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Connecting the Wings of Dynamism: Bibliometric Analysis of Artificial Intelligence and Entrepreneurship Fields*

Dinamizmin Kanatlarını Birleştirmek: Yapay Zekâ ve Girişimcilik Alanlarının Bibliyometrik Analizi

Murat ÇEMBERCİ[a], Ercan KARAKEÇE[b]

[a]*Department of Administration, Management and Organization, Faculty of Economic and Administrative Sciences, Yıldız Technical University, İstanbul, Türkiye*
[b]*Department of Foreign Trade, Vocational School of Social Sciences, Istanbul Medipol University, Istanbul, Türkiye*

[a]*Yıldız Teknik Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, Yönetim ve Organizasyon Bölümü, İstanbul, Türkiye*
[b]*İstanbul Medipol Üniversitesi, Sosyal Bilimler Meslek Yüksekokulu, Dış Ticaret Bölümü, İstanbul, Türkiye*

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ABSTRACT

This study aims to create a holistic viewpoint by concentrating on two dynamic areas of artificial intelligence and entrepreneurship with the rigorous application of bibliometric analysis. The concept of artificial intelligence, constantly heard as the digital world gradually penetrates our lives, and entrepreneurship referred to as the atomic element of economic infrastructure, are addressed in the same pot as this research. The attitude of both areas against varying circumstances constitutes the essential basis of this examination. The view that the effectiveness in the areas can be increased with the synergy to be created between the two focuses is supported. With this intention, the study commences with an informative literature section, where the introductory elements of the areas are conveyed. Afterward, it tries to clarify why these zones need to be examined together. Following this, a robust method frequently used to bring unfamiliar kinds of literature cooperatively is a bibliometric analysis study conducted using data obtained from the Web of Science database and subjected to various analyses. In the last stage, the study is completed by examining these outputs and analyzes. As a result, conclusions support "the duo" can be investigated jointly. The study contributes to the idea that artificial intelligence and entrepreneurship are wings working in synchrony for the requirement of success.

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* **Sorumlu yazar / Corresponding author**
*E-mail address: ekarakece@medipol.edu.tr

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ÖZ

Bu çalışma yapay zekâ ve girişimcilik gibi iki dinamik alana bibliyometrik analiz yöntemi ile odaklanarak bütünsel bir bakış açısı oluşturmayı hedeflemektedir. Dijital dünyanın hayatlara gün geçtikçe nüfuz etmesiyle sıklıkla duymaya başlanılan yapay zekâ kavramı ile ekonomik altyapının atomik unsuru olarak anılan girişimcilik, bu araştırma ile aynı pota içerisinde ele alınacaktır. Her iki alanın da değişken durumlarla olan ilişki biçimi bu çalışmanın temel dayanak noktasını oluşturmaktadır. İki odak arasında oluşturulabilecek sinerji ile alanlardaki etkinliğin artırılabileceği önerisi desteklenmektedir. Bu niyetle çalışma bilgilendirici literatür kısmıyla başlamakta, alanlara ait temel unsurlar aktarılmakta ve bu alanların neden birlikte irdelenmeye gerek duyulduğu açıklanmaya çalışılmaktadır. İkinci bölümde farklı literatürleri bir araya getirmede sıklıkla kullanılan bibliyometrik analiz çalışması ile Web of Science veri tabanı üzerinden çekilen veriler çeşitli analizlere tabi tutulmuştur. Son aşamada da bu çıktıların ve analizlerin irdelenmesi ile çalışma tamamlanmıştır. Netice itibariyle iki alanın ortak bir maksatla ele alınabileceği fikrini destekleyecek bulgular elde edilmiştir. Böylelikle başarıya erişimde yapay zekâ ile girişimcilik olgusunun senkronize çalışması gereken kanatlar olması gerektiği fikrine katkı sunulmuştur.

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1. INTRODUCTION

In the current environment where technology is increasingly expanding its influence, competition continues to evolve within this acceleration (Zou, 2024). In the business ecosystem, it is seen that those who are unprepared/caught in the movement must face some difficulties due to the dizzying competition (Chaudhary et al., 2024). Entrepreneurs who face difficult conditions must consider numerous factors in establishing and running procedures for business essentials (Camuffo et al., 2024; Coali et al., 2024). When uncertainties are added to the environmental factors, the decision-making and implementation stages of the entrepreneur can turn into problematic issues (Kromidha & Bachtiar, 2024), and s/he experiences problems while carrying out actions (Tallman & Koza, 2024). For these reasons, the existence of elements that can support the entrepreneur in the processes s/he needs to solve can be life-saving (Usman et al., 2024; Xu et al., 2024). In this direction, it is stated that considerable traditional requirements have been replaced by digitally supported applications in the steps taken, empowering entrepreneurs to take control of their business operations (Felicetti et al., 2024). It has been shared that improvements can be made at many points in the relevant process by taking advantage of various developments in information technologies (Badzińska, 2016).

This study is a pioneering exploration of a crucial research question: Can digitalization significantly contribute to the areas entrepreneurs need, fostering numerous interactions with artificial intelligence? The goal is to create a symbiosis that can revolutionize awareness and problem-solving (Giuggioli & Pellegrini, 2023). Given the compelling reasons, it is crucial to examine artificial intelligence, which was born and developed in engineering (Nti et al., 2022), and entrepreneurship, a distinct discipline, in a joint pot (Obschonka & Audretsch, 2020). The aim is to uncover this intersection area's potential benefits and awareness. Firstly, a brief literature review on these two distinct fields was shared to reinforce the potential for a synergistic interaction. Subsequently, a bibliometric analysis was conducted, including publications printed after 2000 on the Web of Science (WoS). Finally, the findings were shared, and the evaluations were completed by interpreting the analyses obtained in the research.

2. THE BACKROUNDS OF THE WINGS: A BRIEF LITERATURE

The two fundamental concepts that form the wings of the study remain within the scope of distinct disciplines. While the notion of artificial intelligence is often associated with computer and basic sciences (Copeland, 1993; Nilsson, 2009), and entrepreneurship (Hisrich et al., 2017) is generally referred to as a concept studied by business and management disciplines (Shane & Ulrich, 2004). Since the scopes, priorities, and jargon used by the two fields are different, a basic level of literature transfer in the study before the analysis section is deemed functional for the mentioned grounding.

2.1. Artificial Intelligence

Artificial intelligence, the field that enables human characteristics to be performed through machines and programs (Jiang et al., 2022), has seen significant evolutions since its inception (Muthukrishnan et al., 2020). The continuous development of new applications is a clear indication of the potential of AI, constantly expanding the transference of human achievements to machines (Deshpande &

Kumar, 2018). For this study, it would be more appropriate to regard artificial intelligence as a generalized/superordinate concept. When focusing on the details, many subcategories of artificial intelligence are mentioned.

Machine learning is a subbranch of artificial intelligence, and it uses past data in the learning process (Helm et al., 2020). Deep learning is also concerned with the scope of machine learning and performs the self-learning process with the support of artificial neural networks (Montesinos López et al., 2022). Another kind that is considered significant in this field is fuzzy expert systems. It tries to solve by imitating the opinions of human experts in the field (Manoharan et al., 2024). A different structure in this field is natural language processing increases human-machine interaction. It enables machines to understand and interpret people (Chowdhary, K.R. (2020). An extension of artificial intelligence applications is robotics, which represents the performance of human-like actions by machines (Molfino et al., 2024).

Artificial intelligence practices have made remarkable progress since the beginning (Kubassova et al., 2020). This evolution chain is also progressing with the development of technology (Muthukrishnan et al., 2020). The dynamism experienced in the sector forces both the production and consumption sides to remain constantly alert/alive and to undergo technological transformation (Horowitz et al., 2018; de Mattos et al., 2024). This situation affects producers and users of these products/services. Furthermore, it requires continuous struggle (Shao et al., 2022). Thus, the necessity to look at the issue from the point of artificial intelligence strategically arises (Borges et al., 2021).

2.2. Entrepreneurship

It is stated that there is no joint definition accepted in the literature for entrepreneurship, which is expressed with various characterizations from diverse sources (Çemberci & Karakeçe, 2020). However, when focusing on the most frequently used descriptions, it is seen that explanations are made firstly by undertaking the action with a historical basis (Casson & Casson, 2014), then evaluating the opportunities in the following processes, and taking the crucial steps for innovation and commercialization (Dyer et al., 2008; Hébert & Link, 2009).

In this sense, the entrepreneur contributes significantly to the environment with his/her problem-solving, enriching, and innovative structure (Hyytinen, 2021). It gives him/her an identity for the discovery and coordination of the factors of production (Lipparini & Sobrero, 1994). S/he has a pivotal role in increasing the level of welfare with the asset s/he allocates to the economic and social surroundings (Méndez-Picazo et al., 2012; Neumann, 2021). His/her action-oriented and visionary attitude persists in the continuity of value production for the environment (Boutillier & Uzunidis, 2014; Reid & Crawford, 2022).

While all these activities are implemented, the entrepreneur must take various actions from production to the end consumer (McMullen & Shepherd, 2006). However, at this stage, deviations in the actions of the parties with whom the entrepreneur communicates force him/her to be constantly alert (Chavoushi et al., 2021). In addition, within the market mechanism, as Porter mentioned in his five forces model (Porter, 2008), the entrepreneur may be compelled to struggle with numerous potential competitive actors. Thus, the entrepreneur is at the center of the transformation because of the nature of his/her position. Moreover, s/he has to establish an unbreakable relationship with dynamism (Grundy, 2006).

2.3. Connecting Artificial Intelligence and Entrepreneurship

Several studies have explored various aspects of entrepreneurial activities, seeking to enhance their effectiveness and productivity (Audretsch, 2012). The rise of digitalization has fundamentally transformed business practices, leading to a reassessment of the structures and operations in entrepreneurship to remain competitive in today's rapidly evolving markets (Kraus et al., 2019; Fossen & Sorgner, 2021). In this context, the potential of artificial intelligence as a valuable resource in the business environment has been highlighted (Borges et al., 2021).

It is emphasized that multiple elements in life will be affected and contributed to by the development and implementation of artificial intelligence technologies (Davenport & Ronanki, 2018). It is stated that the creativity and innovation cycle, closely related to entrepreneurship, will be carried further with artificial intelligence technologies, which are a part of digital modification (Ertel, 2017; Vinchon et al., 2023). It is expected that many applications that need to be done in the entrepreneurship process will occur a shell change via artificial intelligence (Tran & Murphy, 2023). In this sense, studies that associate aspects of artificial intelligence with entrepreneurship have begun to be reflected in the literature (Giuggioli & Pellegrini, 2023; Obschonka & Audretsch, 2020).

Based on the causation and effectuation basis (Sarasvathy, 2001) of the relationship between entrepreneurship and artificial intelligence, research is being conducted to support a ground where the fields will benefit from each other (Kamble et al., 2023; Lupp, 2023). While assisting the usefulness of technology in entrepreneurship is considered essential in some circumstances (Yoon & Kwon, 2023), some scenarios are also mentioned where the planned success/benefit cannot be handled (Eggers, 2012). It is stated that considerable market factors should be considered and acted accordingly (Zhu & Matsuno, 2016). Elements such as perception, adoption, and desire to benefit from technology are mentioned as aspects to be dealt with within the organization (Marangunić & Granić, 2015). Aspects such as infrastructural requirements, cost, integration, and security also emerge as issues that arise within the market/outside the organization (Metke et al., 2010). With the Technology Acceptance Model, research

is being conducted on the factors that prevent technology from being integrated into the resolution, and the focus is on facilitating the achievement of the expected advantages of artificial intelligence (Rahimi & Oh, 2024).

Thus, the idea that associating entrepreneurial decisions and actions with artificial intelligence technologies will produce meaningful results for both fields represents the synchronous operation of the wings mentioned in the title of this study.

3. MATERIALS AND METHODS

Developments in the scientific field are rapidly advancing with the aid of technology (Ba et al., 2024; Chandra & Dong, 2018; Coccia, 2024). This global progress is evident in the publication pools, which are supplied with new creations of researchers worldwide. This accumulation of studies creates a challenge and highlights the scientific community's interconnected nature. Implementing applications relieving researchers of this hardship will accelerate academic development (Steffen et al., 2024). The demand for such solutions is apparent in the literature, with studies on this topic being highly sought after (Donthu et al., 2021; Moral-Muñoz et al., 2020). Among these solutions, the guidance of bibliometric analysis is particularly valued and preferred, providing a global perspective for new researchers in the field (Donthu et al., 2021; Lim & Kumar, 2024).

With bibliometric studies, it is feasible to map the studies conducted in the field using statistical and mathematical methods on the imprint and content information of the works (McBurney & Novak, 2002). Various aspects such as "citation analysis, co-citation analysis, bibliographic coupling, co-author analysis, co-word analysis" are evaluated in the research, and all details will help researchers determine (Zupic & Čater, 2015). It is also stated that this method is used to identify the relationships between diverse domains (Mukherjee et al., 2022). In this way, it is likely to discover which focuses are emphasized in the field/s, what processes are progressing, and inferences about the future can be provided (Gan et al., 2022). On the other hand, some clues can be collected to specify the aspects of the area or related topics that are open to improvement (Koseoglu et al., 2016).

In light of all these causes, the bibliometric analysis method was preferred in this study, and scans were conducted for the specified research questions: (1) Are the fields of artificial intelligence and entrepreneurship addressed jointly in academic studies? (2) What are the most common topics/concepts addressed in these studies? (3) Which are the most productive authors, journals, and countries in this regard?

The Web of Science (WoS) database was preferred for this research. WoS is considered a respected and reliable resource (Dirik et al., 2023). The analyses were done by data retrieved from the WoS database. It was utilized from WoS Analytics offered in WoS menus and VosViever program version 1.6.20. With the help of these programs, it is possible to access elements that facilitate understanding by providing visualizations in the analyzed areas (Sajovic & Boh Podgornik, 2022).

The study covered works published until 07.08.2024. The steps accepted in the literature were followed in the analysis. (Dontu et al., 2021; Öztürk et al., 2024). The expressions subject to analysis in the research were structured to include the study title, abstract, and keywords. Artificial intelligence has many subtypes/applications (Cui et al., 2024). Benefiting from similar studies in the literature (Mariani et al., 2023; Soori et al., 2023), only the mentioned expressions of artificial intelligence, machine learning, deep learning, fuzzy expert systems, artificial neural networks, natural language processing, robotics were included in the scope. Within these criteria, as based on the literature section, artificial intelligence search was scanned with "artificial intelligence", "machine learning", "deep learning", "fuzzy expert system*", "artificial neural network*", "natural language process*", "robotic*" keywords; and for entrepreneurship, the scan was made by adding "*" to the end of the searched word, including expressions starting with "entrepreneur*". In the first scan, it was seen that there were no publications before 2000, and the foremost two studies that met the criteria were published in 2001. Naturally, the year 2000 becomes a noticeable era. In this case, 1067 works were listed first. Withdrawn publications (25) and non-English ones (21) were removed from the list. Not to limit the scope of the field, all relevant categories were included, especially SSCI, SCI-Expanded, and ESCI. The analysis was conducted with the remaining 1021 works after this process.

4. RESULTS AND DISCUSSION

When the types of works recorded in the database were examined, it was seen that the majority were articles (747) and proceedings (173); the remaining few works were editorials and book chapters. When the indexes in which the fields scanned were interrogated, the total number of publications in the citation indexes of social sciences (SSCI + Conference) was 479, while the citation index of science (SCI-Expanded + Conference) reached 406. The number of publications in the ESCI index has reached 270.

Figure 1 shows that the accumulation of work was spread over the years. It was noticed that single-digit numbers exceeded in 2013 (13), and three-digit numbers (115) reached as of 2020. The increase in the number of publications after 2019 was remarkable. In the graph, it was noticed that the majority of the most cited studies were prepared in the last five years. In the same graph, the citation figures were shaped in parallel with the number of publications. It revealed that the academic community adopted the publications.

The top 10 journals with the most publications were Frontiers in Psychology (29), Sustainability (29),

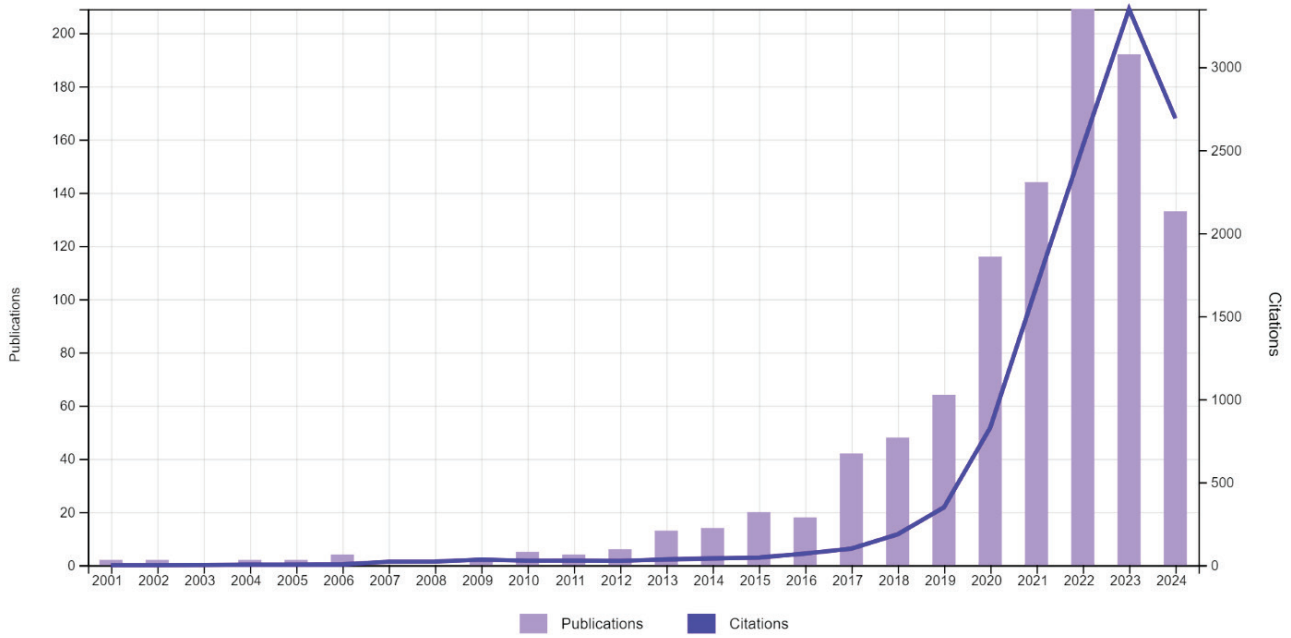

Figure 1. Publications and citations in year.
Source: Web of Science Analytics.

Technological Forecasting and Social Change (24), Industrial Robot an International Journal* (18), Industrial Robot The Journal of Robotics Research and Application* (17), Small Business Economics (14), Journal of Business Research (13), International Journal of Entrepreneurial Behaviour Research (13), Journal of Intelligent Fuzzy Systems (12) and Technology Innovation Management Review (10). Interview-based publications were published in the journals marked in italics.

In the order of authors with the most publications, Pransky, J. 35; Gupta, B.B. 8; Wang, W., Chen, Y., and Gaurav, A., 6; Liu, Y., Neubert, M., Nijkamp, P., Panigrahi, P.K., Pfeifer, S., and Wang, X. were at the top of the list with five publications. Pransky's publications were the interview works mentioned. The most cited authors in the analysis were Wang, W.; Neubert, M.; Gupta, B.B.; Panigrahi, P.K.; Pransky, J.; Guarav, A.; Nijkamp, P.; Pfeifer, S.; Zekic-Susac, M.; Arshi, T.A. In the co-citation analysis, which is used for publications frequently cited jointly, the author ranking was as follows, starting from the most influential publication: Shane, S.; Nambisan, S.; Obschonka, M.; Audretsch, D.B.; Teece, D.J.; Davidsson, P.; Agrawal, A.; Zahra, S.A.; Acs, Z.J.; Shepherd, D.A.

In most cited studies in the selected publication group, it was seen that Warner, K. and Weager, M. (2019); Makridakis, S. (2017); Camarillo, D.B. et al. (2004); Dubey, S., and team (2020); Hannigan et al. (2019) were included in the list.

In terms of publication affiliations, the following were in the top ten with publications: University of London (19), University of California System (15), Indian Institute of Management IIM System* (14), Jilin University (13), State University System of Florida (11), Harvard University (10), Indian Institute of Technology System IIT System* (10), Lebanese American University (10), University System of Ohio (10) and Sankyo Robot* (9). Affiliations marked in italics and with "*" also belonged to interview-based works.

When the top 10 countries with the most citations were examined, it was seen that the USA (196) and China (193) were at the top of the list, followed by India (89), England (85), Italy (67), Germany (60), Spain (55), France (47), Australia (36), and Canada (30). When country relations were examined in studies with co-authors, the sequence based on at least ten publications was lined up as follows: USA, China, England, Italy, India, Germany, France, Spain, Taiwan, and Australia.

As reflected in Figure 2, when the most typically used common concepts were listed with the condition of being used at least five times, the first ten expressions out of 118 that meet the criteria are artificial intelligence, entrepreneurship, machine learning, deep learning, big data, innovation, robotics, digitalization, entrepreneurship education, and technology. In the ranking made by separating the main search concepts, the ones that stand out were innovation, digitalization, entrepreneurship education, technology, and digital transformation. Autonomous robots, robot design, mobile robot expressions and education, crowdsourcing, and sustainability expressions related to robots were also among the followers. In addition, the figure guiding showed which images were considered and examined in common with which ones. In addition, it becomes easier to question concept relationships with the guidance of colored groups (Van Eck & Waltman, 2010).

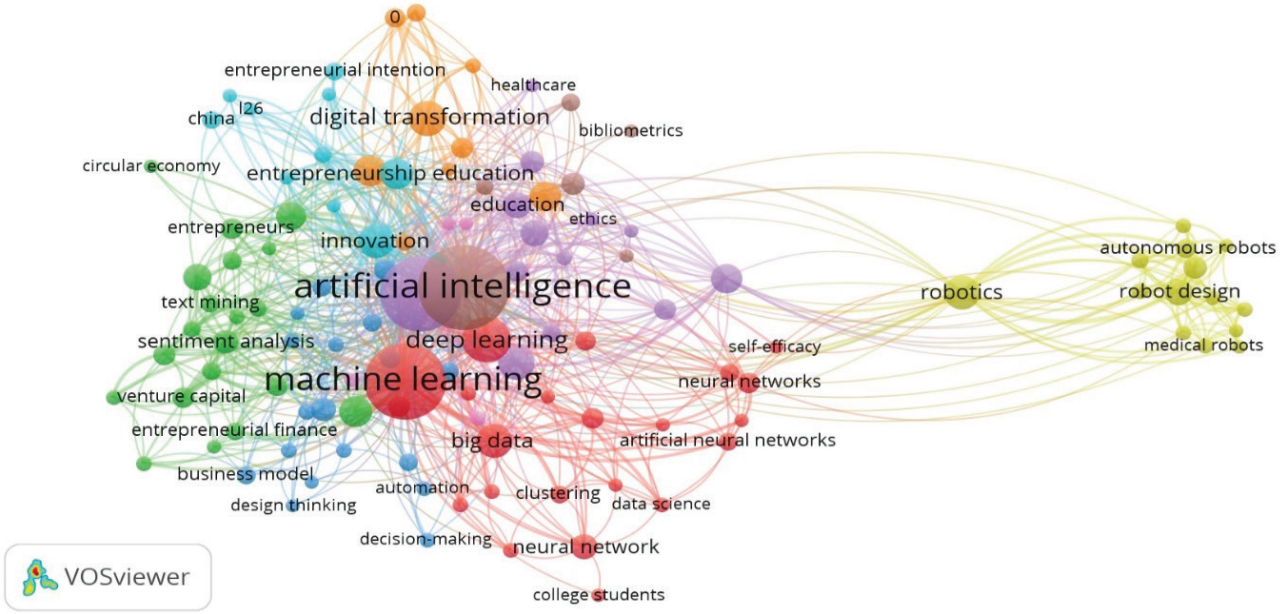

Figure 2. Keyword usage and ıntensity.
Source: VOSviewer.

Figure 3 portrays the frequency of use of the concepts that emerged in the analysis over the years. This figure was meaningful in terms of showing which notions have been researched. It also told which ones have been more popular over the years. As can be noticed, the dominance of green and yellow tones in the field reflects those studies with a broader scope that have been performed in the last three years. In addition, the studies in the field showed a shift from technical issues (purple area) to managerial areas. It illustrated that circular economy, digital transformation, sustainability, decision-making, venture capital, crowdfunding, start-up, digital entrepreneurship, innovation, creativity, and ChatGPT concepts were studied more frequently.

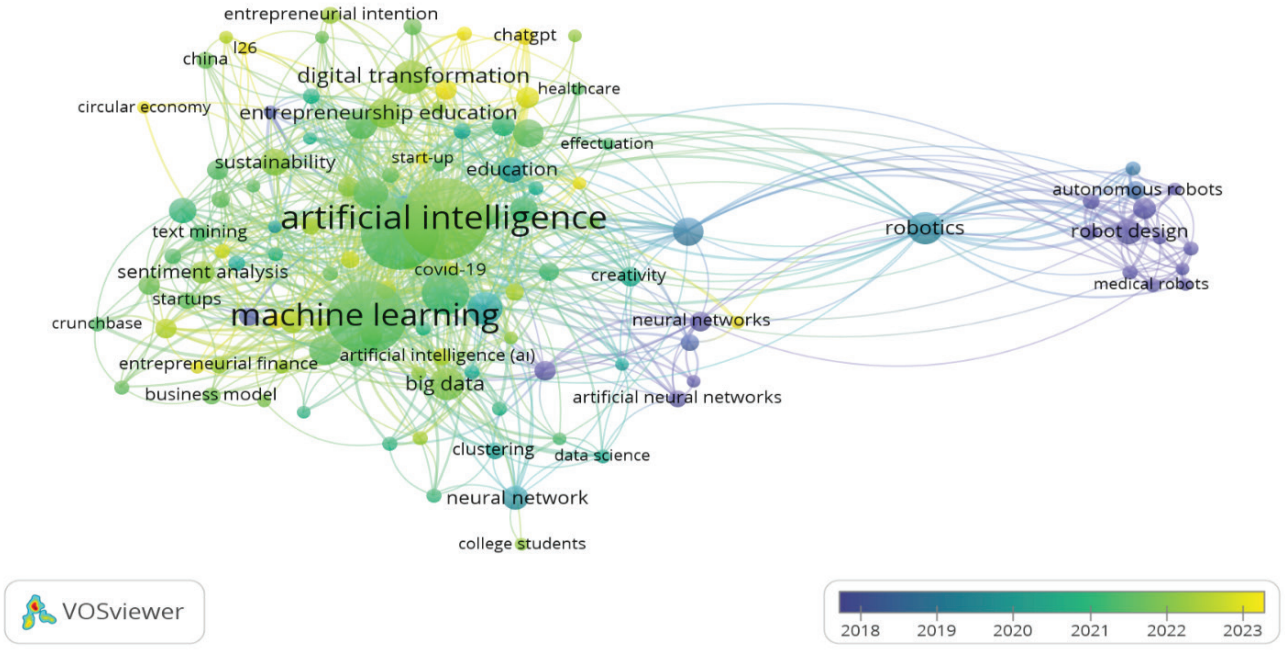

Figure 3. Keyword usages in years.
Source: VOSviewer.

5. CONCLUSION

Many analyses are being conducted to deepen entrepreneurial exercises and improve desired consequences (Leendertse et al., 2022; Stam, 2018; Van Looy et al., 2011). In particular, the digital transformation has changed the corporate implementation. Thus, differences in market essentials have become debatable in existing steps in a competitive habitat (Bickley et al., 2024; Nambisan et al., 2019). In this study, the notion of entrepreneurship has been addressed and examined with the concept of artificial intelligence, considered a distinct fracture of digitalization and is being studied by both popular media and the academic community.

Since both fields are within the scope of divergent disciplines, the situation may seem complicated for researchers who are interested in the investigation focus. With this study, artificial intelligence technology and entrepreneurship were evaluated collaboratively. A ground was prepared that would guide future research. Then, a humble contribution was made that would form a bridge between these fields. In addition, an attempt was made to create a fundamental stance between these attractive domains.

As a result of the research, the notion that the fields of entrepreneurship and artificial intelligence would have a collaborative future was supported. The questions in the methodology section were answered: (1) the cooperative issues in the domains were identified. The main themes were clarified. Some signals were given about the evolutions of the topics over time. Indications were shared about effective networks and alliances in the studies by presenting (2) contributor authors, journals, and countries. These inklings provided some agents to be followed and guided contributions to researchers with publication intentions. In addition, revealing the author and work citations (3) assisted in facilitating the understanding of the essential details of the areas. In addition, the issue of which authors to reference in this field in the literature facilitated when conducting similar research.

It was emphasized which concepts were frequently studied within the scope. Figure 3 shows that the handled terms were gradually concentrated on the entrepreneurial focus. As a consequence of the keyword analyses, technology and digitalization topics were among the most frequently emphasized terms, apart from the search ones. It was seen that the concept of innovation, which is prominent in entrepreneurship, found its place in the top ten rankings. It is likely to be interpreted that other entrepreneurship-related notions were studied less than the relevant-mentioned ones. This case indicated the existence of a gap in the area. In this context, it contributed to the possibility of probable concepts that have yet to be highlighted in the future. Clues shared about the aspects of the common field that are open to evolution. Thus, the patterns between the concepts that concern the two fields were revealed. In this way, a supportive contribution to academic development was made, and white-hole guidance was provided for future publications. Evolutionary expansion is anticipated to be strengthened as other related matters are surveyed. It can be stated that this study is a promising commencement for researchers in both fields and will provide insight.

Even though citation index figures show that artificial intelligence was a technical matter that concerns engineers, the field of social sciences was also interested in the subject. On the other hand, entrepreneurship was also examined by scientists and basic scientists, and this framework was significant in terms of field interaction. When we look at the number of publications and citations, the increase experienced in the post-Covid period was remarkable. It should not be interpreted as a coincidence that the acceleration in the last five-year indicators is within the same period.

In addition, essential information was shared to determine the attitude of the academic community in the countries on two critical issues concerning the future. It can be recommended that studies be conducted in the future that will confirm a relationship between this attitude of the academic community and economic indicators. In addition, it was noticed as a surprising outcome that Japan and South Korea, which come to mind first when it relates to technology, were outside the top ten in the rankings presented in this field. In addition, it was seen that the USA and China had tough competition in this field. Either the author and other figures on a country basis showed that the competition between the USA and China in commercial areas (Ju et al., 2024) continues in this domain. In particular, the efforts of China and India in publishing are reflected in the figures.

In addition to all these gains and insights, the study has several limitations. First, the scope was defined by the data obtained from WoS. The probable relevant findings could be confirmed with other database examinations. In addition, VOSviewer and WoS Analytics were used in the analyses. So, the results were limited by program capabilities. More comprehensive results could be presented by offering solutions that would increase the depth of the field with different solutions and programs. However, it is crucial to remember that this study is not the final word. The field is dynamic and constantly evolving, and it is essential to update and re-examine the study over time. Finally, the study provided a research opportunity by focusing on the examinations published until the date specified in the methodology section. The results of the analysis may change with subsequent publications. This review will guide future researchers, especially when the dynamism of the two fields examined is in question.

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