A Systematic Literature Review on the Role of Artificial Intelligence in Entrepreneurial Activity

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ABSTRACT

New models of entrepreneurship are emerging because of increasing digitalization and the development of artificial intelligence (AI). There is a lack of existing research on the intersection between digitalization and entrepreneurship. Therefore, this systematic literature analysis aims to expand knowledge in this area and provide a semantic analysis of existing contributions. Following the SPAR-4-SLR protocol, it analyzes 520 scientific articles from the Dimensions.ai database up to July 2022. The methodology uses natural language processing (NLP) and tools such as bibliometrix and VosViewer, which reveal the main characteristics of the titles and texts of the abstracts and their links with the numbers of citations and with scientific impact. This study provides guidelines and clear recommendations for scientists to focus their scientific research on AI and entrepreneurship and entrepreneurs by including the link between AI and entrepreneurship in their strategies. As future lines of research, the authors highlight the potential of using NLP in bibliometric analysis.

KEYWORDS

AI, Artificial Intelligence, Entrepreneurship, Semantic Analysis, Systematic Literature Review

INTRODUCTION

The social impact of the digital revolution has been significant, affecting various aspects of daily life and work patterns (Makridakis, 2017) and making digitalization an important element in both economy and society (Peng & Tao, 2022). Technology is a crucial tool (Cheng et al., 2021) and is especially important for companies wishing to optimize their processes and strategies (Bui & Lo, 2022). Moreover, digitalization is useful both for mature companies with established business models

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facing a paradigm shift (Mithas et al. 2013) and for business ideas that need to establish themselves in the market. In recent years there has been great uncertainty in the international environment, with the result that the relationship between sustainability and digitalization has received much scholarly attention from authors such as Nyagadza (2022). This is because, on many occasions, the demands of business sustainability force organizations to seek the creation of value and structural changes in order to survive over time, adapt, and continue to satisfy the needs of society.

Entrepreneurship is a trend topic (Indrianti et al., 2020), and authors such as Audretsch and Moog (2022) argue that it deserves priority because it is linked to some of today's economic and social problems. Tools such as Artificial Intelligence (AI) acquire special relevance in the digitalization of organizations, given the need for entrepreneurs to continuously adapt and keep abreast of new developments (Kraus et al. 2018). Thus, AI has been driven by the continuous changes in the market and the increasing needs of a growing population. The information technology (IoT) revolution has contributed significantly to the momentum of AI technology and to the interest shown by business and government leaders (Zhang & Lu, 2021). However, little has been written specifically on the link between entrepreneurship and AI (Popkova & Sergi, 2020; Dubey et al., 2020), despite authors such as Obschonka & Audretsch (2019) pointing out that the introduction of AI in entrepreneurship ushers in a new era.

Among other systematic literature reviews, it is worth highlighting Giuggioli & Pellegrini (2022), who point out the benefits of AI in entrepreneurial development. Our research, however, not only focuses on so-far absent semantic analysis but also continues and extends the analysis of the last two years, which is especially relevant due to the digital boost that followed the Covid-19 situation. On the other hand, Di Vaio et al. (2020) analyze the literature on AI and business models. In recent years, literature reviews have looked at the links between various topics, including education (Tahiru, 2021); health (Shah & Chircu, 2018); public administration (Reis et al., 2019); and consumer behavior (Mariani et al., 2022). It is the lack of existing systematic literature reviews about the role of AI in entrepreneurship that makes the present study valuable.

In the present study, the following research questions have been answered:

RQ1: How has the intersection between AI and entrepreneurship evolved?
RQ2: Who are the main authors in the field, and how do they relate to each other?
RQ3: What are the main linked research topics?
RQ4: How is it possible to leverage semantic analysis in a systematic literature review?

In order to answer these questions, this research proceeds as follows. Next, the key concepts of AI and entrepreneurship are analyzed. Then the methodology used is provided. Discussion of the results and an outline of the bibliometric results follow, including the semantic analysis of the scientific contributions. Finally, the main conclusions, the limitations encountered, and future lines of research are presented.

Theoretical Background

Emerging technologies such as big data analytics and artificial intelligence are increasingly widely used (Dubey et al., 2020). Entrepreneurs require continuous adaptation to changes in the environment, and technological tools can function as external enablers in new business activity (Davidsson et al., 2018). Thus, data, defined as information and knowledge combined intelligently, become success factors capable of leading to new opportunities in the market (Soltanifar et al., 2021). Therefore, AI and big data are also key concepts in current business research, and the effective use of this data is an urgent problem in the field of information science (Li et al., 2022). According to Obschonka & Audretsch (2020), at the risk of sounding utopian, they may have the capacity to replace entrepreneurs or at least provide a symbiosis between technologies and entrepreneurs themselves. The novelty of

this study relies on its leveraging of natural language processing techniques in evaluating the link between artificial intelligence and entrepreneurship.

Entrepreneurship

The digital revolution has changed the methods of value creation (Guo et al., 2022). Consequently, scientific research on how digital elements influence business models has grown exponentially in recent years (Caputo et al., 2021). With organizations becoming increasingly digital (Dubey et al., 2020), we need to understand the role they play in the sustainability and growth of the business and the positioning of the organization in the market. Given the rapid changes occurring in the market and the increasing competition due to globalization, it becomes essential for entrepreneurs to use advanced technologies to gain a competitive advantage (Darwish et al., 2020). Thus, we also need to understand better the benefits and risks that may arise from their use. In particular, as Khalid (2020) highlighted, learning with AI in higher education institutions is relevant to the promotion of entrepreneurial activities.

Authors such as Upadhyay et al. (2021) have analyzed the existing antecedents for entrepreneurs embracing AI in digital entrepreneurship, and a growing interest in artificial intelligence has been triggered due to its transformative effect on entrepreneurship (Ratten, 2020). AI has significantly influenced the strategies and procedures of entrepreneurial organizations, as it helps to access and collect relevant data (Davidsson, 2016), which changes from being just data to relevant smart data (George et al., 2014), which in turn allows AI to become an enabler of new entrepreneurship ideas (von Briel et al., 2018).

Artificial Intelligence

Artificial intelligence is a key driver of both technological and economic growth (Shoufu et al., 2022) and provides new opportunities for companies (Pfau & Rimpp, 2021). Specifically, as academics such as Gupta and Dhawan (2018) pointed out, AI is a way to make a computer think similarly to how humans think, i.e., intelligently. Given the paradigm shift that society is facing, digital tools are a driver for growth and development, enabling the transformation of the nature and scope of business activity (Nambisan, 2017). Thus, it is essential to analyze how AI may impact global productivity and other aspects of life in the near future (Gupta et al., 2023).

AI is a key element in the development and management of knowledge (Pai et al., 2022). Authors such as Dean et al. (2020) point to the need to adopt artificial intelligence techniques, as each technique enables groundbreaking implications for organizational efficiency. Technologies such as big data and predictive analytics enable organizations to create new products or services to meet changing customer needs (George et al., 2014), although for information to be of value, effective data management is essential (Jamil & Yukongdi, 2020).

AI, one of the most advanced technologies (Lv et al., 2022; Khanam et al., 2022), has influenced the global economy, thus impacting its development. It is a multidisciplinary technology that enables the integration of cognition with machine learning and emotion recognition (Lu, 2019). It combines computer science, logic, and other disciplines and has been applied in such important processes as natural language recognition (Duan et al., 2009), enabling human-computer interaction, data storage, and decision-making. AI has been used for the optimization of business strategies (Saura et al., 2021), enabling organizations to develop more efficient business goals and strategies, such as enhancing service quality, productivity, and cost-effective service excellence (Wirtz, 2020). In sum, it responds to and optimizes processes with the aim of providing appropriate responses to user needs.

Nevertheless, there are still open challenges to be tackled if the adoption of AI in businesses is to be successful, for example the scalability of AI, the lack of AI experts, and the limited understanding of AI in society in general. These are roadblocks hindering the development of AI for business leaders and entrepreneurs (Kaplan & Haenlein, 2020).

METHODOLOGY

The methodology of the systematic literature reviews (SLR) encapsulates the process of gathering, ordering, and evaluating the existing literature in a review of existing concepts; it has been used in many relevant scientific works, such as Ali (2019). Many authors use this method in order to classify the topic and its theoretical framework and to analyze the bibliometric elements (Ribeiro-Navarrete et al., 2021; Nyagadza, 2022). However, not enough semantic analysis has yet been reported on the main contributions. This systematic literature review thus aims to reduce the existing gap in the literature about the link of AI with entrepreneurship.

The literature analysis was carried out following the SPAR-4-SLR protocol (Paul et al., 2021), which aims at being transparent, rigorous, exhaustive, and robust. According to this protocol, the process consists of the following three stages:

- **Assembling:** This phase aims to identify the type of publications to be included in the scope of the publication and the period covered by the review. By this means, the keywords for search are defined. The acquisition of the literature is part of this stage.
- **Arranging:** The process continues with the organization, filtering, and processing of the literature. In this phase, the inclusion and exclusion criteria are defined, to set the scope of the SLR.
- **Assessing:** The value generation resulting from the SLR takes place in this last stage. The goal is to analyze and evaluate the collected literature in order to generate insights and identify the gaps and research opportunities. It also covers the visualization of the results and the evaluation of the limitations of the study.

The methodology is described in Figure 1.

Figure 1. SPAR-4-SLR methodology
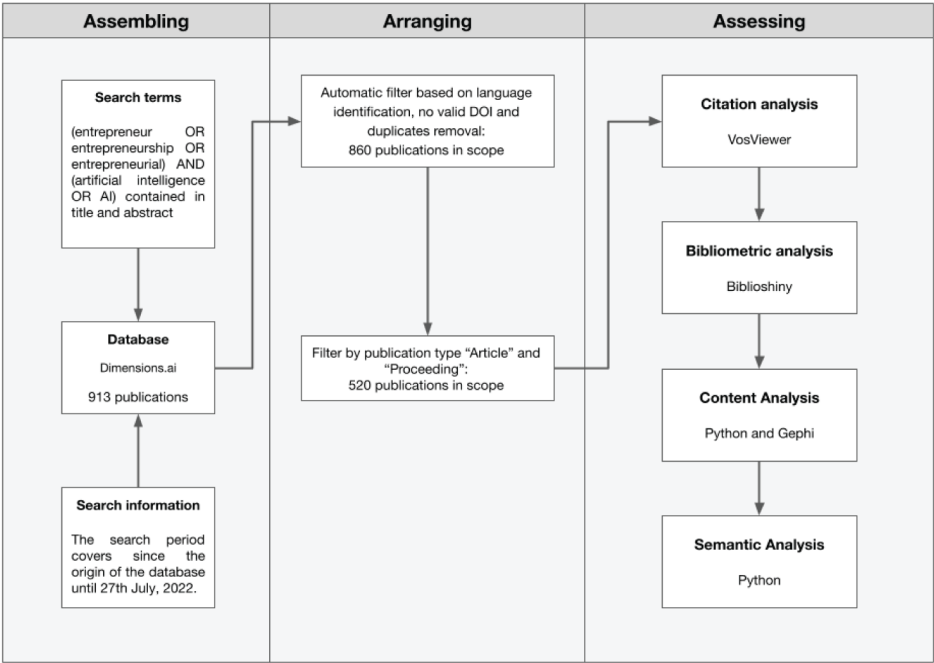
The tools used to analyze results include VosViewer for the citation analysis (Van Eck & Waltman, 2010), Biblioshiny, an R package for bibliometrics, and Python and Gephi for the content and semantic analysis.

Assembling

Digitalization nowadays is present throughout the organization. Therefore, the entrepreneur needs to consider both the general idea and its detailed implementation. In order to analyze the set of issues related to AI and entrepreneurship, a search was carried out in dimensions.ai (Thelwall, 2018), which indexes a myriad of publications from a wide range of relevant sources. This scholarly database has been used by previous researchers such as García-Sánchez et al. (2019).

For this purpose, the systematic literature review was completed with the analysis of articles resulting from the following search in both title and abstract, in the period between 1977 and 27 July 2022:

(Entrepreneurship OR entrepreneurial OR entrepreneur) AND (artificial intelligence OR AI)

Arranging

In order to filter the collected articles in the assembling phase, an automated analysis of the language of both title and abstract is first completed. Leveraging the use of Natural Language Processing techniques is a way of simplifying the arranging process when performing a systematic literature review. To this end, the articles whose language was not English have been automatically discarded after performing a language identification on both title and abstract.

Articles whose DOI was not valid were also removed from the scope of the review. Finally, only those publications that were an article from a journal or a proceeding from a conference were kept in the scope of the analysis.

Assessing

Assessing is the last stage of the SPAR-4-SLR protocol; it provides real value and allows us to answer the research questions posed. This allowed us to focus on the analysis and evolution of the topic, including concrete associations and models. In addition, in order to provide relevant data, we proceeded with the bibliometric analysis followed on previous occasions by authors such as Martínez et al. (2022), using bibliometrix, an R language-based tool used in comprehensive science mapping analysis and bibliometric analysis (Aria & Cuccurullo, 2017). Finally, we completed the semantic analysis, which can generate insights from a large amount of textual information from the remaining articles by leveraging NLP and artificial intelligence, including topic modeling, which is a popular statistical tool used in the extraction of latent and meaningful trends from a large dataset (Vayansky & Kumar, 2020). Specifically, a co-occurrence network-based topic algorithm is used, where the documents of the corpus are understood as a combination of topics, and the topics are sets of words that respond to probability distributions. Finally, an n-gram analysis, evaluating the co-occurrent terms in a corpus, was completed, following Erdogan et al. (2005).

RESULTS

Scientific Production Evolution

Digitization and the growth of digital tools have increased significantly in recent years, and in particular, there has been a growing trend since 2017, as described in Figure 2. Popkova & Sergi (2020) analyzed the influence of the use of human capital and AI, and Dubey et al. (2020), among others, also consider environmental dynamism. Thus, in addition to the notable increase of publications in this aspect, another trend can be observed nowadays: the researched and related topics go beyond the technologies themselves, into analyzing their repercussions and impact on society.

Figure 2. Annual Scientific Production
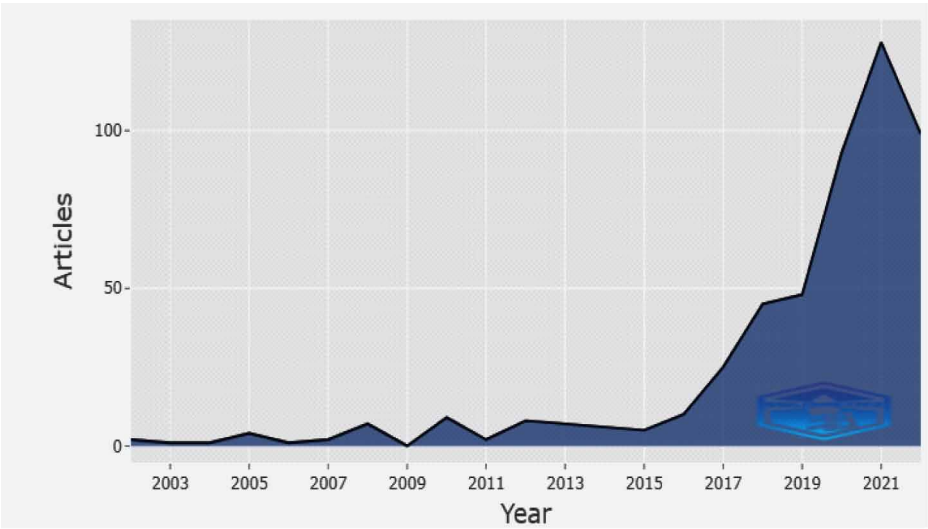
Citations Affiliations

Figure 3 refers to the most cited institutions. Specifically, it refers to the affiliations of the authors making the scientific contributions. Thus, Harvard University, Sydney University, Jilin University, The Indian Institute of Technology, and Queensland University should be highlighted.

Citation Analysis by Authors

Among the most representative authors in the field of entrepreneurship and AI represented in Figure 4, Sarasvathy et al. (2003), Makridakis (2017), Popkova & Sergi (2020), and Dubey et al. (2020) should be highlighted. In particular, Makridakis pointed out in 2017 the uncertainty about the future

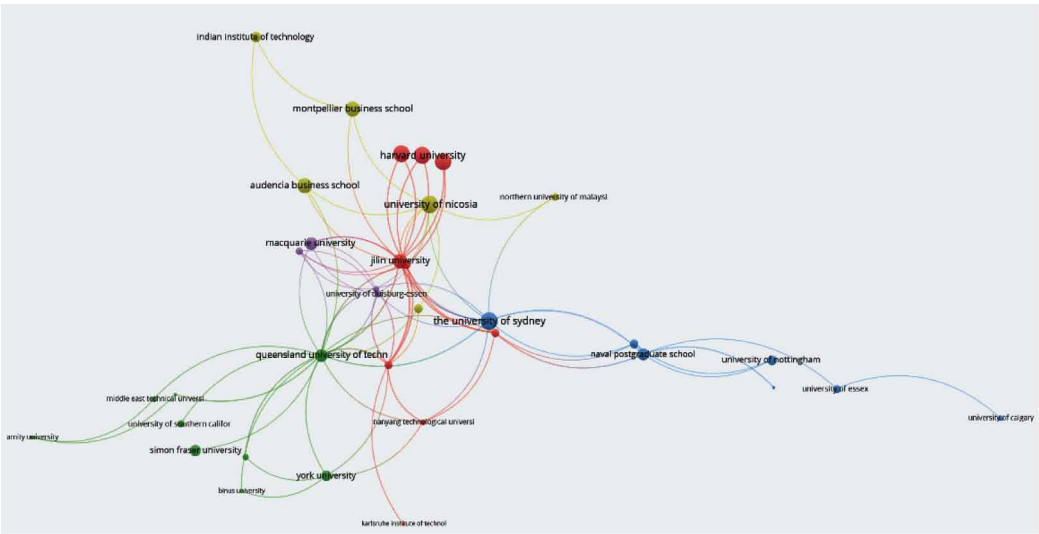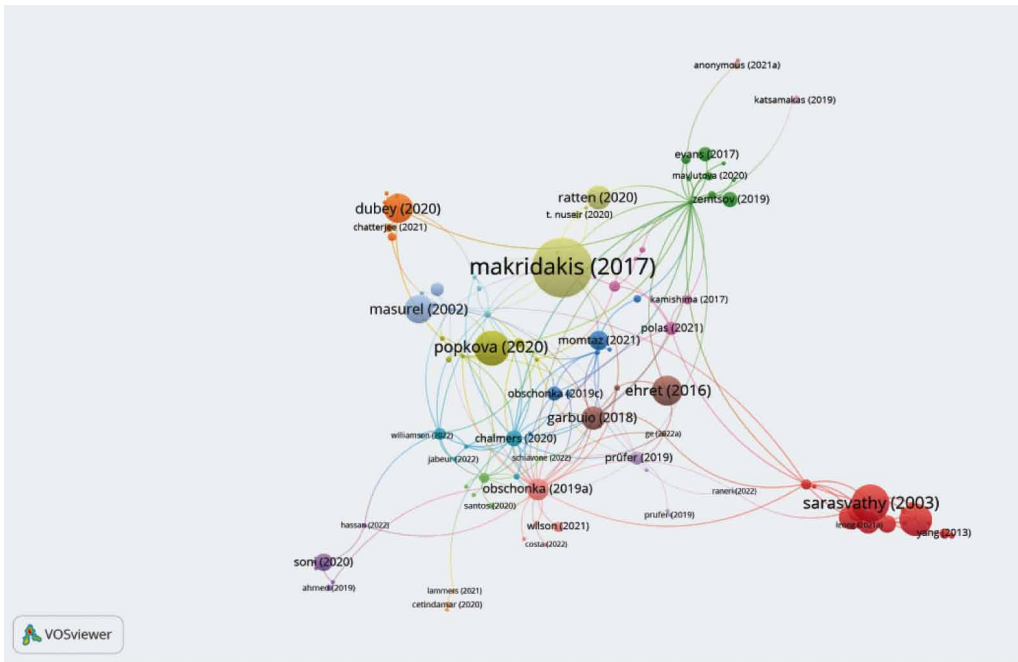**Figure 3. Citation network at affiliation level**

Figure 4. Citation network at author level

impact of AI technologies and their potential to create a utopian or dystopian world. Sarasvathy (2003) links entrepreneurship to Herbert Simon's 'Science of the Artificial' and Popkova & Sergi (2020) linked social entrepreneurship to human capital and AI in Industry 4.0. Dubey (2020) noted the importance of big data and artificial intelligence for operational performance under the effects of entrepreneurial orientation and environmental dynamism.

Citation Analysis by Country

The most influential countries in terms of research linked to AI and entrepreneurship are the United States, China, and the United Kingdom, followed by others such as Germany and Russia (see Figure 5).

Semantic Analysis

Topic Modelling - Co-Occurrence Network Analysis

As part of the semantic analysis, a topic identification was completed, in which the topics resulted from a co-occurrence network analysis, following Paranyushkin (2019). In order to build the graph, a corpus was created using the set of terms from the titles and abstracts of the publications. The terms from the corpus are filtered, applying lemmatization and removing the stopwords. In the graph, the set of terms are nodes and the edges between the nodes are linked according to the distance between terms in a sentence. To represent the network (Figure 6), Gephi was used as the software for network analysis (Bastian et al., 2009), and a cluster identification of the nodes was completed based on the modularity class parameter. In order to infer the topics, the most relevant nodes in each cluster are retrieved, and sorted by betweenness centrality (Brandes, 2001). Equivalently to other topic identification algorithms, such as Latent Dirichlet Allocation (LDA), one of the most extended topic-modeling algorithms (Blei et al., 2003), the topics are

Figure 5. Citation network at country level
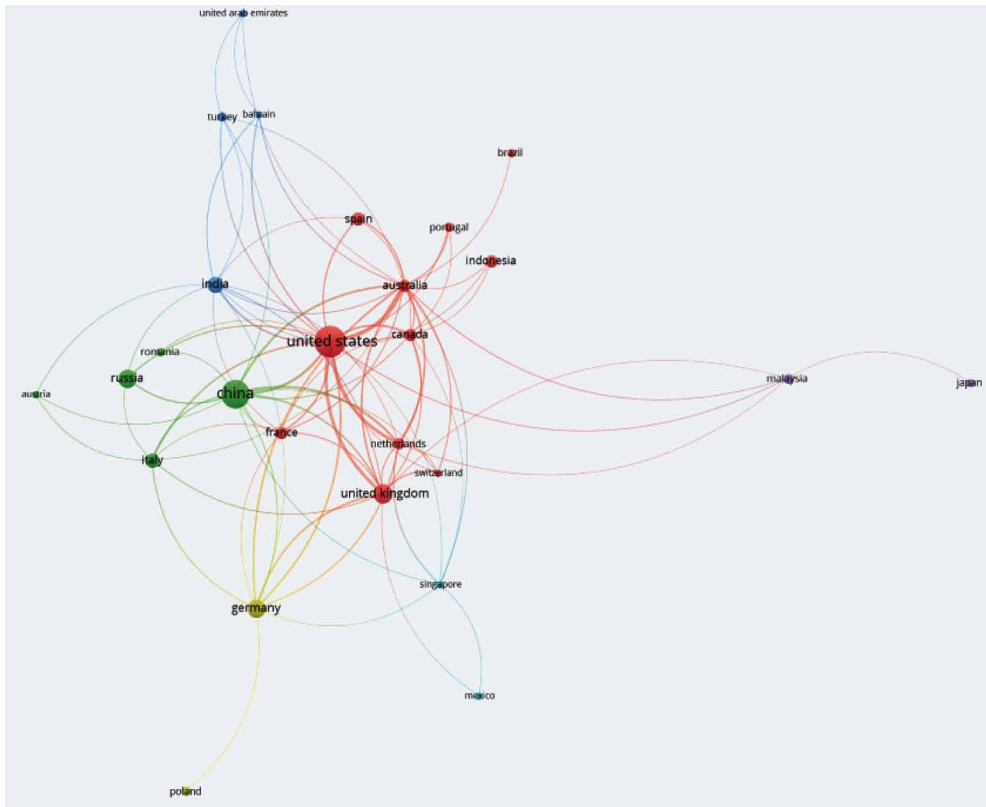
inferred from these terms, summarized in Table 1. An advantage of this algorithm over LDA is that the experiments performed are repeatable.

The issues inferred from the systematic review confirm the rapid developments and trends that have been taking place in recent years. Thus it is innovations, through new industry and technology, that allows faster development of organizations through greater knowledge of the data (Topic 1). On this, authors such as Reim et al. (2020) propose the application of artificial intelligence as an innovative model in organizations. In turn, taking into account Topic 2, it is observed that AI linked to entrepreneurship calls for action and enables risk-taking and industrial development, understood as a system that enables decision-making. Burström et al. (2021) analyze the innovation posed by AI in business models. Topic 3 refers to the need to be able to adapt to change if information and business processes are to be managed efficiently, and formative university models improved, and the impact on the development of the country optimized. Topic 4 presents the challenge of AI in society, referring to the influence that the financial sphere or the production of goods can have on organizations. Makridakis (2017) refers to this issue, considering that the speed of technological change will both bring enormous opportunities and generate significant challenges. Topic 5 presents new uses, such as neural networks. Topic 6 presents the influence on the market as a key factor for business success and sustainability. Finally, topic 7 refers to machine learning and the techniques and algorithms derived from its application. Noteworthy here is the work of Shepherd & Majchrzak (2022), which analyzes how machines have the potential to increase the impact of entrepreneurs, always considering the risks that may arise from this.

Figure 6. Co-occurrence network

N-Gram Analysis

An analysis of the highlighted bi-grams and tri-grams was carried out in order to deepen the semantic analysis of the documents obtained. From this, in addition to the themes previously inferred from the most noteworthy keywords, it can be observed how massive data analysis, information systems, and neural networks are influential in the prism of entrepreneurship linked to artificial intelligence. Neural networks, considered as evolved computational models, have been linked to entrepreneurship by authors such as Tkachenko et al. (2019) and Bogachov et al. (2020). Big Data and AI were considered drivers of a new stage in entrepreneurship by Obschonka & Audretsch (2020). Concerning the experience of the pandemic, authors such as Chen et al. (2022) have considered that the application of AI to business management and information systems enables strategic responses. Other topics that should be considered relevant in Table 2 are the digital economy and machine learning, highlighted by authors such as Obschonka & Audretsch (2020) and Jabeur et al. (2022). From the sustainability perspective, the bi-grams referring to smart cities and the circular economy, mentioned by authors such as Wilson et al. (2021), are highlighted. Thus, it should be noted that AI and entrepreneurship encompass current and fashionable concepts, enabling - through their optimal management - their application in society and different organizations.

Relationship With Citations

No relationship was found between the number of citations in the publications and the number of words contained in the title and abstract. This shows the falsity of the assumption that articles with

Table 1. Inferred topics

Colour	Topic	Terms
🟢	Innovation	Technology, Digital, Development, Use, Datum, Innovation, Entrepreneur, Industry, Base Economy.
⚫	Call to Action	System, Information, Make, Design, Include, Management, Knowledge, Support, Risk, Industrial.
🔵	Adaptation to Change	Business Model, Change, Develop, University Student, Process, Improve, Country Impact.
🟡	Challenge	Market, Service, Product, Public, Human Challenge, Good, Financial, Resource, Sector.
🔴	New uses	Economic, Social Network, Activity, Growth, Policy, Theory, Medium Life, Neural.
🟠	Influences	Production, Factor, Influence, Important, Food, Affect, Key, Success, Consumption.
⚪	Machine Learning	Learn, Machine, Method, Algorithm, Quality, Teach, Technique, Deep.

shorter titles and longer abstracts have more citations. This assumption relies on the idea that having an attention-grabbing title and a detailed abstract accurately characterizes the publication itself. The results (Figure 7) demonstrating otherwise might be explained by the fact that the journals have different style and format requirements.

CONCLUSION

This research presents a systematic review of the literature on entrepreneurship and AI, its development, evolution, and related key topics. The analysis thus contributes an advance in the state of the art and an expansion of the influence of semantic selection in both title and abstract. It extends current research and provides new lines to consider in future analyses of entrepreneurship and AI, by highlighting both the main related research topics and the solvency and growth of this scientific area.

AI is a multidisciplinary science capable of being applied to the development of new business strategies; it is required, in many cases, for companies' survival and adaptation to change. AI thus

Table 2. Top-10 Bi-grams, tri-grams and frequency

ID	Bi-gram	Frequency	Tri-gram	Frequency
1	Big data	111	Decision support system	18
2	Information system	98	Big data analytics	13
3	Neural network	96	Natural Language Processing	12
4	Business Model	80	Neural Network ANN	12
5	Machine Learning	79	Management Information System	12
6	Smart City	72	Business personal Experience	11
7	Digital economy	53	Deep Learning Algorithm	10
8	Digital transformation	48	4.0 Industrial revolution	10
9	Internet-of-Things	43	Technological business personal experience	10
10	Circular economy	35	Strategic emerging industry	9

Figure 7. Relationship of number of citations and the number of words in the title and abstract of the publication
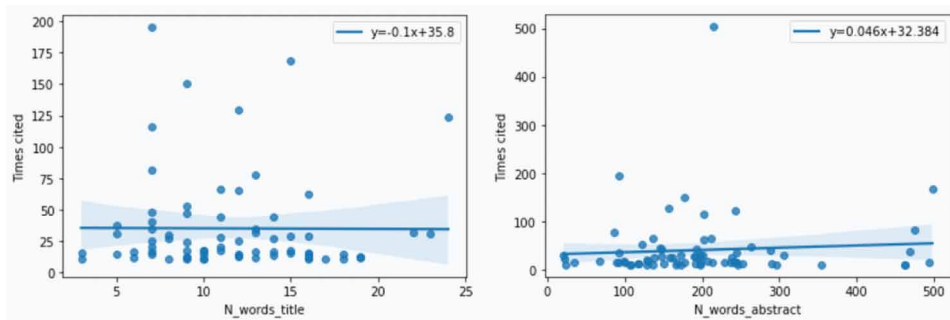
enables the development and growth of entrepreneurial activities. Thus, as linked elements, both terms demonstrate a greater potential in the uncertain future. For the in-depth analysis, machine learning was used for text processing and semantic analysis.

Due to the current context and the exponential growth of technology, scientific interest in the area has been increasing in recent years, especially since 2017, with many countries focusing on the analysis of this topic, as it allows the design of policies and strategic decisions that promote the growth and development of society. It should be noted that the countries with the highest scientific production are the United States, China, and the United Kingdom. The most representative authors in the area are Sarasvathy et al. (2003), Makridakis (2017), and Popkova & Sergi (2020).

This research sheds light on how the intelligent use of semantic analysis, powered by natural language processing techniques, can contribute to the development of a more exhaustive literature review. In relation to the semantic analysis of topics, keywords such as innovation, new uses, and call to action should be highlighted.

IMPLICATIONS

This literature review provides a holistic view of the concepts and information of interest to policymakers and entrepreneurs and allows them to understand the current state of AI in relation to entrepreneurship. The insights generated in this research can guide governmental strategies and policies aimed at supporting entrepreneurial development and filling the main gaps mentioned by different scientists over the years. The literature review is also useful in helping us understand the evolution of the concepts and the growing linkages between them observed in recent years.

Globally, the existing links between researchers, organizations, and governments should be built on in order to develop the principles needed to ensure the sustainable use of technologies and enable the implementation of infrastructures and systems that support the development of entrepreneurship in the developing digital information revolution. In academia, this study encourages other researchers to understand the importance of data and motivates further research in this area.

LIMITATIONS AND FUTURE RESEARCH LINES

The limitations of this analysis can be the starting point for new lines of research. One example is that while a representative academic database was used, others, such as Google Scholar or IEEE, could have been included. Another is that all non-English language documents were excluded: further semantic studies could be carried out that consider and analyze the representative topics in each language.

Also, AI-related topics, including their links with entrepreneurship, are evolving rapidly. The fact that the analysis of the literature was carried out up to 2022 makes possible interesting comparisons after this date. In turn, analyzing the moderating role of some particular variables linked to digitalization in organizations will allow for an in-depth investigation of the causal relationship. In addition, it would be worthwhile to explore in depth the benefits of elements such as machine learning on entrepreneurial development. Similarly, a quantitative cross-country analysis of similar economic environments will add further value to this research.

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