Cultural and Creative Entrepreneurship in Intersection with Technology 4.0: A Bibliometric Análisis

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Abstract

This article analyzes research on creative and cultural entrepreneurship in relation to technology 4.0 through a bibliometric approach. Using the Scopus database, the authors conducted a search for relevant publications between 2012 and 2024, using the following search equation: (TITLE-ABS-KEY (entrepreneurship AND creative) OR TITLE-ABS-KEY (creativity) AND TITLE- ABS-KEY (technology 4.0) OR TITLE-ABS-KEY (entrepreneurship AND culture) OR TITLE-ABS-KEY (cultural) AND TITLE-ABS-KEY (technology 4.0)). 246 publications were identified, with 40.7% academic articles, 35.8% conference papers, and 11.4% book chapters. The analysis was carried out with the R and VOS VIEWER programs, focusing on research trends, the most productive authors, the institutions involved and the countries with the greatest scientific production. The results highlight Lotka's Law, showing that most authors have only published one document, while a few concentrate a large part of the scientific production. India and Indonesia lead global production in this field, followed by Malaysia, Germany and the United Kingdom. The most cited articles are also identified, underlining the growing importance of Industry 4.0 in research fields related to creativity, culture and emerging technologies.

Keywords: Entrepreneurship, Industry 4.0, Technology 4.0, Culture, Bibliometrics.

1. Introduction

In the current global context, the fourth industrial revolution or Industry 4.0 has generated a profound transformation in the economy, society and culture, mainly through the integration of advanced digital technologies such as artificial intelligence, the Internet of Things (IoT), robotics, big data and cloud computing. These technologies have redefined production processes and are shaping the future of work, education and entrepreneurship (Martinelli et al., 2021). According to various studies (Jamwal et al., 2021), Industry 4.0 is not only revolutionizing manufacturing and technological industries, but is also having a significant impact on traditionally less technological sectors, such as cultural and creative industries. This fact is caused by the generation of new models offered to the market, the entry into digital economies

and the different visions presented today by cultural and creative entrepreneurship in an environment more closely linked to information technologies.

Industry 4.0 is precisely the articulation of physical and digital systems, favoring a greater interrelation between data derived from machines and humans. In this context, artificial intelligence and its derivatives (machine learning) contribute to the performance of complex tasks, the objectives of operational tasks and the prospects for innovation.The use of data mining and predictive analytics, for example, not only makes it easier for entrepreneurs to anticipate market needs, but also makes the presentation of products more accurate (Kotras, 2020). In addition, augmented reality and virtual reality are technologies that create experiences beyond the limits of human creativity, opening up new possibilities for art, culture and entertainment. The development of these technologies has contributed to the global transformation of production and consumption, with a direct impact on the forms of production carried out by different economic sectors (Laskurain-Iturbe et al., 2021).

In the field of entrepreneurship, 4.0 technology has played a crucial role in the expansion of emerging companies (startups), especially those linked to the creative economy. These new technologies have allowed entrepreneurs to explore global markets, reduce entry costs and increase their competitiveness, all through innovative solutions based on advanced technology (Dana et al., 2022). Start-ups have benefited from connectivity and automation to improve production and meet the needs of the globalized economy with unique products. In this sense, Technology 4.0 has contributed to the development of new businesses by facilitating market access for cultural and creative entrepreneurs with digital platforms and tools that previously seemed difficult to obtain (Hisrich and Soltanifar, 2021). In this way, it has contributed to democratizing access to technology, enabling new forms of innovation that support economic growth.

Thus, cultural and creative entrepreneurship refers not only to the impact of innovation on the generation of economic value, but also to the social and cultural aspects of art, music, film, fashion, design and other creative fields. This type of entrepreneurship consists of creating products, services or experiences from original ideas that have an impact on society (Chang and Chen, 2020). In recent decades, the connection of technology 4.0 with creative business has enabled a new paradigm of entrepreneurship, which has contributed to solving complex problems from the convergence of creativity and technology. Today it is commonplace for cultural and creative entrepreneurs to make use of technologies such as artificial intelligence, augmented reality and blockchain to change the factors of production, as well as to induce the consumption of cultural goods and services (Rane et al., 2023)This intersection between creativity and technology is driving a new wave of entrepreneurship that is reshaping cultural industries globally.

In this context, researchers and policy actors have focused on the relationship between cultural entrepreneurship and technology 4.0. The creative and cultural industries, which in the past were minor economic sectors, with the digital transformation, nowadays a change in operations can be seen that has given them greater relevance in the economy. Digitalisation has helped entrepreneurs in this sector to further expand into different markets, expand their collaborative

networks and improve global visibility (Raimo et al., 2022). At the same time, the application of 4.0 technology has been seen as a challenge for entrepreneurs because they are forced to develop advanced digital competences and adapt to highly competitive contexts. In this sense, the confluence between cultural entrepreneurship and 4.0 technology is seen as a unique opportunity to pursue other forms of innovation and growth in the digital economy (Herman, 2022).

One of the most noteworthy aspects of this intersection is the role played by digital platforms in the rise of cultural and creative entrepreneurship. The platforms have favored the creation, distribution and marketing of cultural products globally, to the point that entrepreneurs can access a population or market that was unthinkable before. For example, YouTube, Netflix and Spotify have changed the way creative products are consumed, because they offer cultural entrepreneurs access to millions of people around the world (Poell et al., 2021). Similarly, the Adobe Creative Cloud, Unity and Unreal Engine platforms are providing cultural and creative entrepreneurs with the necessary tools to generate better quality digital products, democratizing the use of technology and developing innovation in these companies (Hutson, 2024). This convergence between technology and creativity stimulates new forms of cultural and artistic products, as well as disruption in entrepreneurship, because they encourage new business structures in the cultural industry.

In the academic sphere, the analysis of the relationship between cultural entrepreneurship and technology 4.0 has generated different research to understand the success factors of entrepreneurs and how these factors influence the environment. Bibliometric studies have become a valuable tool to understand the trends of studies and evaluate the impact of scientific dissemination in this field.. The bibliometric analysis identifies the main research areas, the most influential authors and the leading institutions in the study of cultural and creative entrepreneurship in relation to technology 4.0 (Bui Hoai et al., 2021). Furthermore, it provides an overview of how the field has evolved over time and what future research directions may be relevant to the development of knowledge in this area.

Given the growing interest in the intersection between cultural entrepreneurship and technology 4.0, this article aims to conduct an exhaustive bibliometric analysis to diagnose the current state of scientific knowledge in this field. Using the Scopus database, which is internationally recognized for its broad and rigorous coverage of scientific research, this study analyzes scientific production related to cultural and creative entrepreneurship in conjunction with technology 4.0. The Scopus database allows a selection of data from a wide range of scientific publications that serve as a tool to ensure the validity and reliability of the results obtained (Liang et al., 2021). The bibliographic exploration has been elaborated using a combination of keywords concerning entrepreneurship, creativity, culture and technology 4.0, with the purpose of identifying the most important and up-to-date publications in this field.

Based on this topic and the need to expand knowledge in relation to it, this bibliometric analysis has been carried out using tools such as R software and VOS Viewer, which allow the data to be managed and displayed efficiently. Furthermore, a descriptive documentary approach has been adopted that makes it possible to identify the main research trends and evaluate the impact of scientific publications (Fabre et al., 2021). This approach provides a comprehensive view of the

state of the art at the intersection between cultural and creative entrepreneurship and technology 4.0, highlighting the most influential authors, institutions and countries in this field. Likewise, it allows us to identify emerging research areas and gaps in knowledge, which can be useful to guide future research in this area.

In this way, this document is presented as a contribution to scientific knowledge regarding cultural and creative entrepreneurship in the context of technology 4.0, showing the advances in this field over recent time, as well as the factors that have enabled its evolution. Through bibliometric analysis, it is possible to understand in detail the dynamics that are affecting cultural and creative entrepreneurship in the digital era, focusing its study on how emerging technologies affect the evolution of this sector.

2. MATERIALS AND METHODS

The Scopus database was used for the bibliometric analysis, as it is an internationally recognised academic platform that brings together the most relevant scientific research. Scopus brings together a large number of scientific journals, therefore, it offers a wide range of high quality academic documents, which favours obtaining updated articles. In addition, its indexing policies and requirements for scientific publications provide confidence when searching for high quality documents, which generates confidence in the validity and reliability of the results obtained (Borre et al., 2023).

The search was carried out in August 2024, using a combination of key terms relevant to the topic of this research: “entrepreneurship”, “creativity”, “culture” and “technology 4.0”. To do this, the following search equation has been used: (TITLE-ABS-KEY (entrepreneurship AND creative) OR TITLE-ABS-KEY (creativity) AND TITLE-ABS-KEY (technology 4.0) OR TITLE-ABS-KEY (entrepreneurship AND culture) OR TITLE-ABS-KEY (culture) AND TITLE-ABS-KEY (technology 4.0)).

In addition, for the management and analysis of the bibliometric data obtained from Scopus, the R and VOS VIEWER software were used (Ramírez et al., 2023). In addition, a descriptive documentary approach was adopted, which made it possible to identify research trends and evaluate the impact of scientific publications, highlighting the most influential authors, institutions and countries in the specific field (Ocaña-Fernández and Fuster-Guillén, 2021; Carmona-Serrano et al., 2020). This approach provides a comprehensive view of the topic addressed, which helps understand its evolution for future research.

Table 1 List of terms used in bibliometric analysis

Key term	Description
Artificial intelligence	Simulation of human intelligence processes by computer systems.
Education 4.0	Educational model adapted to the technologies and needs of Industry 4.0.
Industry 4.0	Fusion of advanced technology and automation in industrial processes.
Engineering education	Specialized training in engineering principles and practices.
Industrial revolutions	Significant historical changes in production and technology.

Creativity	Ability to generate original and innovative ideas or solutions.
Industry 5.0	Integration of advanced technology with a focus on human-machine collaboration.

Source: author using R software based on information from Scopus (2024).

The bibliometric search was carried out for a period of 12 years, from 2012 to 2024. This interval was selected, since there are no articles published in Scopus with the same topic before 2012. Therefore, the analysis focused on publications corresponding to these dates.

In total, 246 publications related to the topic were identified in the database, all of which were included in the analysis. Regarding the distribution by type of document, 40.7% correspond to articles, adding up to a total of 100 publications. This is followed by conference papers, which represent 35.8%, with 88 publications in total. In third place are book chapters, which constitute 11.4% of the publications, with a total of 28 documents.

All this data was organized and managed in R Studio for subsequent analysis; The following analyzes were carried out: documents by year, documents by author, documents by affiliation, documents by country/territory and documents by funding sponsor.

3. RESULTS AND DISCUSSION

Law of bibliometric productivity

Lotka's Law is a fundamental principle in bibliometrics that describes the unequal distribution of scientific productivity among authors. In the words of Lotka (Pratiwi et al., 2023), this law helps to understand how scientific production is distributed and identifies the most productive writers on a specific topic, which has important consequences for science management and evaluation. of the investigation.

Table 2 shows that 1 author wrote and published 4 documents, another author published 3 documents, 30 authors each wrote and published 2 documents and 127 authors have a single published document in Scopus. This means that a small group of authors concentrates a large part of the publications, while the majority of researchers contribute a much smaller number of works.

Table 2 Lotka's Law

Documents written	N. of Authors	Proportion of Authors
4	1	0.629
3	1	0.629
2	30	18.9
1	127	79.9

Source: author using R software based on information from Scopus (2024)

Bibliometric indicators

The results of the bibliometric analysis, displayed in Figure 1, show a clear hierarchy in scientific production worldwide. India and Indonesia lead this ranking with a significantly higher number of published papers. Malaysia follows closely, consolidating Asian dominance in this area.

Germany and the United Kingdom complete the group of the five countries with the greatest number of documents. Other countries such as the United States, Italy and Mexico, although they are also important producers, are located at a lower level.

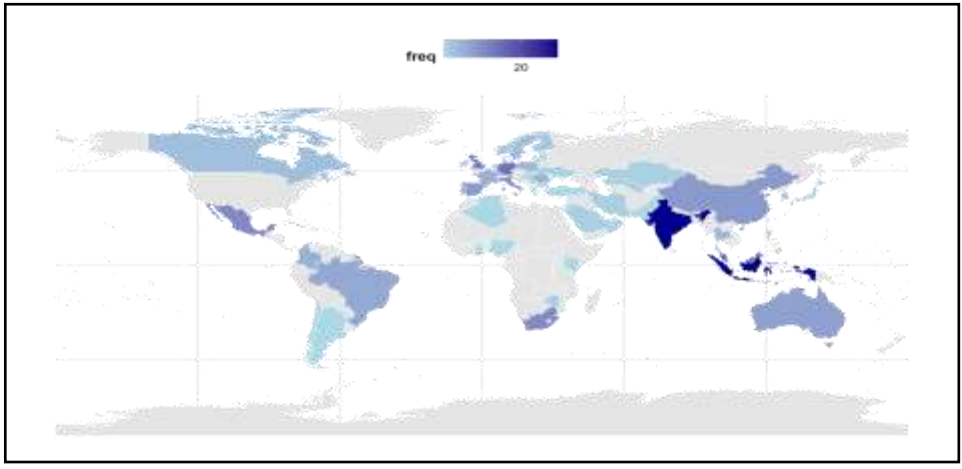

Figure 1. Scientific production by country, source: author based on information from Scopus (2024).

This distribution suggests a concentration of scientific production in a few countries, with India standing out as the main producer. However, it is important to consider that this graph only shows a partial aspect of global scientific production and that other factors, such as the area of knowledge or the impact of publications, could influence the interpretation of these data.

Following this line of analysis, Figure 2 details the institutions with the highest productivity in the research area.

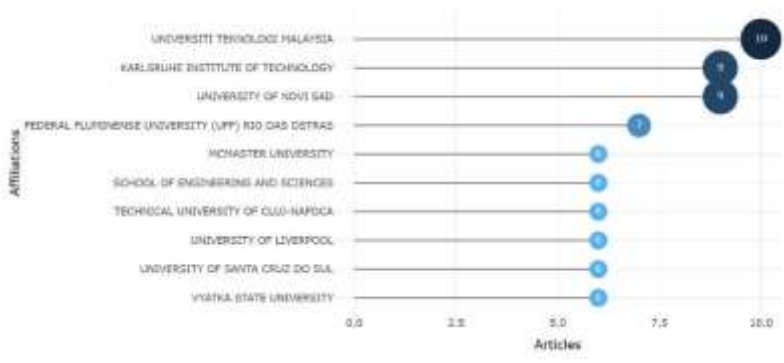

Figure 2. Most relevant affiliations, source: author based on information from Scopus (2024).

The graph presented shows a clear disparity in the production of scientific documents between the listed institutions. Universiti Teknologi Malaysia clearly stands out as the leader, with a scientific production of 10 documents, followed closely by the Karlsruhe Institute of Technology and the University of Novi Sad, with 9 documents each. This suggests intense research activity and greater international visibility of these institutions in the academic field. Subsequently, it is observed that the Federal Fluminense University (UFF) Rio das Ostras follows very closely with 7 documents, and finally, the remaining seven institutions have 6 documents each. This group could indicate a constant effort to generate knowledge, although on a smaller scale than the leading institutions.

To continue analyzing the evolution of scientific production throughout the period studied, the following graph is presented that shows the production of documents per year.

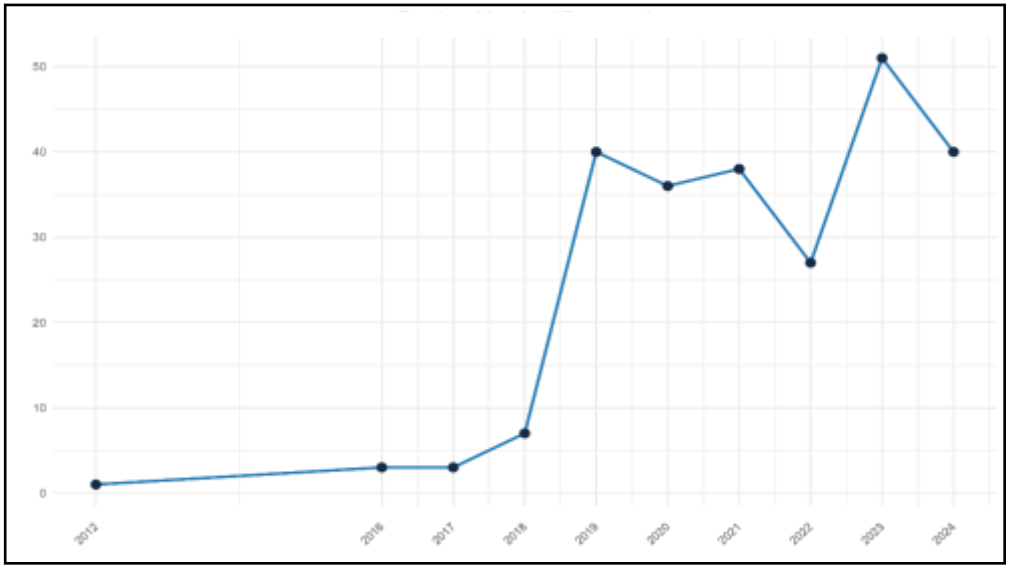

Figure 3. Documents by year, source: author based on information from Scopus (2024).

The analysis of the annual scientific production in the field of creative and cultural endeavors in conjunction with technology 4.0 reveals that for the years 2013, 2014 and 2015 there was no scientific production related to the research topic, starting in 2018 there was an increasing trend, with a peak in 2019 and later in 2023. This growing attention from the academic community suggests a consolidation of this topic as a relevant field of research. However, significant fluctuations are observed, such as the decrease in 2021-2022, possibly attributable to external factors such as the COVID-19 pandemic.

Following the same order of ideas, Table 3 presents the 10 authors with the most published documents. The most active authors in the publication of documents on creative and cultural endeavors with 4.0 technology have contributed with 3 and 4 documents, with Bruno, C, who

leads this group with 4 published documents. Below is the ranking of the 10 most participatory authors in the research area.

Table 3 Documents by author

Author	N° of documents
Bruno, C.	4
Ciolacu, M.	3
Ali, N.M.	2
Aliyu, F.	2
Anshari, M.	2
Canina, M.	2
Chun, H.	2
Dev, K.	2
Dewi, M.	2
Flatscher, M.	2

Source: author using R software based on information from Scopus (2024).

Finally, Table 4 shows the ten articles related to the topic of study that have the most citations.

Firstly, the most cited article is that of Maddikunta, P. et al. (2022), titled "Industry 5.0: A survey on enabling technologies and potential applications", with 830 citations. Next, the study by Kipper, Liane Mahlmann et al. (2021) titled "Scientific mapping to identify the competencies required by industry 4.0", with 141 citations. This study provides insight. Finally, the work of Lööw, J et al. (2019), titled "Mining 4.0: The impact of new technology from a workplace perspective", has been cited 87 times.

Table 4 Most cited documents

Author	Title	Cites
Maddikunta et al. (2022)	Industry 5.0: A survey on enabling technologies and potential applications	830
Kipper et al. (2021)	Scientific mapping to identify the competencies required by industry 4.0	141
Lööw et al. (2019)	Mining 4.0: The impact of new technology from a workplace perspective	87
Jerman et al. (2020)	Transformation towards smart factory system: Examining new job profiles and competencies	84
Buasuwan et al. (2018)	Rethinking Thai higher education for Thailand 4.0	80
Hernández-de-Menéndez et al. (2020)	Technologies for the future of learning: state of the art	73
Kolade et al. (2020)	Employment 5.0: The work of the future and the future of work	72
Shatunova et al. (2019)	STEAM as an Innovative Educational Technology	68
Catal et al. (2019)	Aligning education for the life sciences domain to support digitalization and industry 4.0	45
Humayun et al. (2021)	Industrial revolution 5.0 and the role of cutting edge technologies	43

Source: author using R software based on information from Scopus (2024).

Analysis of relationships and co-occurrences

Finally, in the cluster analysis through VOS VIEWER, figure 5 reveals the terms with the greatest impact grouped by co-occurrence, where keywords such as: Industry 4.0, Students, Industrial Revolution, Education 4.0, Artificial Intelligence, among others, are observed.

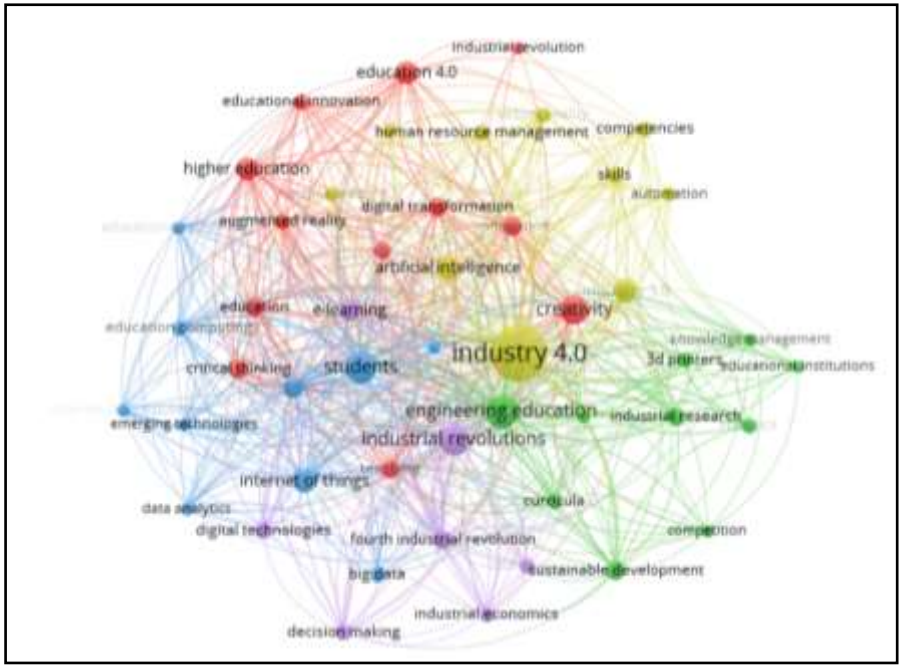

Figure 4. Terms associated with the study topic "Creative and cultural ventures with 4.0 technology", source: author based on information from Scopus (2024).

4. CONCLUSIONS

In this article, a comprehensive bibliometric analysis was carried out using the Scopus database to identify key trends in research on creative and cultural entrepreneurship in combination with technology 4.0. Through various tools such as R Studio and VOS VIEWER, important findings were achieved related to scientific productivity, the geographical distribution of research and the main authors and institutions that lead this field. The results provide a comprehensive view of the state of the research and suggest significant implications for the future development of this topic.

Analysis of scientific productivity revealed a strong concentration of publications in a few countries, with India and Indonesia leading the production, closely followed by Malaysia. This Asian dominance in scientific production highlights the growing relevance of these regions in research on creative entrepreneurship and technology 4.0. Furthermore, the presence of Germany

and the United Kingdom among the top five countries underlines the importance of research in these areas at a global level. These results suggest that there is a consolidation in scientific production in certain regions, which could imply opportunities for international collaboration in future research.

In terms of productivity by institution, Universiti Teknologi Malaysia as the leader, with a scientific production of 10 documents, closely followed by the Karlsruhe Institute of Technology and the University of Novi Sad, with 9 documents each, stood out as the most influential, surpassing other universities. This indicates a sustained focus on research into creative and cultural endeavors by this institution, which contributes to its international visibility. In contrast, the Federal Fluminense University (UFF) Rio das Ostras follows very closely with 7 documents, and the remaining seven institutions found have 6 documents each; more moderate production levels, but still significant. These results suggest the need to strengthen collaboration networks between institutions to promote greater exchange of knowledge and resources.

The temporal analysis of scientific production showed that starting in 2018, growth was experienced in the number of publications, with peaks in 2019 and 2023. This increase reflects a growing interest in the intersection of creativity, culture and 4.0 technology in academic research. . However, significant fluctuations were observed, especially during the COVID-19 pandemic, suggesting that external factors can influence the dynamics of scientific production. The general trend points to a consolidation of the topic as a relevant and expanding area of research.

In terms of Lotka's law, it was observed that a small group of authors concentrated the majority of publications, while a large number of researchers contributed only one document. This is consistent with the patterns of scientific productivity described by this law, indicating that research on creative and cultural endeavors with 4.0 technology is largely driven by a small core of highly productive researchers.

Finally, the analyzes of co-occurrences and relationships showed a strong connection between terms such as "Industry 4.0", "education 4.0", "artificial intelligence" and "industrial revolution". These results suggest that research in this area is being oriented towards the convergence between advanced technologies and creativity, which could open new opportunities for innovation in different industrial and educational sectors.

In conclusion, this bibliometric analysis highlights the growing importance of creative and cultural endeavors with 4.0 technology in academic research, with strong leadership from Asian countries and a small group of authors and institutions that dominate the field. The observed trends suggest that this is an expanding topic, with great potential to continue developing in the coming years. However, it is necessary to encourage international collaboration and geographical diversification of research to make the most of the opportunities that this area can offer.

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