
Canada	59	34	63	
Indonesia	43	7	44	
Italy	43	29	44	
Taiwan	33	22	37	

Table 2 shows the most prolific authors in the field of innovation and technological adoption, relating their h-index and citations in Scopus and wos. The author with the highest number

of publications in the area is Albert P.C. Chan (The Hong Kong Polytechnic University), who has published a total of 6 articles in these databases, with an h-index of 70 in Scopus. Regarding the author with the highest impact indicators within this list, we find Viswanath Venkatesh from The University of Minnesota, who has an h-index of 65 and a total of 51871 citations in wos, while in Scopus an h-index of 70 and 69947 citations; only in Scopus, his 5 registered articles report 959 citations, which means an average of more than 191 per article. It is worth noting that 13 out of the 20 authors in this list are affiliated with institutions in the United States, which is consistent with the previous findings.

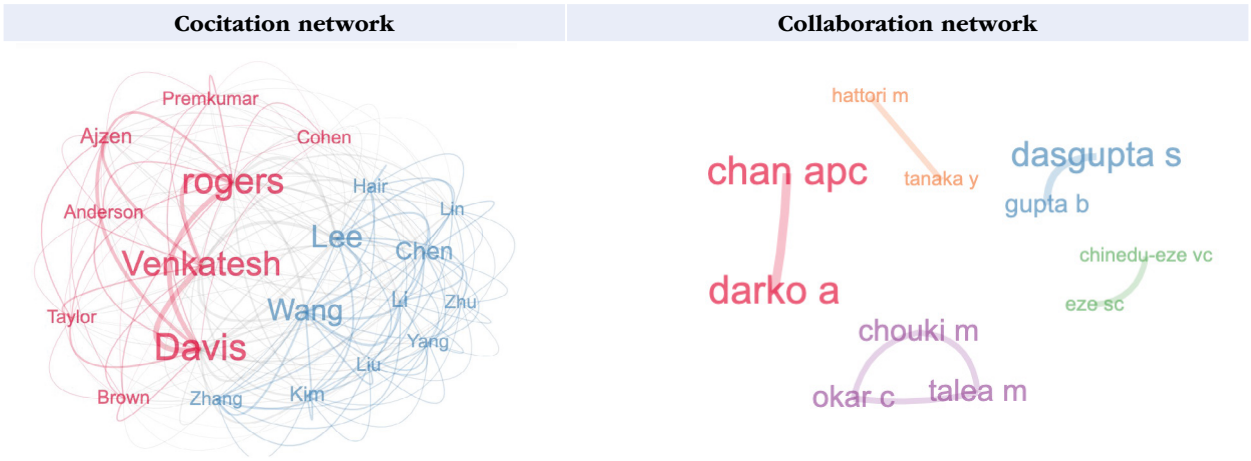
Table 2. Publications by Authors

Author	WoS			Scopus			Total Publications
	Number of publications	H-index	Citations	Number of publications	H-index	Citations	
Chan, Albert P.C.	NR	NR	NR	6	70	18.673	6
Daım, Tugrul	2	32	5.381	4	38	7.644	6
Darko, Amos	NR	NR	NR	6	27	3.263	6
Sepasgozar, Samad	4	27	1.957	6	28	2.267	6
Dasgupta, Subhasish	1	6	432	6	9	727	6
Venkatesh, Viswanath	5	65	51.871	5	70	69.947	5
Gupta, Babita	2	15	1.263	5	10	1.478	5
Chen, Hsin	NR	NR	NR	5	9	665	5
Versendaal, Johan	2	8	218	4	16	775	5
Eze, Sunday Chinedu	2	10	311	5	13	474	5
Kurnia, Sherah	NR	NR	NR	4	20	1.670	4
Tsou, Hungtai	3	14	943	4	16	1.294	4
Qureshi, Sajda	NR	NR	NR	4	18	1.232	4
Talea, Mohamed	NR	NR	NR	4	18	1.194	4
Mohamed Udin, Zulkifli	NR	NR	NR	4	10	443	4
Chinedu-Eze, Vera C.	2	8	141	4	14	294	4
Tanaka, Yasuhito	NR	NR	NR	4	8	285	4
Okar, Chafik	NR	NR	NR	4	7	144	4
Hattori, Masahiko	NR	NR	NR	4	4	37	4
Chouki, Marieme	1	1	19	4	3	32	4

NR: no record.

Figure 4 presents the co-citation and collaboration networks of authors. The first one expresses an author's influence within a scientific community through the impact of their research and the degree of referencing it receives. For this case, the five authors with the highest influence and considered seminal authors in innovation and technological adoption are Viswanath Venkatesh (University of Minnesota), Fred D. Davis (Texas Tech University), Everett M. Rogers (Ohio State University), Joseph Wang (University of California), and David Pope Anderson (University of California). The second network associates groups of researchers who have the highest number of publications as co-authors, and it is closely related to Table 2. For example, the group composed of Albert P.C. Chan and Darko A (the authors in positions 1 and 9 in the list of the highest number of publications on the topic) is the most important, as these researchers are co-authors of three articles (registered in the databases), while Chouki M and Okar C have two publications (the authors in positions 1 and 2 in the list of the highest number of publications on the topic). This demonstrates, as in the case of Chan, that collaborative work generates greater productivity.

Figure 4. Authors Networks

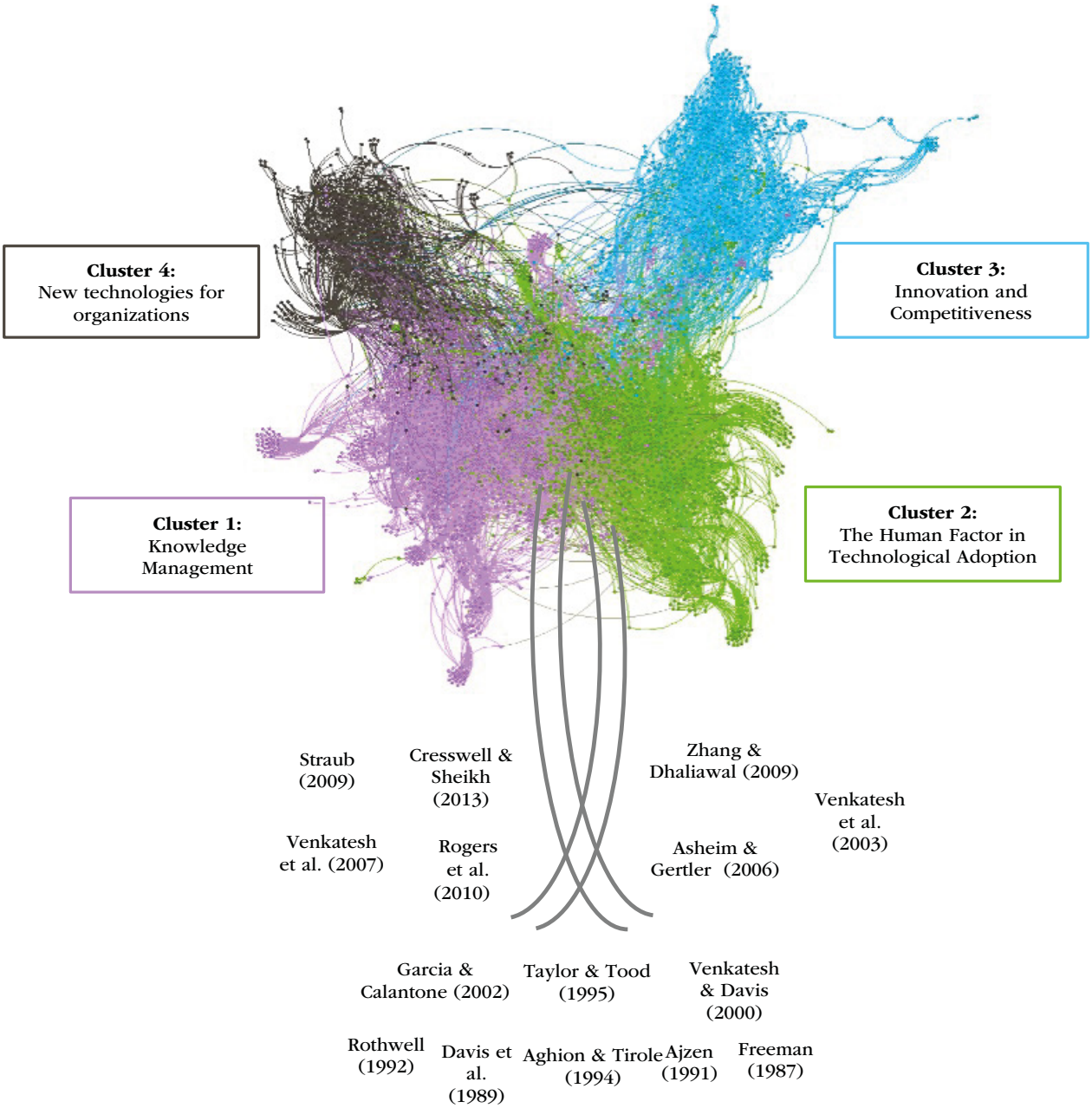


Network Analysis

The co-citation network is generated from records obtained in WoS and Scopus, and for its visualization, the metaphor of the tree of science is employed (Figure 5), where documents are classified into three categories that allow describing the origin, evolution, and

trends of research in this area. At the root, seminal, classic, or also known as hegemonic documents are classified, which present the theoretical foundations of the topic. In the trunk, documents known as structural are associated, which connect the classics with the most recent ones, but especially, which begin to define trends in the topic. The classic and structural documents were used to build the theoretical approach of this article. Finally, in the branches, the four main identified clusters are located.

Figure 5. Tree of Science



The following is an analysis of the documents representing the branches, where the most recent research lines are identified, determining the emerging sub-areas from the literature.

Cluster 1: Knowledge Management

One of the main research lines in technological adoption in the business sector is Knowledge Management, conceived as the generator of competitive advantages for organizations. Technological adoption brings multiple challenges for organizations, and it is considered that to promote innovation, it should not only focus on R&D but also complementary assets such as the underlying infrastructure (Teece, 1986). In other words, innovation should not be limited to the technological core, but an organizational integration should be proposed that focuses on different internal and external components (Ettlie & Reza, 1992). Therefore, to face the challenges that organizations are exposed to, it is essential to have human capital, an essential factor for individual, business, and socioeconomic growth, as well as for the adoption and adaptation of new technologies (Blundell et al., 1999).

Thus, it is recommended to strengthen the theoretical approaches that allow for the analysis of Knowledge Management in organizations, based on their capacity for resources and human capital with the required skills for this purpose. As a result, organizations can effectively manage knowledge by identifying, capturing, storing, mapping, disseminating, creating, and utilizing it to obtain the most advantageous benefits (Egbu et al., 2005).

However, organizations must strengthen their human capacities to face each challenge in terms of technological adoption, since failing to do so may cause even a leading company to lose not only technological leadership but also market leadership (Alderighi & Feder, 2021). Consequently, it is suggested that organizations carry out education campaigns to increase awareness of the benefits of technology adoption (Andaregie & Astatkie, 2022), since the adoption of technology and human capital are crucial determinants for organizational growth (Skare & Blažević Burić, 2021).

In line with this, innovation, and particularly new technology, should be associated with the practices of organizations that stimulate employee participation, autonomy, and learning practices. Innovation can be understood as a phenomenon interrelated between working conditions and organizational practices (Mofakhami, 2022). This is considering

the human capacity to obtain extraordinary results derived from a specific need, which has generated early adoption of technology and industrialization (Mokyr et al., 2022).

However, to effectively achieve knowledge management within organizations, it is essential to have committed administrators, as training requires specialists with skills that most companies lack, which can be costly (Canhoto & Clear, 2020), However, when directors can identify the potential to add value through new knowledge for the company, it favors decision-making concerning cost-benefit (Merendino et al., 2018).

Cluster 2: The Human Factor in Technological Adoption

In the process of technological adoption in organizations, it is essential to analyze the essential factors to achieve objectives and maximize results. In this analysis, it is possible to identify that one of the fundamental factors is the human being as the central axis in all aspects related to its development, adoption, and use.

Initially, it is pertinent to indicate that technology has gradually become a critical source of sustainable competitive advantages in organizations (Kim et al., 2008), and maintaining a competitive advantage in the current market is important for both companies and society (Jensen & Scheraga, 1998). It is worth noting that the advantage is characterized by the magnitude of the impact on the consumer (Mattila, 1999), that is, the results can be evidenced through acceptance and use, starting from its ease of use and utility for users (Morosan & Jeong, 2008).

Consequently, the human-organization-technology synergy should be considered as a general concept that allows to explain the heterogeneity of the incorporation of technology in organizational management (Xu & Lu, 2022), the customer-employee dyad interaction is a vital component in establishing a prosperous relationship based on the interactions that occur within it (Mattila, 1999). Therefore, the human being is not only conceived as an essential factor within the organization but is also relevant as an external factor, since consumer acceptance is the key to technology adoption (Liu et al., 2020).

Based on the previously mentioned, it is necessary to emphasize that the adoption of IT could lead companies to develop a competitive advantage, generating loyalty, brand

awareness, brand knowledge, and perceived value in the consumer (Varelas et al., 2021), as long as the basic concept is considered that perceived usefulness is a determining factor for technology usability (Bianchi et al., 2022), meaning that the adoption of new IT must be appealing to the end user, their motivation, and the benefits it generates for them (Jajić et al., 2022).

Finally, organizations must strive to develop new IT, based on the knowledge of the effect it will generate on end users or customers (Licup & Materum, 2021), but for this objective to be successful, conviction and knowledge on the part of employees are necessary to link the synergy between these essential elements.

Cluster 3: Innovation and Competitiveness

Currently, organizations face a globalized market and direct competition between companies worldwide. Additionally, they face increasing needs for operational renewal, especially regarding the adoption of innovative technologies that aim to meet the needs of customers, companies, employees, and users in general.

The above discussion shows that there is a wide range of variables that can influence the likelihood of an actor adopting an innovation (Wejnert, 2002), which contributes to the renewal of the company through its dynamic and reciprocal relationship with the competencies of the companies (Danneels, 2002), generating an integration between innovations, administrative, technological and product ideas, enhancing productive capacity (Abrahamson & Rosenkopf, 1997).

Hence, the integration of innovation and the implementation of new information technology are correlated with substantial advancements in the efficiency of operations in intricate industrial settings, as well as with a significant rise in the development of novel products, process enhancement, and exploration of avenues for growth (Xue et al., 2012). This means that products from high-tech industries generally have a strong influence on the abilities of managers to initiate and expand new businesses (Oakey & Cooper, 1991).

Consistent with the aforementioned description, it is presumed that the encouragement of any novel technology, which involves substantial research and development inputs

and innovation, is a critical element for maintaining industrial growth in the twenty-first century (Oakey & Cooper, 1991), even facilitating the integration of companies into global value chains and placing them in a higher quality business environment (Vu et al., 2021), therefore, it is evident that companies could respond to market challenges by using new technologies and being more innovative (Nugroho et al., 2022).

It is noteworthy that the implementation of information technologies and the ability to innovate significantly affect organizational performance. However, this impact must be amplified and reinforced by skilled human resources through knowledge management and training programs (Sam' et al., 2022), since success in technology adoption and innovation often requires cooperation between individual actors and organizations. (Bentivoglio et al., 2021).

To conclude, it can be deduced that the adoption of novel technologies can facilitate both organizational efficiency and effectiveness, representing a crucial source of sustained competitive advantage for companies in the long run (Neumeyer et al., 2021). Therefore, entrepreneurs must take advantage of knowledge and technological developments to achieve results that add value to the organization (Ganotakis et al., 2021).

Cluster 4: New Technologies for Organizations

New technologies aim to respond to the solution of the problems and needs organizations are exposed to, generating alternatives that allow them to be more competitive, enhancing their operation, generating new products, attracting new customers, and venturing into new markets.

To illustrate the above, the use of intelligent applications proposed by different technologies such as blockchain and the cloud has strengthened data security processes, access policies, and support data privacy for organizations (Taherizadeh et al., 2018). Furthermore, other studies suggest that blockchain is a highly disruptive technology that could have the ability to reconfigure all aspects of society and its operations (Swan, 2015), which has increased its acceptance and use in large-scale business environments (Woodside et al., 2017).

Likewise, new technologies provide tools to protect organizations from attacks that compromise their security, information, and processes, such as cyber-attacks, which can be controlled with blockchain technology or cloud-based information (Kshetri, 2017). Therefore, it can be affirmed that blockchain technology and cloud-based information are emerging and potentially revolutionary technologies for the processes associated with businesses (Saberi et al., 2019).

Blockchain technology initially sought to solve problems in the financial sector, but thanks to its functionality and security, it has become a very attractive tool for solving problems in the non-financial industries (Crosby et al., 2016). The use of technology is associated with acceptance and its benefits, which in essence are the solutions for the challenges organizations face and its effective contribution to social inclusion in developing countries (Pilkington, 2016).

Nevertheless, the intention to adopt blockchain technology must be accompanied by the issues related to the development of technical capabilities for deployment (Kamble et al., 2019). In other words, to effectively leverage technological adoption and maximize the benefits that come with it, it is necessary to provide training, knowledge management, and technology skill development (Andaregie & Astatkie, 2022).

Discussion

The bibliometric analysis performed on technological adoption in the business sector reveals fundamental trends and patterns essential for understanding the evolution and impact of this area. By identifying the four main clusters (Knowledge Management, The Human Factor in Technological Adoption, Innovation and Competitiveness, and New Technologies for Organizations), this analysis provides a multidimensional and enriching perspective on the topic.

In the Knowledge Management cluster, the importance of considering knowledge as a strategic resource is highlighted. This approach shows that efficient knowledge management

is key to the successful integration of new technologies, which can lead to innovations and strengthen market competitiveness. This understanding directly connects with the Innovation and Competitiveness cluster, which links technological adoption with a company's ability to innovate and remain competitive in a globalized market. The effective integration of new technologies is crucial for improving processes, products, and services, highlighting the interdependence between technological innovation and business success.

In parallel, the Human Factor in Technological Adoption cluster emphasizes that technological success depends on the tools and the acceptance, motivation, and behavior of the individuals involved. This finding highlights the need for people-centered approaches to technology implementation, addressing resistance to change and promoting training and skill development. This human aspect is a cross-cutting element that influences all areas of the technological adoption process.

Finally, the New Technologies for Organizations cluster examines how emerging technologies, from artificial intelligence to blockchain-based solutions, are redefining the business environment. These technologies present unprecedented opportunities to transform organizations, improve security and trust, and contribute to sustainability. This focus on new technologies intertwines with the other clusters, demonstrating how technological innovation is a key driver for knowledge, competitiveness, and human adaptation in the business world.

Together, these clusters offer a comprehensive understanding of the multiple factors interacting with technological adoption in the business sector, highlighting both the challenges and opportunities in this dynamic and constantly evolving field. Moreover, the analysis of these clusters has practical implications. They provide businesses and policymakers with a framework for understanding and addressing the challenges of technological adoption. These findings emphasize the need to implement a holistic approach that focuses not only on technology but also on human and organizational aspects to ensure successful implementation.

Conclusions

This article analyzes the origin, evolution, and research trends on technological adoption globally in the business sector. Bibliometric tools and techniques were used, considering the main databases (WOS and Scopus). Additionally, a scientific mapping was done to identify the most important documents, authors, journals, and countries in the field. Furthermore, the main research fronts in this field were established.

This research has certain limitations. Despite using Scopus and WOS databases as the main sources, which are recognized worldwide, publications that may be relevant in the field but are published in journals that are not indexed in these catalogs were not included in the mapping. In addition, specific bibliometric techniques and the natural bias of researchers can generate limitations in the interpretation of data. Therefore, it is recommended that future research validate the findings presented in this article. The following research, presented in Table 3, agenda arises because of the analysis of the clusters.

Table 3. Future Research Directions

Cluster	Topic	Reference
Knowledge Management	Establishing the effect of the technological adoption impact on human capital in different contexts and cultures.	(Skare & Blažević Burić, 2021)
	Analyzing the relationship between the growth of new technology and the corporate governance processes of organizations.	(Merendino et al., 2018)
The Human Factor in Technological Adoption	Evaluating how the combination of different technologies could generate significant social and climate benefits, such as the combination of Blockchain and Big Data use.	(Liu et al., 2020)
		(Ezzaouia & Bulchand-Gidumal, 2022)
Innovation and Competitiveness	Analyzing how innovation and the transfer of technology affect productivity and competitiveness.	(Rambe & Khaola, 2021)
	Analyzing the impact of cooperation and the quality of R&D activities of SMEs in different contexts.	(Lewandowska, 2021)
New technologies for organizations	Deepening the research on technologies that support security aspects of sensitive data, evaluating the sensitivity to information loss or hacking.	(Taherizadeh et al., 2018)
	Since blockchain adoption is in its early stages, research should be conducted on blockchain and its evolution of implementation in the supply chain.	(Saberi et al., 2019)

The scientific community's interest in this field is increasing, as indicated by bibliometric analysis. The journal *Sustainability* leads in the number of publications, but it is not specialized in technology and innovation topics. On the other hand, *Technological Forecasting and Social Change* is the second journal with the most publications and it focuses on these topics. As for countries, the United States leads global research because influential authors such as Viswanath Venkatesh, Everett M. Rogers, and Fred D. Davis are associated with universities in this country.

The review of the documents shows that organizations are constantly exposed to multiple challenges to achieve greater competitiveness, improve their products' quality, reduce costs, and generate customer satisfaction. An essential factor in addressing these challenges is innovation and technological adoption, as it enables them to strengthen their operations, maximize profitability, and generate positive impacts on society in terms of environmental sustainability. Furthermore, the literature agrees that human beings are central to all aspects related to the development, adoption, and use of technology. Therefore, the implementation and use of technology are based on individual and collective acceptance, motivation, and behavior.

Knowledge management is perceived as the generator of competitive advantages for organizations, in which human capital is the differentiating factor. Thus, organizations must promote investment in R&D to strengthen this competitive advantage. Additionally, it is essential to consider that new technologies bring significant benefits to organizations in terms of productivity, security, and trust. However, these benefits transcend organizations, as they also generate positive impacts related to social, environmental, and climate factors. Therefore, organizations must effectively leverage technological developments to maximize these benefits, starting with training, knowledge management, and the development of technological skills.

Finally, it is pertinent to indicate that there is a direct relationship between investment in R&D and countries' productivity and competitiveness. Therefore, national governments must modify their trade, industrial, and governmental policies to favor investment in R&D in organizations. This is based on the fact that the adoption of new technologies contributes to organizational effectiveness and is a key source of long-term competitive advantage for companies.

Contributor Roles Taxonomy (CRediT)

Pedro Duque: Conceptualization; Investigation; Methodology; Project administration; Software; Supervision; Validation; Visualization; Writing (original draft, review & editing)

Sergio Díaz: Conceptualization; Data curation; Formal Analysis; Investigation; Methodology; Project administration; Software; Validation; Visualization; Writing (original draft, review & editing)

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