


Big Data in Entrepreneurship

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ABSTRACT

Entrepreneurship research is paying increasing attention to big data. However, there is only a fragmented understanding on how big data influences entrepreneurial activities. To review previous research systematically and quantitatively, the authors use bibliometrics method to analyze 164 research articles on big data in entrepreneurship. They visualize the landscape of these studies, such as publication year, country, and research area. They then use VOSviewer to conduct theme clustering analysis, finding four themes, namely the COVID-19 pandemic and small medium enterprise (SME) digitization, application of big data analytics to decision making, application of big data in platform, and the effects of big data on enterprises. In addition, they construct an integrated framework that integrates the antecedents of big data adoption and influence mechanism of big data on entrepreneurial activities.

KEYWORDS

Bibliometric Analysis, Big Data, Digital Technology, Entrepreneurship

INTRODUCTION

This is the era of big data. Digital technology has transformed the connection and greatly increased the engagement between enterprises and users, as it gives users access to shop online and interact on social media (Li & Zhang, 2021). Users are no longer merely passively accepting products or services, but getting deeply involved in product or service innovation. Further, using digital technology, such as the Internet of Things (IoT), cloud computing, and big data technology, to collect, store, and analyze massive data provides great convenience for enterprises to accurately forecast user demands and market trends (Ardito et al., 2018b; Gauzelin & Bentz, 2017). Big data is playing an unprecedented role in the entire entrepreneurial ecosystem (Cappa et al., 2021).

Obviously, big data is rapidly affecting many industries, such as traditional manufacturing, retail services, and finance, and thereby changing the competitive landscape of enterprises in these industries (Li et al., 2018). Enterprises may establish data analysis departments or seek external data analysis services to utilize big data. Enterprises with strong data analysis capabilities are establishing core competitive advantages (Hajli et al., 2020), thus improving their market share and competitive position (Ghasemaghahi & Calic, 2020). As Tabesh et al. (2019) pointed out, powerful big data technologies help enterprises extract information from big data and, ultimately, turn it into a business opportunity. In this sense, enterprises should implement big data strategies to better utilize data resources.

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Entrepreneurship research is paying increasing attention to big data. However, the research on big data in entrepreneurship remains fragmented (Ardito et al., 2018a). Previous research has analyzed the process of data management (Zeng & Glaister, 2018), the antecedents of big data adoption (Maroufkhani et al., 2020; Verma & Bhattacharyy, 2017), the application of big data in product innovation, strategic decision-making, business model innovation, and other entrepreneurial activities (Ghasemaghaei & Calic, 2020; Mikalef et al., 2019; Tabesh et al., 2019; Wiener et al., 2020). For example, Huang et al. (2017) pointed out that enterprises use big data analysis to construct, hedge, and monitor, market opportunities, and thus effectively reduce the uncertainty in new business development. Amit and Han (2017) stated that the application of big data technology reduces the cost and time of testing and verifying entrepreneurial ideas, thereby promoting enterprises to identify opportunities. In sum, big data is especially important for early-stage enterprises (Olanrewaju et al., 2020).

Big data adoption is a new trend in business development. As a new production factor, data resource profoundly affects the entrepreneurial activities of enterprises. Although several scholars have realized the important role of big data in entrepreneurship, there is a lack of in-depth and comprehensive research in this field. Existing research tends to analyze the relationship between big data and entrepreneurial activities from different perspectives and context, which is relatively scattered. Different research perspectives and context may also lead to different research conclusions, resulting in confusion among scholars (Cappa et al., 2021; Saleem et al., 2021a). Therefore, it is necessary to visualize the landscape of existing research and construct an integrated framework of big data for entrepreneurship. Bibliometric methods can analyze article information quantitatively and scientifically, visualize the research themes, and present the evolution of themes (Yan et al., 2021). Drawing from this, bibliometric analysis used to analyze existing research was adopted, as it is highly suitable for this study. This study aims to help scholars grasp the existing research and comprehend the relationship between big data and entrepreneurship, and further promote entrepreneurship theory development in the digital era.

This study is structured as follows. First, Research Methodology and Biometric Analysis presents the bibliometric methods, literature selection, and analyses process. Next, authors analyze the basic information of the articles and conduct themeclustering analysis. Then, to construct an integrated framework of big data for entrepreneurship, researchers summarize the antecedents of big data adoption and influence mechanism of big data on entrepreneurial activities. In the Discussion section, theoretical implications, practical implications, and future research directions are proposed based on the existing research, and, finally, conclusions are put forward.

RESEARCH METHODOLOGY

Bibliometric Methods

Bibliometric analysis is a systematic and scientific analysis method suitable for quantitative analysis of research themes, dynamic trends, and future research directions in the target field (Velt et al., 2020; Yan et al., 2021; Zaheer et al., 2019). This study aims to visualize the landscape of existing research and construct an integrated framework of big data for entrepreneurship. Therefore, the authors utilize bibliometric methods to promote a deeper understanding of the background and multi-level connection between big data and entrepreneurship.

LITERATURE SELECTION

Drawing on the previous bibliometric analysis (Olanrewaju et al., 2020; Wiener et al., 2020), the authors used (TS = ((“Big data” OR “Data analytics”) and (entrepreneur* OR “SME*” OR “small business*” OR “small and medium*”))) to search literature in the Web of Science Core Collection.

Additionally, the language to limited to English and the document type to an article, and then 474 articles were obtained (the search was carried out in March 2022). To weed out irrelevant articles, the team members read the titles, abstracts, and keywords of the articles, and read the full text, if necessary. The authors excluded and deleted articles that only focused on the macro level or only used big data as a backdrop. Finally, 164 articles related to the application of big data in entrepreneurial activities were obtained.

ANALYSES

This study analyzed 164 articles based on publication year, country, research area, journal source, and cited times. Then, a VOSviewer was used to analyze the titles, abstracts, and keywords of the articles, selected terms that appeared frequently, and these were then classified according to their relationship, thus realizing visual clustering analysis. In addition, the authors read these articles carefully and found that 13 of them were related to the antecedents of big data adoption, and 38 were related to the influence mechanism of big data on entrepreneurial activities. This study constructed an influence mechanism diagram according to these 51 articles.

BIBLIOMETRIC ANALYSES

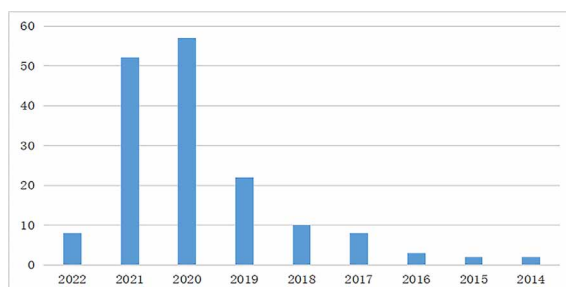
Publication Years

In recent years, the development of the digital economy has made research on big data in entrepreneurship a trending topic. In February 2014, *KSII Transactions on Internet and Information Systems* published two articles about this topic. One was *Business Intelligence and Marketing Insights in an Era of Big Data: The Q-sorting Approach*. Using the Q-sorting approach, Kim (2014) attempted to qualitatively determine the types and characteristics of big data marketing strategies by studying Korean enterprises engaged in big data businesses. This research provided guidance for start-ups and SMEs to develop big data businesses. The other article was *Inter-category Map: Building Cognition Network of General Customers Through Big Data Mining*. Song et al. (2014) studied user preferences for brands by analyzing big data in social media, built cross-category maps, and improved the online recommendation model. From these two articles, the authors found that they were both related to the application of big data in marketing. This shows that in the era of big data, start-ups and SMEs are positively developing big data marketing strategies to improve their data analysis skills.

Since 2014, the application of big data in enterprises has become popular. The relevant research shows a rapid growth trend. This study sums the annual number of articles in this field (Figure 1).

Articles published in 2020 and 2021 both exceeded 50, showing a large increase. This indicates that research on big data in entrepreneurship has attracted great attention in the past two years. The rapid growth of research also makes bibliometric methods vital in overviewing articles.

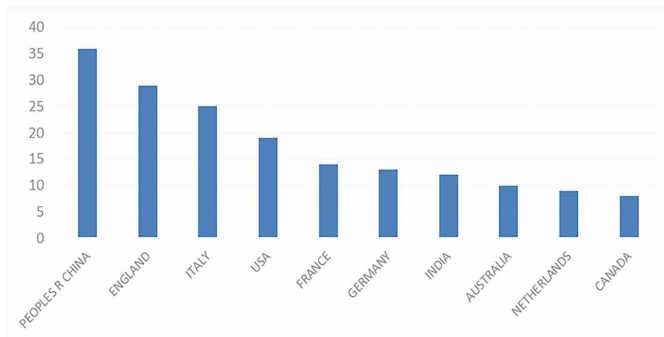
Figure 1. Distribution of articles by publication year



COUNTRIES

The authors also analyzed the distribution of the articles by countries (Figure 2). China tops the list with 36 articles. It can be seen that Chinese enterprises attach great importance to big data adoption, which is also closely related to national policies. According to the *Report on China Digital Economy Industry Development Index 2021*, the digital economy is an important engine for upgrading and transforming traditional industries. The “Digital economy,” as one of the significant development strategies in China, has been included in the *Work Report* of the Chinese government for four consecutive years. It is inevitable that big data, as a key factor of production, will attract the attention of Chinese scholars in the digital era. In addition, according to Zeng and Glaister (2018), China has the largest digital market in the world, and Chinese enterprises are actively applying big data, which objectively promotes academic research on this topic. England and Italy rank second and third with 29 and 25 articles, respectively. In addition, other countries, such as the US, France, Germany, and India, have good academic research achievements. This is because many of these countries have started the digital revolution under the impact of digital waves. For example, England launched the *England Digital Strategy* in 2017, and India launched the *Digital India Strategy* in 2015. To some extent, the number of studies reflects the importance different countries attach to the application of big data in entrepreneurship. The 10 countries shown in Figure 2 attach more importance to research on big data and entrepreneurship than other countries. This shows that researchers and entrepreneurs in other countries need to pay more attention to this topic.

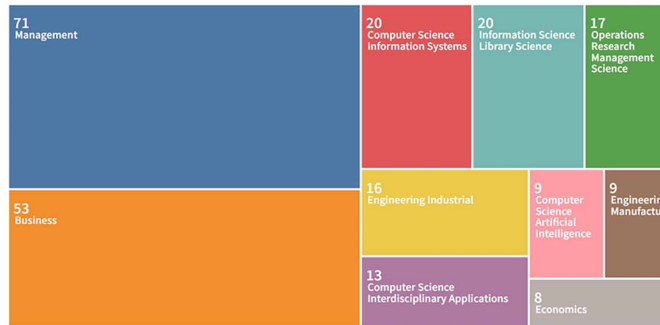
Figure 2. Distribution of articles by country



RESEARCH AREAS

Figure 3 shows the distribution of the articles based on research areas. Out of 164 articles, 71 are in the management field and 53 are in the business field. In addition, the authors found relevant articles in the field of computer science information systems, library and information science (LIS), operations research management science, engineering industrial, computer science interdisciplinary applications, computer science artificial intelligence, engineering manufacturing, and economics fields. This indicates that research of big data in entrepreneurship belongs to an interdisciplinary field. Therefore, researchers should not only focus on management and business fields, but also pay attention to other fields when conducting relevant research. Interdisciplinary research provides researchers with a broader vision, reveals the research context comprehensively, and stimulates the generation of unique insights.

Figure 3. Distribution of articles by research area



SOURCE JOURNALS

Figure 4 shows the distribution of the articles by publication journal. The most productive journals are the *Journal of Business Research*, *Small Business Economics*, and *Sustainability*. This shows that research on big data in entrepreneurship receives great attention from the top journals in management and business fields. In addition, other high-level journals in related fields, such as the *International Journal of Production Research*, *Journal of Enterprise Information Management*, and the *Journal of Knowledge Management*, *Technological Forecasting*, and *Social Change* have an interest in this topic. The focus of a journal will influence the focus of researchers to some extent. Therefore, journals should pay more attention to important and meaningful research issues. Researchers can focus on articles in these journals to track the latest research on big data and entrepreneurship.

Figure 4. Distribution of articles by journal



THE MOST CITED ARTICLES

The number of citations of an article reflects the recognition degree within the academic circle (Yan et al., 2021). Generally, the more an article is cited, the more influential it is (Wu & Zhang, 2022). Table 1 shows the top 10 most-cited articles. *Shifting intra-and inter-organizational innovation processes towards digital business: An empirical analysis of SMEs* is cited 148 times, which is the most frequently cited article. This article was published in *Creativity and Innovation Management* by Scuotto et al. in 2017. They found that the use of Information and Communication Technology (ICT) promotes big data adoption and helps enterprises cope with the external dynamic environment.

Through empirical research, this study proved that ICT promotes the generation of new products and services, thus improving the innovation performance of SMEs.

The authors found that these highly cited articles mainly focused on how big data affected open innovations, business models, innovation performance, operational performance, enterprise performance, etc. At the same time, there are studies on the obstacles and solutions to adopt big data for SMEs. These articles lay a foundation for follow-up research on big data in entrepreneurship.

Table 1. The most cited articles on big data and entrepreneurship research

	Article Title	Authors	Year	Publisher	Times Cited
1	<i>Shifting intra-and inter-organizational innovation processes towards digital business: An empirical analysis of SMEs</i>	Scuotto et al.	2017	Creativity and Innovation Management	148
2	<i>Big data analytics capabilities and knowledge management: Impact on firm performance</i>	Ferraris et al.	2018	Management Decision	111
3	<i>An exploration of contemporary organizational artifacts and routines in a sustainable excellence context</i>	Carayannis et al.	2017	Journal of Knowledge Management	87
4	<i>Industry 4.0: A Solution towards Technology Challenges of Sustainable Business Performance</i>	Haseeb et al.	2019	Social Sciences-Basel	73
5	<i>Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism: A study of manufacturing organizations</i>	Dubey et al.	2020	International Journal of Production Economics	68
6	<i>Intellectual capital in the age of Big Data: Establishing a research agenda</i>	Secundo et al.	2017	Journal of Intellectual Capital	68
7	<i>The impact of digitalization on business models</i>	Bouwman et al.	2018	Digital Policy Regulation and Governance	67
8	<i>Big data for open innovation in SMEs and large corporations: Trends, opportunities, and challenges</i>	Del Vecchio et al.	2018	Creativity and Innovation Management	61
9	<i>How Can SMEs Benefit from Big Data? Challenges and a Path Forward</i>	Coleman et al.	2016	Quality and Reliability Engineering International	60
10	<i>Deep learning in business analytics and operations research: Models, applications, and managerial implications</i>	Kraus et al.	2020	European Journal of Operational Research	49

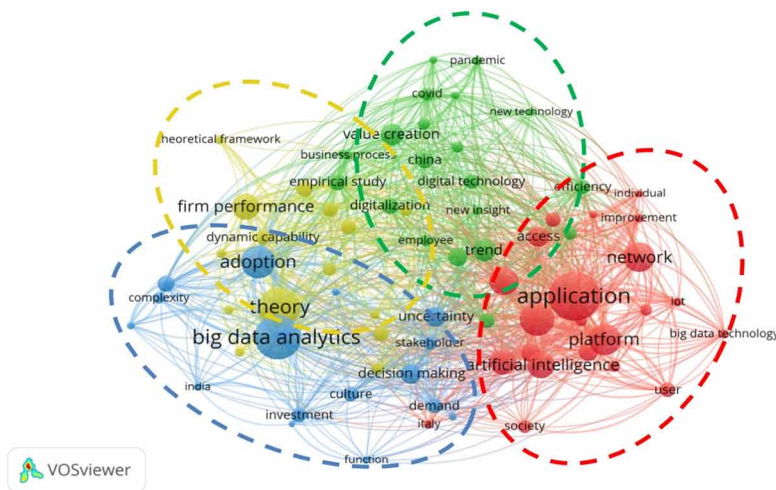
THEME-CLUSTERING ANALYSIS

In this study, the authors employ VOSviewer to conduct theme-clustering analysis according to the titles, abstracts, and keywords of the articles, and to extract the terms used frequently. The results are shown in Figure 5. The authors first removed the terms “model,” “concept,” “implications,” and others that were not related to the research topic. Secondly, the authors replaced synonyms, such as

“BDA” with “Big Data Analytics,” and replacing “Small Medium Enterprise” with “SME.” Finally, they set the minimum frequency of term occurrences to five. Out of 4,430 terms, 225 were eligible. The default option was to select the most relevant 60% of the terms for analysis, resulting in 135 terms. The larger the circle in Figure 5, the more frequently the term was used.

Lines between terms indicate that terms appeared together in the same article (Mmbaga et al., 2020). From Figure 5, it can be intuitively found that “application,” “big data analytics,” “adoption,” “artificial intelligence,” “firm performance,” and other terms appear frequently. From these high-frequency words, scholars attach importance to the research on the impact of big data adoption and application on enterprises. Specifically, research in this field is divided into four themes.

Figure 5. Visual bibliometric map for big data and entrepreneurship research



CLUSTER 1: THE COVID-19 PANDEMIC AND SME DIGITIZATION

The green area in Figure 5 is Cluster 1, which is called the COVID-19 pandemic and SME digitization. The key terms in Cluster 1 include Covid, pandemic, China, digital technology, digital transformation, digitalization, efficiency, business process, competitive advantage, employee, government, value creation, and empirical study.

Cluster 1 focuses on digitization of SMEs under the COVID-19 pandemic. Since the beginning of 2020, the COVID-19 pandemic was widespread, creating a severe blow to the global economy. SMEs have been facing great pressure to survive, and many have been forced to stop production. In the context of the COVID-19 outbreak, digital technology has played an important role in sustaining the production of SMEs. For example, big data technology tracks the movement of goods in real time to support epidemic prevention. Online office software has made telecommuting a reality for employees. Big data analysis helps enterprises acquire valuable information and identify potential opportunities (Guo et al., 2020). Therefore, big data supports the survival and development of enterprises to a certain extent in the highly uncertain external environment. Specifically, Cluster 1 focuses on how enterprises responded to external changes and create value through digitization during the COVID-19 pandemic. Through empirical research, Guo et al. (2020) found that digitization activated the dynamic capabilities of enterprises and enabled SMEs to cope better with external uncertainties. Wibowo et

al. (2021a) explored the influence mechanism of big data on the marketing performance of SMEs during the COVID-19 pandemic. They found that big data adoption activates the value creation and innovation capabilities of enterprises, thus improving their marketing performance. Lee and Jung (2021) focused on the sales support of Korean SMEs and proposed new distribution strategies. They proposed that in the post-COVID-19 pandemic era, SMEs should quickly introduce new technologies, such as artificial intelligence and big data, develop precise marketing strategies (Shan et al., 2022), and gradually realize digitalization.

CLUSTER 2: APPLICATION OF BIG DATA ANALYTICS TO DECISION MAKING

Cluster 2 includes big data analytics, big data adoption, adoption, data science, decision making, demand, human resources, investment, top management support, uncertainty, complexity, and stakeholder. It is blue and referred to as, application of big data analytics to decision making.

Cluster 2 focuses on the role of big data analysis in enterprise decision-making. Big data analysis has become popular in theoretical analysis and practical application, and has had a significant effect on the decision-making behavior of new enterprises and SMEs. Embedded in a turbulent business environment, enterprises apply big data analysis to dynamically respond to external changes and make decisions quickly. Wal-Mart collects and analyzes a large amount of user transaction data, evaluates their behavior and value, and makes accurate decisions. Similarly, Netflix uses its powerful data analysis capability to discover user preferences from user data, meet user needs, and achieve precise marketing. Gauzelin and Bentz (2017) found that big data analysis systems collect and convert data on business operations and environments into information, thus promoting timely decision making and improving operational efficiency. Varma and Dutta (2021) guided start-ups to endow human resources functions through data-driven decision-making.

CLUSTER 3: APPLICATION OF BIG DATA IN PLATFORM

The third cluster is the red area in Figure 5, namely, application of big data in platform. The key terms included in Cluster 3 are platform, application, big data technology, IoT, machine learning, artificial intelligence, business opportunity, evolution, service, user, network, ability, and society.

Platform connects enterprises and users by providing a platform for their value creation. Enterprises use the platform to promote products, and users express their opinions on the platform to improve their sense of participation (Park et al., 2021). In this process, the platform accumulates a large amount of transaction data to enhance its competitiveness. Cluster 3 focuses on the application of big data in platform enterprises. Specifically, Zeng et al. (2021) used a multi-case study method to study the value creation of shared economy platform enterprises in China. Building big-data-driven network effects is a method for platform enterprises to coordinate external resources to create value, which is beneficial for solving the resource dilemma. Song et al. (2021) focused on how financial service providers used big data analytics to help SMEs obtain financing. Research shows that financial service providers support new enterprises and SMEs to obtain financing by customizing accurate financing supply and demand information through big data analysis. This research is helpful to alleviate the financing difficulties in entrepreneurship.

CLUSTER 4: THE EFFECTS OF BIG DATA ON ENTERPRISES

The yellow area in Cluster 4 is referred to as the effects of big data on enterprises, which includes outcome, firm performance, financial performance, market performance, business value, advantage, big data analytics capability, dynamic capability, knowledge management, and entrepreneurial orientation.

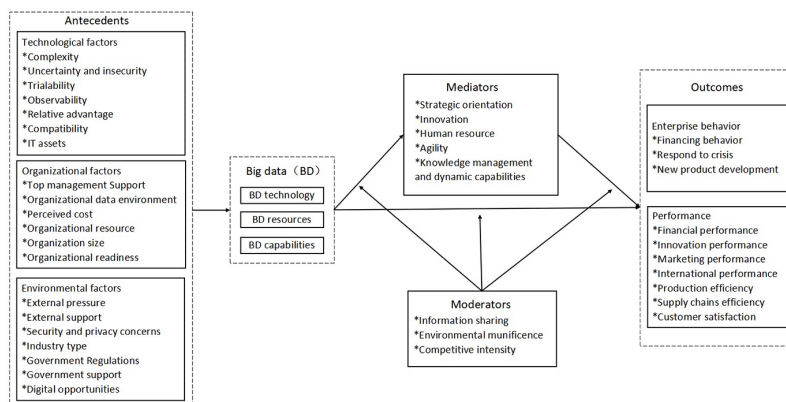
Big data adoption offers many benefits to entrepreneurial activities. For example, big data analysis improves the efficiency of product development (Hwang & Kim, 2022) and customer satisfaction (Vitari & Raguseo, 2020). However, not all enterprises are suitable for developing big data business, as it requires high data analysis capabilities (Cappa et al., 2021). As a result, it may be wise for some small businesses with limited resources to use the services provided by specialized data analysis companies. Cluster 4 focuses on the output of big data. Specifically, Vitari and Raguseo (2020) confirmed that the business value of big data analysis would bring high enterprise performance. Ferraris et al. (2018) considered Italian enterprises as the research object and found that big data analytics ability has a positive impact on enterprise performance and that knowledge management plays a mediating role. Ciampi et al. (2021) found that big data analytics ability positively affects business model innovation, and entrepreneurial orientation plays a mediating role. Cappa et al. (2021) explored how the three dimensions of big data (volume, variety, and veracity) affect enterprise performance. The study shows that the volume of big data negatively affects performance, variety positively moderates the negative impact of volume on performance, and veracity has a positive impact on performance.

The division of the four clusters is not completely independent and an article may belong to two or more clusters at the same time. Cluster 1 focuses on the impact of the external situation on big data applications; Cluster 2 focuses on the role of big data analysis in enterprise decision-making; Cluster 3 focuses on the application of big data in platforms; and Cluster 4 focuses on the impact of big data on enterprise outcomes. Researchers can follow clusters that are relevant to their research.

IDENTIFYING ANTECEDENTS, MEDIATORS, MODERATORS, AND OUTCOMES

Big data is an emerging technology, but it can also be a type of resource or capability (Kim, 2014). In order to summarize the antecedents of big data adoption and the influence mechanism of big data on entrepreneurial activities, the team members carefully read 164 articles. The authors found that 13 articles were related to the antecedents of big data adoption, and 38 articles were related to the influence mechanism of big data on entrepreneurial activities. This study summarizes these 51 articles and forms the framework as shown in Figure 6.

Figure 6. Integrated framework of big data in entrepreneurship



THE ANTECEDENTS

Enterprises may encounter some obstacles in the implementation of big data analysis (Lutfi et al., 2022), such as lack of professional knowledge of data analysis, lack of laws and regulations on big data, and concern about data security (Bahrami et al., 2021; Coleman et al., 2016). Therefore, it is essential to understand the antecedents of big data adoption by SMEs and to formulate targeted big data adoption strategies. The technology-organization-environment (TOE) framework comprehensively explains how technology, organization, and environment affect the adoption of technology (Maroufkhani et al., 2020). Combined with the TOE framework, this study summarizes the factors that affect the big data adoption mentioned in the existing literature. First, technological factors refer to the endogenous and exogenous factors of technology. Technological factors include: technological complexity, uncertainty and insecurity, trialability, observability (Maroufkhani et al., 2020), relative advantage, compatibility (Yadegaridehkordi et al., 2020; Maroufkhani et al., 2020), and IT assets (Verma & Bhattacharyy, 2017).

Second, organizational factors refer to the subjective attitude and objective support of the organization for the adoption of new technology. Organizational factors are composed of: top management support, organizational data environment, perceived cost (Verma & Bhattacharyya, 2017), organizational resource, organization size (Yadegaridehkordi et al., 2020), organizational readiness (Lutfi et al., 2022; Maroufkhani et al., 2020), and other factors. Third, environmental factors refer to the external pressure and support that enterprises face when adopting new technologies (Shan & Lu, 2020). Environmental factors consist of: external pressure, external support, security and privacy concerns (Yadegaridehkordi et al., 2020), industry type (Verma & Bhattacharyy, 2017), government regulations (Maroufkhani et al., 2020), government support (Lutfi et al., 2022), and digital opportunities (digital design, digital manufacturing, and digital service opportunities) (Ricci et al., 2021).

The aforementioned factors represent the antecedents of big data adoption. Accordingly, the following strategies are proposed to promote successful big data adoption by enterprises. First, reducing technological complexity and improving technological security are beneficial to big data adoption. Second, improving organizational ability and subjective acceptance willingness is essential for big data adoption. Third, increasing external support and strengthening supervision for big data are the driving forces for enterprises to adopt big data.

OUTCOMES OF BIG DATA ADOPTION

This study summarizes the possible impact of big data adoption on new enterprises and SMEs, which can be divided into the following two categories. The first category is enterprise behavior, which includes financing behavior (Donald, 2020; Song et al., 2021), crisis response (Guo et al., 2020), and new product development (Hajli et al., 2020). Financing behavior means enterprises short of funds borrow money from financial institutions. As it is difficult for financial institutions to assess the credit of SMEs, many SMEs still face financing difficulties. The emergence of financial service providers effectively solves the problem of information asymmetry between SMEs and financial institutions, and reduces the transaction costs of SMEs financing (Donald, 2020). Financial service providers use big data on enterprise operations and supply chain management to evaluate the operating conditions and credit status of enterprises (Song et al., 2021), and to provide advice to financial institutions to facilitate a smooth financing process. The outbreak of COVID-19 has brought tremendous impact to enterprises, and the external environment is highly uncertain. Big data adoption helps enterprises quickly perceive external changes, reintegrate, and allocate resources to effectively deal with public crises (Guo et al., 2020). Big data plays an important role in the development of new products. Data aggregation tools and data analysis tools facilitate the successful development of new products (Hajli et al., 2020).

The second category is performance, which consists of financial performance, innovation performance, marketing performance, and international performance. (Gnizy, 2019; Saleem et al.,

2021a; Saleem et al., 2021b; Vitari & Raguseo, 2020; Wibowo et al., 2021a), production efficiency (Hwang & Kim, 2022), supply chain efficiency (Saleem et al., 2021a), and customer satisfaction (Vitari & Raguseo, 2020). These studies show that big data adoption improves financial performance, innovation performance, marketing performance, and international performance. In the Korean manufacturing industry, production efficiency of SMEs using emerging digital technologies, such as big data, is 26% higher than that of other enterprises (Hwang & Kim, 2022). Big data is a valuable resource for improving supply chain efficiency (Saleem et al., 2021a) and customer satisfaction (Vitari & Raguseo, 2020). This shows that most researchers focus on the positive impact of big data on enterprise performance. These studies will help enterprises better use big data to improve performance, but at the same time, researchers should also pay more attention to the negative impact of big data adoption, such as the high cost of processing and storing massive data (Cappa et al., 2021). Enterprises need to weigh the advantages and disadvantages of using big data in actual production and operation activities.

MEDIATORS

Mediating variables have been widely used in research on big data and entrepreneurship. To make the framework clear, mediating variables are classified into five categories. These are: 1). Strategic orientation (market orientation, entrepreneurial orientation, and learning orientation); 2). Organizational innovation (technological innovation, business model innovation, product innovation, and process innovation); 3). Human resources (big data driven human resources practice, human resources service quality); 4). Agility (organizational agility, customer agility, and agile supply chain); and 5). Knowledge management and dynamic capabilities.

STRATEGIC ORIENTATION

Strategic orientation refers to the principles and practices that guide enterprise activities and strategic decisions (Hakala, 2011). Gnizy (2019) believed that big data and performance should be connected by strategy and therefore, regarded strategic orientation as a mediator between big data and international performance. The research focused on three strategic orientations, namely market orientation, entrepreneurial orientation, and learning orientation, and confirmed their mediating role. Ciampi et al. (2021) explored the relationship between big data analysis ability, entrepreneurial orientation, and business model innovation in view of dynamic capabilities. They regarded big data analysis capability as a lower-order dynamic capability and entrepreneurial orientation as a higher-order dynamic capability. They ultimately found that entrepreneurial orientation partially mediates the relationship between big data analytics and business model innovation.

ORGANIZATIONAL INNOVATION

Enterprises utilize big data to understand users' demands, predict future trends, and to carry out corresponding innovation activities in a timely manner. Big data promotes enterprise technological innovation, thus improving supply chain performance and SMEs performance (a et al., 2021). Olabode et al. (2022) studied enterprises in England and found that disruptive business models partially mediated the relationship between big data analysis ability and market performance. In the Chinese emerging market, big data predictive and prescriptive analytics bring product and process innovation to enterprises, further improving firm performance (Saleem et al., 2021b). Wibowo et al. (2021b) confirmed that innovation capability and value creation play a mediating role between big data and market performance by studying Indonesian SMEs.

HUMAN RESOURCES

With the popularization of big data adoption in enterprises, the important role of big data in the human resources field has gradually attracted attention. Big data is helpful for enterprises to make reasonable decisions in human resources practices, such as performance prediction and training direction determination (Kozielski, 2018). Big data adoption improves the quality and practice of enterprise human resources, and then improves the innovation ability and organizational performance of SMEs. The quality and practice of human resources mediates the relationship between big data and innovation capability (Verma et al., 2020).

AGILITY

Digital technology capability is vital for SMEs to build organizational agility, which improves enterprise performance (Troise et al., 2022). The effective use of data aggregation and data analysis tools directly leads to customer agility (enterprises perceive, respond to, and meet user demands quickly), which, in turn, facilitates the success of new product development (Hajli et al., 2020). Wang and Ali (2021) explored the relationship between big data adoption, supply chain agility, and supply chain efficiency. They found that using big data to create agile supply chain processes, enterprises improved the efficiency of the entire supply chain.

KNOWLEDGE MANAGEMENT AND DYNAMIC CAPABILITIES

The amount of information brought by big data is massive, resulting in enterprises having particularly high requirements for knowledge management. This study has found that knowledge management plays a mediating role in the relationship between big data analysis ability and enterprise performance (Ferraris et al., 2018). The higher the digitization degree of the enterprise, the stronger the dynamic capability of the enterprise. Enterprises with strong dynamic capabilities also tend to respond to crises quickly. This study has also confirmed that dynamic capabilities play a mediating role in the relationship between digitization and enterprise crisis response (Guo et al., 2020).

MODERATORS

Only a small number of moderating variables have been used in research on big data and entrepreneurship. The successful application of big data requires a high level of information sharing among all stakeholders. Information sharing positively moderates the relationship between big data adoption and technological innovation activities (Saleem et al., 2021a). The higher the information sharing degree between enterprises and stakeholders, the stronger the promotion effect of the big data adoption on technological innovation. Information sharing also significantly moderates the relationship between big data adoption and supply chain agility (Wang & Ali, 2021). High-quality information sharing between enterprises and stakeholders enhances the positive effect of big data adoption on supply chain agility. Vitari and Raguseo (2020) focused on the moderating effect of environmental conditions (including environmental munificence and environmental dynamism) on big data analysis business value and enterprise performance. The results confirmed that environmental munificence actively moderates the impact of big data analysis business value on enterprise performance. However, the data does not support the moderating effect of environmental dynamism. This also shows that big data analysis business value enables higher performance for enterprises when they are in a fast-growing market. Olabode et al. (2022) suggested that competitive intensity moderates the relationship between big data analysis ability, disruptive business model, and market performance. Disruptive business model plays an important role in gaining insights from big data analysis to improve market performance. This effect becomes more obvious in the case of intense competitive activities.

DISCUSSIONS

Theoretical Implications

This study makes some theoretical contributions to the research on big data and entrepreneurship. First, the authors visualized the landscape of these studies, such as publication year, country, and research area. These analyses help researchers to have a general understanding of the distribution of big data and entrepreneurship research. Second, the authors conducted a theme-clustering analysis and classified themes into four categories. Scientific classification of studies is helpful for researchers to understand the relationship between studies. Third, the authors constructed an integrated framework that integrated the antecedents of big data adoption and the influence mechanism of big data on entrepreneurial activities. The revelation of the influence mechanism between big data and entrepreneurship promotes the development of entrepreneurship theory in the digital era, and lays a foundation for further research on big data and entrepreneurship.

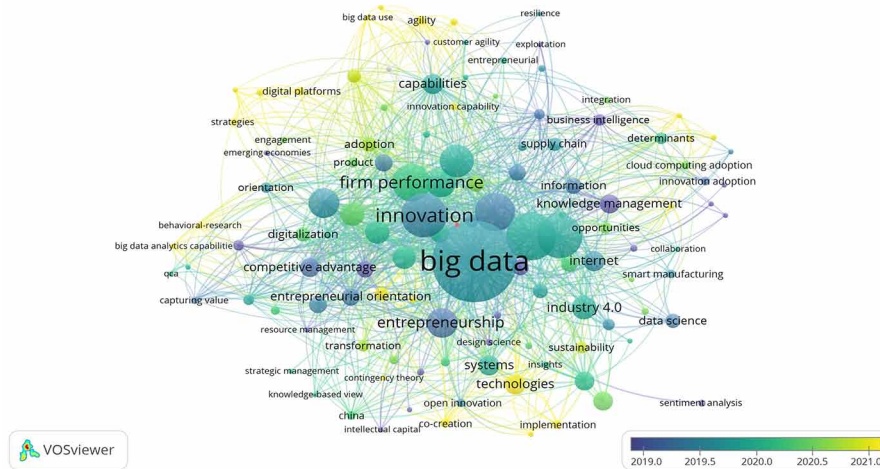
PRACTICAL IMPLICATIONS

This study has considerable significance for enterprise managers to utilize big data and the government to formulate big data rules. The authors summarized the factors that influence big data adoption and put forward suggestions for enterprises to better adopt big data. On the one hand, enterprise managers should enrich organizational resources, improve organizational ability, and subjective willingness to use big data; On the other hand, the government needs to improve the security of big data technology, increase external support for big data, and strengthen supervision. In addition, this study provides strategies for enterprises to use big data more effectively. Managers can manipulate moderating or mediating factors to better utilize big data to improve enterprise performance. For example, big data promotes supply chain performance and SMEs performance through technological innovation. Information sharing positively moderates the relationship between big data adoption and technological innovation (Saleem et al., 2021a). Managers should actively share knowledge with stakeholders, and utilize big data to enhance technological innovation, thus achieving higher enterprise performance.

FUTURE RESEARCH

In this study, keywords in 164 articles are sorted out according to their occurrence period (Figure 7). Due to the large number of keywords in Figure 7, only part of them can be shown in the illustration. Emerging keywords include: supply chain agility, agility, sustainability, sustainable development, innovation capability, innovation performance, digital transformation, digital platforms, artificial intelligence, co-creation, business analytics, and qualitative comparative analysis (QCA). Combined with existing research, this study puts forward three future research directions: 1). Big data and sustainability; 2). Big data and supply chain agility; and 3). Application of the QCA method.

Figure 7. Map of research trends



BIG DATA AND SUSTAINABILITY

Research on big data and sustainability has attracted the increasing attention of scholars in the context of sustainable development. Specifically, the existing research has begun to focus on how big data contributes to sustainable development of organizations. Big data effectively improves organizational sustainability because many of the affordances it provides are aligned with sustainability goals (smart allocation of resources, multidimensional nature). Based on this, Etzion and Aragon-Correa (2016) found that big data can be used to enhance organizational sustainability through activities such as real-time adjustment and enhanced risk management. Corrales-Garay et al. (2020) proposed a conceptual framework for analyzing entrepreneurship through open data, and called on researchers to pay attention to meaningful research on big data and sustainable entrepreneurship. Big data technology promotes the timely advancement of sustainable development ideas, and thus, entrepreneurs can seize opportunities in time (Zeng, 2018). Digital technologies provide a blended value proposition, integrative value creation, and value capture for sustainable business models, thus promoting sustainable entrepreneurship (Gregori & Holzmann, 2020). The aforementioned analysis shows that it is necessary to study the application of big data in sustainability. However, there are limited studies on the application of big data in sustainability. Researchers need to further explore the relationship between big data and sustainability.

BIG DATA AND SUPPLY CHAIN AGILITY

In a dynamic business environment, supply chain agility is a requirement for new start-ups and SMEs to cope flexibly with external changes, as well as a key strategic measure to enhance organizational operation and performance (Centobelli et al., 2020). Many enterprises (such as Wal-Mart and Netflix) use big data to analyze consumer behavior, thus improving decision making efficiency and supply chain agility. Therefore, it is vital to explore the relationship between big data and supply chain agility. Most existing studies only confirm that big data has a positive impact on supply chain agility (Hsu et al., 2021; Wamba et al., 2020). However, these studies are insufficient. Future research should continue to explore the impact mechanism of big data on supply chain agility. For example, what are the mediators of big data that affect supply chain agility? How does big data affect the entrepreneurial

activities and business results of enterprises in supply chain? How do enterprises in supply chain use big data to co-create or capture value? These questions are worthy of further discussion.

APPLICATION OF QCA METHOD

Most existing studies use quantitative analysis to explore how a single antecedent condition affects big data adoption or business results (Saleem et al., 2021a). In essence, an organization is a cluster of interrelated structures and practices (Fiss, 2007). The activities and business results of an enterprise are jointly affected by a variety of factors. Qualitative comparative analysis (QCA) is a set theory configuration analysis method suitable for exploring how combinations of multiple antecedent conditions affect results (Fiss, 2007). However, existing research on big data and entrepreneurship do not pay enough attention to QCA methods, and the use of QCA methods to study complex causal problems should be encouraged. QCA can be used to explore the combination of antecedent conditions that affect big data adoption by enterprises and propose concrete and implementable promotion schemes for enterprises in the future. In addition, it can be utilized to study how other factors, together with big data, affect entrepreneurial activities and business results of enterprises.

CONCLUSION

This study used bibliometric analysis to review research on big data in entrepreneurship. The authors found that the first research in this field was published in 2014. Since then, the relevant research has increased gradually and reached its peak in the past two years. China, England, and Italy rank high in the number of published articles indicating that these countries attach great importance to research on big data in entrepreneurship. The research is mainly distributed in management, business, computer science information systems, and information science library science. The most productive journals and the most cited articles are also listed. The authors used a VOSviewer to conduct theme-clustering analysis, finding four themes, which are: the COVID-19 pandemic and small-medium enterprise (SME) digitization; application of big data analytics to decision making; application of big data in platform; and the effects of big data on enterprises. Finally, the authors summarized the antecedents of big data adoption, as well as the influence path and situational factors of big data on entrepreneurial activities.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available from the corresponding author, Yang Gao, upon reasonable request.

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CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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