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ORIGINAL ARTICLE

Big data analytics and innovation in e-commerce: current insights and future directions

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Abstract

Big data analytics (BDA), as a new innovation tool, played an important role in helping businesses to survive and thrive during great crises and mega disruptions like COVID-19 by transitioning to and scaling e-commerce. Accordingly, the main purpose of the current research was to have a meaningful comprehensive overview of BDA and innovation in e-commerce research published in journals indexed by the Scopus database. In order to describe, explore, and analyze the evolution of publication (co-citation, co-authorship, bibliographical coupling, etc.), the bibliometric method has been utilized to analyze 541 documents from the international Scopus database by using different programs such as VOSviewer and Rstudio. The results of this paper show that many researchers in the e-commerce area focused on and applied data analytical solutions to fight the COVID-19 disease and establish preventive actions against it in various innovative manners. In addition, BDA and innovation in e-commerce is an interdisciplinary research field that could be explored from different perspectives and approaches, such as technology, business, commerce, finance, sociology, and economics. Moreover, the research findings are considered an invitation to those data analysts and innovators to contribute more to the body of the literature through high-impact industry-oriented research which can improve the adoption process of big data analytics and innovation in organizations. Finally, this study proposes future research agenda and guidelines suggested to be explored further.

Keywords Big data analytics · E-commerce research · Innovation · Bibliometric analysis · Scopus indexed · Citation analysis · Bibliometric analysis

Introduction

The topic of BDA is taking more attention among researcher's due to its important role in promoting creative businesses with respect to smart technologies and has gained an increased interest from researchers and practitioners as a key for firm performance and competitive success (Almajali et al. 2022; Alsmadi et al. 2022). BDA involve the use of vast databases comprising refined analytical technique (Bany Mohammad et al. 2022). Essentially, big data analytics encompass a blend of big data and analytics to create business analytics. Big data embrace three main features of variety, volume, and velocity. In particular, variety refers to the varied complexity of datasets, both organized and unorganized ones, while velocity refers to the speed of data processing, whereas volume describes the volume of data (Al-Okaily et al. 2022a). Owing to these features that big data have, the conventional systems are not appropriate for it, mainly

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because the conventional systems are not meant to handle and evaluate data in large quantities.

Hence, certain techniques of data extraction like hierarchical clustering and deep learning are used for big data information extraction (Al-Okaily 2022). Many e-commerce-related analytics are available today to resolve business issues. Big data allow e-commerce firms to cut costs while providing other advantages, particularly through its price effective space and competencies, in addition to its innovative analysis tools (Huarng et al. 2015; Alberti-Alhtaybat et al. 2019; Al-Okaily et al. 2020; Baden-Fuller and Haefliger 2013; Lanzolla and Giudici 2017; Chen and Zhang 2014; Yaseen et al. 2018).

Big data analytics reform the efforts of e-commerce firms in forming a competitive advantage (Huarng et al. 2015; Alberti-Alhtaybat et al. 2019; Lanzolla and Giudici; 2017; Baden-Fuller and Haefliger 2013; Chen and Zhang 2014) in both the conventional physical world (Baden-Fuller et al. 2018; Chen and Zhang 2014; Hartmann et al. 2016; Tian 2017) and in the virtual or digital world (Alberti-Alhtaybat et al. 2019). Through digitization, firms are gaining more opportunities to envision and create advanced model of business within the two-sided markets (Garzella et al. 2020; Alberti-Alhtaybat et al. 2019; Tian 2017; Caputo et al. 2019; Rochet and Tirole 2006) with interconnections between two or more customers with potential money gains to the firms as big data user (see Baden-Fuller et al. 2018; Hartmann et al. 2016; Tiago and Veríssimo 2014; Chen and Zhang 2014; Erevelles et al. 2016).

Clearly, big data analytics are vital for strategic innovation, but scholars have mixed views in terms of the findings of this concept (Snihur and Wiklund 2018). The competencies of big data analytics have been examined in many studies, and this has presented some theoretical and empirical discussion pertaining to issues associated with innovation, technology, and strategic management (among others), within the context of digital networks especially (Aws et al. 2021; Al-Okaily et al. 2021a; Kouropalatis et al. 2019; Mikalef et al. 2019a, b). Somehow, scholars are still uncertain on how firms create and implement digital innovative strategies. In fact, as reported by Bean (2016), in propelling innovation, many firms still do not know how to effectively invest in big data analytics. Indeed, without the right knowledge or abilities, firms could not adopt big data analytics in their strategic decision (Merendino et al. 2018). According to Mikalef et al. (2019a, b), there is an indirect effect that BDACs have on innovation capabilities. In addition, dynamic capabilities fully mediate the effect on both incremental and radical innovation capabilities in the same context; findings indicate that different combinations of organizational inertia including economic, political, socio-cognitive, negative psychology, and socio-technical hamper the formation of each type of capability (Mikalef et al. 2021).

Innovation studies have been stressing on the importance of knowledge and equipment of technology inputs, especially those embracing the technology-driven or technology-push viewpoints (Al-Okaily et al. 2021b; Rosenberg 1982; Nambisan et al. 2017), focusing on the significance of market-driven and user-driven features through the demand-pull viewpoints particularly (Schmookler 1966). From the technology-push viewpoint, Nambisan et al. (2017) described big data analytics as a component of digital technology, and big data analytics are increasingly crucial in innovation process. On the other hand, from the demand-pull viewpoint, big data are perceived as a vital component in understanding the needs of customer and the innovation processes of firms (Al-Okaily et al. 2022b; Trolio et al. 2017).

There are also more integrative views on big data analytics (Brem and Voigt 2009). However, it is still unclear as to how firms can strategically master the innovation process to reinforce their technology base, while also increasing their market demand. Accordingly, the present study examined the strategic use of big data analytics by leading firms in their innovative feats, through the lens of dynamic capabilities for innovation for e-commerce research.

"The main objective of this paper is to provide scholars and practitioners with a comprehensive overview of big data analytics and innovation in e-commerce literature, published in journals indexed by the Scopus database. To achieve this objective, the current research sets out to examine two main research questions that have not been adequately explored in the related literature: (1) What are the key influential and intellectual aspects of big data analytics and innovation for e-commerce literature? and (2) What are the future research directions of the big data analytics and innovation for e-commerce Research?"

Finally, this research contributes to the literature by a field study to grasp the viewpoints of key decision makers in firms that are involved in digital matters. As an attempt to extend the extant literature, the present study attempted to find out how big data analytics-related innovation processes are distinguished from the conventional innovation paths for e-commerce research.

It is crucial that bibliometric analysis goes beyond merely summarizing the findings of performance analysis and science mapping produced by scientific databases. Instead, bibliometric research must identify the gaps, and the outcomes of performance analysis and science mapping may act as a springboard and a supportive partner to other review techniques in advancing theory and practice. Mukherjee et al. (2022). The study provides wide covers of theoretical and practical contributions; our paper follows

Mukherjee et al. (2022) to identify the gaps and theoretical contributions: (1) Promoting objective discovery of knowledge clusters authors adopt (co-citation analysis, bibliographic coupling, and co-occurrence analysis). (2) Clarifying nomological networks to present the state of the field authors adopt co-occurrence analysis of keywords and research streams. (3) Mapping social patterns to understand the social processes supporting knowledge development in the field authors adopt co authorship or co-citation analysis and structural networks among scholars and their affiliation. In terms of practical contributions, our paper also follows Mukherjee et al. (2022) which identify practical contributions; the study covers (1) Promoting objective assessment and reporting of research productivity and impact by adopting productivity of research's (authors, institutions, countries, and journals). (2) Ascertaining reach for coverage claims and identifying social dominance or hidden biases for improvement efforts, the study adopt productivity, impact, and performance of countries.

Literature review

Big data and dynamic capability

There are a number of previous studies that have provided evidence about big data analytics and innovation for e-commerce research. For instance, Teece et al. (1997) were among the early studies that provided the definition of dynamic capability and big data analytics and innovation for e-commerce. According to the authors, it entails the ability of firm in incorporating, building, and reorganizing both its internal and external abilities in dealing with the rapidly shifting environments. Dynamic capabilities have then been examined through different viewpoints and issues, particularly within the domain of management (Lin and Wu 2014; Brown et al. 2011; Giudici and Reinmoeller 2012).

From the viewpoint of dynamic capability, by promptly altering their resources and processes, e-commerce could identify and appropriately react to the environmental threats and opportunities, and in this way, firms could consistently maintain their competitive advantage (Al-Okaily et al. 2021c; Day 2014; Helfat and Peteraf 2009; Kouropalatis et al. 2019; Chatzoglou and Chatzoudes 2018; Lin and Wu 2014). Notably, through selecting and managing different sources and types of information, firms could proactively reinvent their new and present knowledge (Day 2014; Helfat and Peteraf 2009; Merendino et al. 2018; Corte Real et al. 2017), and big data analytics have been perceived as a promising e-tool in capturing weak signals from consumers and in predicting the trends of both the market and the consumers (Rialti et al. 2019; Bharadwaj et al. 2013; Day 2014; Corte Real et al. 2017; Erevelles et al. 2016; Reeves and Deimler 2011).

Rialti et al. (2019), Erevelles et al. (2016) and Wernerfelt (2014) indicated that firms that use insights from big data in finding out the unfulfilled consumer needs appear to have superior dynamic capabilities. Through information extracted from big data, corporate decision-makers could effectively respond to current dynamic environmental trends (Al-Qudah et al. 2022; Erevelles et al. 2016; Kouropalatis et al. 2019; Rialti et al. 2019; Eisenhardt and Martin 2000). The effective exploitation of big data insights on consumer helps firms in constructing a dynamic business model, and this will improve firm performance while expediting the firm's value creation process (Kouropalatis et al. 2019; Erevelles et al. 2016; Ferraris et al. 2018; Rialti et al. 2019; Bharadwaj et al. 2013; Teece et al. 1997; Day 2014).

Additionally, when firms use big data analytics in developing products and enhancing business processes for e-commerce, they might be stimulated to become innovative businesses (Bharadwaj et al. 2013; Choi et al. 2017; Teece et al. 2016). In fact, the framework of dynamic capabilities essentially focuses on the need to methodically undertake entrepreneurial innovation as an integral part of long-term corporate strategy (Erevelles et al. 2016). Levine et al. (2017) relevantly stated that successful business strategies require firm to identify innovative paths to consolidate and develop new competitive advantages. Furthermore, leveraging high-quality large data during the decision-making processes allows firms to overcome hurdles (Erevelles et al. 2016; Erevelles et al. 2016; Dixon et al. 2014; Eisenhardt and Martin 2000).

Within the digital economy, the dynamic capabilities framework is regarded as a powerful tool in the creation, implementation, and transformation of business models (Prange et al. 2018; Teece 2018; Dixon et al. 2014; Teece and Linden 2017; Balusamy et al. 2017; Warner and Wager 2019; Karimi and Walter 2016; Quinton and Simkin 2017; Prange et al. 2018). Somehow, the relationship between dynamic capabilities, big data analytics, and digital innovation processes is still under researchable and therefore should be investigated thoroughly (Balusamy et al. 2017; Davenport et al. 2012; Prange et al. 2018).

Big data analytics

Big data analytical tools are differentiated by their data-relating speed, volume, and variety, which are influenced by data creation, storage and usage (LaValle et al. 2011; Vahn 2014; Balsmeier et al. 2018). Firms have gradually shifted to focus more on strategic information management, and this move has compelled them to seek new data sources like the web (Barton and Court 2012; Vitolo et al. 2015). As reported by Lanzolla and

Giudici (2017), the web has now become firms' leading information source in the creation of information systems, models, and "machines," especially in their efforts to reach their full potential. Owing to the vast availability of information today, new procedures for big data analytics have been established (Mashhadi et al. 2018; Carillo et al. 2019). Notably, intelligence models have been revamped to correspond to the web dimension and the strategic outlook (Lanzolla and Giudici 2017). Meanwhile, models and tools of information management have evolved, in line with the new requirements of strategic decision, and the evolution of these models and tools resulted from the identification of the key analysis dimensions (Hamdallah et al. 2022; Kuosa 2011; Reinmoeller and Ansari 2016; Garzella and Fiorentino 2014).

Contributions from various managerial disciplines were integrated in the formation of a comprehensive and systematic view (Wagner 2004; Popovic et al. 2012), and it appears that capability of innovation is highly crucial (Giudici et al. 2018; Gobble 2013). Past studies have indeed highlighted the significance of management and data analysis in mitigating processes and creativity of innovation (Olszak and Kisielnicki 2016; Perry-Smith and Mannucci 2017; Bresciani et al. 2018). In this regard, countless of data points need to be expounded to create new products, processes or business models, and new ways to approach consumers need to be identified, to increase customer satisfaction (Al-Okaily et al. 2022c; Shipilov et al. 2017; Markides and Anderson 2006; Mahmoud et al. 2018; Hammouri et al. 2021; Nusairat et al. 2021). Indeed, big data analytics can facilitate consumer behavior analysis (Levine et al. 2017; Hofacker et al. 2016; Peteraf et al. 2013; Kannan and Li 2017), while predictive analytics could help in understanding the behavior of users and consumers (Markides and Anderson 2006; Lu and Weng 2018). Using big data analytics, decision makers have better understanding of current customers and future as well needs, the demand of market and market trends as well (Jin et al. 2016; Coussement et al. 2015; Peteraf et al. 2013; Lutfi et al. 2021; van Rijmenam et al. 2018).

Successful product innovation through big data use has been linked to innovation process acceleration, customer connections, and innovation ecosystem development (Lutfi et al. 2022a, b; Agostini et al. 2019; Yoo et al. 2012; Zhan et al. 2017; Al-Gasawneh et al. 2020; Al-Adamat et al. 2020). Additionally, Zhan et al. (2017) and Wamba et al. (2017) reported that big data analytics can reduce firm cost. Meanwhile, Yoo et al. (2012) indicated that innovation with universal digital technologies shows features like heavy reliance toward digital technology platforms, presence of distributed innovations, and the use of combinatorial innovations. Relevantly, Choi et al. (2017) and Kwon et al. (2014) mentioned the need to correctly manage high data structuring, because aside from stimulating creativity and innovation, cognitive model creation can also promote homogenization and constraint (Dobusch and Kapeller, 2018; Wamba 2017).

In facilitating innovation processes, considering the current trends and developments, scholars and practitioners alike need to deeply examine the new approaches utilizing business analytics, predictive analysis, and big data management models (George et al. 2014; Vahn 2014; Lindstrom 2016; Carillo 2017). In addition, Lindstrom (2016) mentioned the need to diffuse both rich data and deep data alongside big data. The notions of "technology-push" and "demand-pull" have been the subjects of debate among many innovation scholars (Nemet 2009). The idea of technology-push suggests that innovation process results from new market-affirmed discoveries, inventions, and technologies (Donthu and Gustafsson 2020; Gunasekaran et al. 2017; Dosi 1982; Huarng et al. 2015), while demand-pull concept suggests that innovation process is stimulated by the needs of consumers, as product end-user, and these needs become input to the innovation process (Donthu et al. 2021; Fiorentino et al. 2020; Rosenberg 1969). The innovation development model was initially constructed based on the concept of technology-push, especially during the 1950s all throughout the early 1960s. During this time, innovation was regarded as an outcome of a roughly linear process which begins with scientific discovery, followed by R and D, and ends with the developments of industrial technology which become new innovative processes and products the market would later recognize (Hashimoto et al. 2018; Lim 2021; Freeman 1974).

Methodology

The bibliometric approach, which is one of the comprehensive approaches, has been followed in this paper to include reviewing the literature published in highly reputable databases such as Scopus (Umeokafor et al. 2022), including tracking the publications in these databases and examining the qualitative and quantitative nature of these publications. The bibliometric approach is characterized by many innovative and unique characteristics. The methodology is presented objectively without biases (Horng et al. 2022). In addition, this type of research is concerned with including all the papers in a particular field and thus reaching interesting results leading to a significant expansion of the current works in the literature.

The bibliometric analysis aims to provide a systematic, reliable, and objective analysis of trends in the literature over time, and thus, bibliometric analysis can provide comprehensive maps of the current knowledge structure in certain aspects of the literature (Rialti et al. 2019). In

addition, this method is mostly used to measure the impact of research articles and to estimate how much influence a selected research article has on future research. It usually does this by counting the number of times the article is cited after it is published (Kraus et al. 2022; Lutfi et al. 2022a, b).

Data collection procedures

The bibliometric data were collected through the Scopus database, which is considered one of the most prestigious databases in various fields of knowledge, especially in the field of business (Alshater et al. 2022). Other databases were excluded, in particular databases that do not provide Automatic data export, which requires using manual data export, leading to the repetition of some errors. Web of Science (WOS) database has also been excluded because most articles indexed in the Scopus database are already on the WOS database. To achieve this bibliometric study objectives, a set of possible queries has been developed so as not to exclude any article that could be included in the bibliometric analysis. The appearances of this search query were as follows: The keywords "Big data analytics" and "Innovation" were used, which resulted in "541" articles written in English and published in journals and conference proceedings. The focus was on including articles containing the keywords "Big data analytics" and "Innovation" in the title or keywords, and therefore, no article was excluded from "541" articles, and they were all included in this study from 2011 to 2021.

Data tools

To achieve the objectives set in this study, the R Studio used a dedicated bibliometric package called Biblioshiny was used, and to understand the intellectual structure of the study field, a VOSviewer was used to map this structure. Citation analysis was used through VOSviewer to answer the first question, while co-citation/co-authorship was used to know various academic relationships in scientific communities, which illustrate the interest in the field of study globally. To answer the second question, the content analysis approach was used, which is used to analyze keywords. Thus, this approach can be used to reach the most important topics related to the field of study, and thus the ability to suggest new directions for researchers.

Results and discussion

In this section, we provide the results in our three major categories with a thorough discussion on each. The first section provides publication overview on the input data collected; the second section provides citation analysis; the last section presents network analysis.

General information and performance analysis: publication overview

Bibliometric analysis should start the data analysis with general information (publication overview) that was used in analysis. Table 1 shows that (541) documents were analysis associated with (434) sources (Journals, Books, etc.), from the total documents 284 articles and 181 are conference papers. Cooperation's between authors seen through that only 80 documents come from single authors and rest of documents from multi-authored which slightly reflect the increasing collaboration between scholarly work of big data analytics and innovation.

According to the data collected from the Scopus database, the average citations per documents are 15.78 considered high; especially, there are around 132 and 91 documents published in 2021 and 2020, respectively, which indicates the raising academic interest in this field. Also, average citations per year per document are 3.821 the results indicating a strong connection and increasing trend among the documents regarding academic collaboration in research related to big data analytics and innovation in e-commerce.

Distribution of literature over time, as discussed in the methodology part, this study adopted the period study from 2011 to 2021; ten years journey of researches reflects how the researchers become interesting in discuss how big data analytics and innovation for e-commerce is. Figure 1 shows there is irregular positive annual increase in number of publications indexed in the Scopus database with 132 documents in 2021 compared to one document in 2011. However, it is not secret that companies get profit and benefit from big data also enables e-commerce companies to enhance decision making and gain a competitive advantage to increase their performance and products. It also allows to analyze customer behavior. New business models are emerging all the time, leading to scholars' focus on comprehending different relationships between big data analytics and innovation on e-business.

Table 1 General information (publication overview)

Description	Results
Main information about data	
Timespan	2011–2021
Sources (journals, books, etc.)	434
Documents	541
Average years from publication	2.86
Average citations per documents	15.78
Average citations per year per doc	3.821
References	32,681
Authors	1755

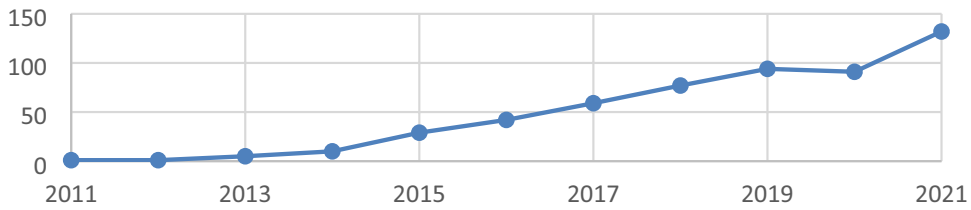

Fig. 1 Distribution of literature over time (growth of big data analytics and innovation for e-commerce research)

Table 2 Most relevant journals

Rank	Sources	Articles	Publisher	SJR 2022
1	Sustainability (Switzerland)	19	(MDPI)	0.664
2	Advances in Intelligent Systems and Computing	13	Springer Nature	0.215
3	Lecture Notes in Computer Science	12	Springer Nature	0.407
4	Technological Forecasting and Social Change	9	Elsevier	2.336
5	Acm International Conference Proceeding Series	8	ACM	0.232
6	IFIP Advances an Information and Communication Technology	7	Springer Nature	0.25
7	Journal of Business Research	6	Elsevier	2.316
8	Lecture Notes in Electrical Engineering	6	Springer Nature	0.148
9	Annals of Operations Research	5	Springer Nature	1.165
10	Business Process Management Journal	5	Emerald	0.844

Table 3 Number of articles per country

Rank	Country	Article
1	USA	287
2	India	249
3	China	174
4	UK	128
5	Italy	115
6	Australia	78
7	Greece	66
8	Malaysia	62
9	Germany	43
10	Brazil	38

Table 4 Most relevant institutions

Rank	Affiliations	Articles
1	University of Minho	17
2	International Center for Agricultural Research in Dry Areas (Icarda)	14
3	Norwegian University of Science and Technology	11
4	University of Salento	11
5	Ubi tech	10
6	University of Patras	10
7	Hefei University of Technology	8
8	Indian Institute of Technology Delhi	8
9	Notreported	8
10	Ryerson University	8

According to the analysis of most relevant journals, Table 2 provides clear help to authors to recognize the leading journals in this area. We notice that the most productive journals are mostly from respected and highly cited in the fields affiliated such as (*MDPI, Springer, Elsevier and Emerald*). *Sustainability (Switzerland)* found the most prestigious journal in the field with 19 documents followed by (*Advances in Intelligent Systems and Computing)* with 13 documents. Referring to *sustainability (Switzerland)*, the journal is specialized in publishing the experimental, computational, and theoretical research relating to natural and applied sciences, engineering, economics, social sciences which encourages researchers to proceed their publications.

Table 3 summarizes the most productive country in big data innovation research on e-commerce, USA, found the most productivity country in publishing with 249 articles followed by India with 249 articles; this is not surprising that India has that much of concerning because, in particular, India has witnessed a sharp uptick in innovation in this space. Companies are developing newer ways to integrate big data analytics into their business units.

Analysis of most relevant institutions describes the top institutions publication most relevant researches in big data analytics and innovation for e-commerce; Table 4 shows that the *University of Minho* in Portugal had published 17 documents followed by *International Center for Agricultural Research in Dry Areas (ICARDA)* with 14 documents (ICARDA) being international organization not belonging to any University, in third rank *Norwegian University of*

Science and Technology and *University of Salento* in Italy with 11 publication for each one. These results may provide a detail information be for students, researchers, and industry leaders to know the top affiliations institutions in this field. Unfortunately, the top four affiliations not belong to top four countries leads in this field publications.

Figure 2 clarifies the most relevant authors with number of publications studies in Scopus database in field big data analytics and innovation for e-commerce. As seen in the figure, there are 31 documents published without author's name, followed by *Simon Elias Bibri* who published under *Norwegian University of Science and Technology* that explains why this affiliation among top 3 is published in this field.

Citation analysis

Citation analysis is used to examine the frequency and graphs of citation articles (links from one document to another documents). It is also technique for analyzing the documents to understanding and discover connect the document with other, the citation analysis in bibliometric methodology depending on of big data analysis which is the topic of this paper.

Most cited documents

Table 5 provides most cited documents with this field from data collected from the Scopus database during 2011–2021. We select only those articles which are cited more than 160 times which present top 10 documents. We notice that there is a correlation between the journal ranking and the time

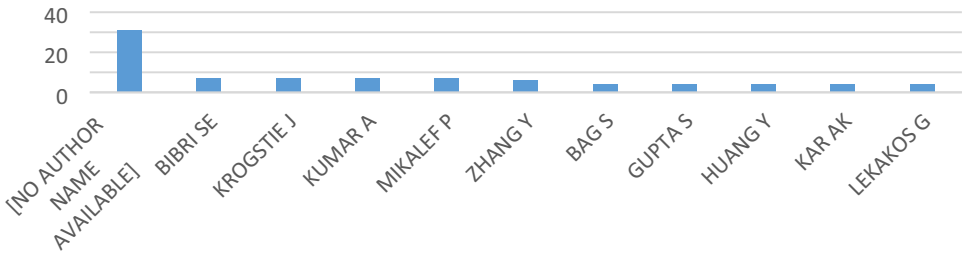

Fig. 2 Most relevant authors

Table 5 Most cited documents

Rank	Authors/year	Title	Source title	Cited	SJR rank
1	Reed and Dongarra (2015)	Exascale computing and big data	Communications of the ACM	305	Q1
2	Hilbert (2016)	Big Data for Development: A Review of Promises and Challenges	Development policy review	296	Q1
3	Lareyre et al. (2019)	Artificial Intelligence in Surgery: Promises and Perils	HHS Public Access	291	Q2
4	Lee and Lee (2015)	Industrial Big Data Analytics and Cyber-physical Systems for Future Maintenance and Service Innovation	Procedia CIRP	262	Q2
5	Lu et al. (2014)	Toward efficient and privacy-preserving computing in big data era	IEEE	245	Q1
6	Bonilla et al. (2018)	Industry 4.0 and Sustainability Implications: A Scenario-Based Analysis of the Impacts and Challenges	Sustainability	228	Q1
7	Zhou et al. (2016)	Energy Internet: The business perspective	Applied Energy	205	Q1
8	Ardito et al. (2019)	Toward Industry 4.0: Mapping digital technologies for supply chain management-marketing integration	Business Process Management Journal	199	Q1
9	Mikalef et al. (2019a, b)	Big Data Analytics Capabilities and Innovation: The Mediating Role of Dynamic Capabilities and Moderating Effect of the Environment	Big Data Analytics Capabilities and Innovation	177	Q1
10	Bag et al. (2020)	Big data analytics as an operational excellence approach to enhance sustainable supply chain performance	Resources, Conservation and Recycling	166	Q1

of citation most of documents published in Q1 sources in Scopus database. We only discuss the top three articles.

(a) Reed and Dongarra (2015) article entitled "*Exascale computing and big data*" and published in Communications of the ACM. This study focused on the importance of high-performance computing and big data tools and cultures in enhancing innovation and performance. Was the highest number of citations in Scopus database with 305 cite, the source of publication *(Communications of the ACM)* ranked as a Q1.

(b) Hilbert (2016) article entitled "*Big Data for Development: A Review of Promises and Challenges*" used conceptual framework to review from 180 articles related to the topic of big data, with 296 cite the source of publication *(Development policy review)* ranked also Q1.

(c) Lareyre et al. (2019) article entitled "*Artificial Intelligence in Surgery: Promises and Perils*" reviewed and summarized major topics in artificial intelligence (AI) including their applications. With 262 cites, the source of publication *(HHS Public Access)* ranked Q2 in Scopus database.

Most cited countries

Geographical contribution is a concern; Fig. 3 shows the frequency of the most active countries in terms of big data analytics and innovation during the period 2011–2021. It is important to mention that these countries referred to the author's affiliated country at the time of publication. It is not surprising to see the USA and India as the leader and global hub of big data analytics and innovation research, followed by the UK and china. There could be three reasons which might explain the presence of the India within the leading countries in this field:

- India has been investing heavily in big data to increase the efficiency of its governance since 2014.
- The demand for analytical talents is rapidly increasing, yet there is a significant supply gap. India can provide the employees with suitable salaries.
- India's non-IT sectors have seen a huge potential for engineers for data analytics. The newfound approach of using data analytics and AI has led to the development of innovative solutions for different problems in various non-IT sectors.

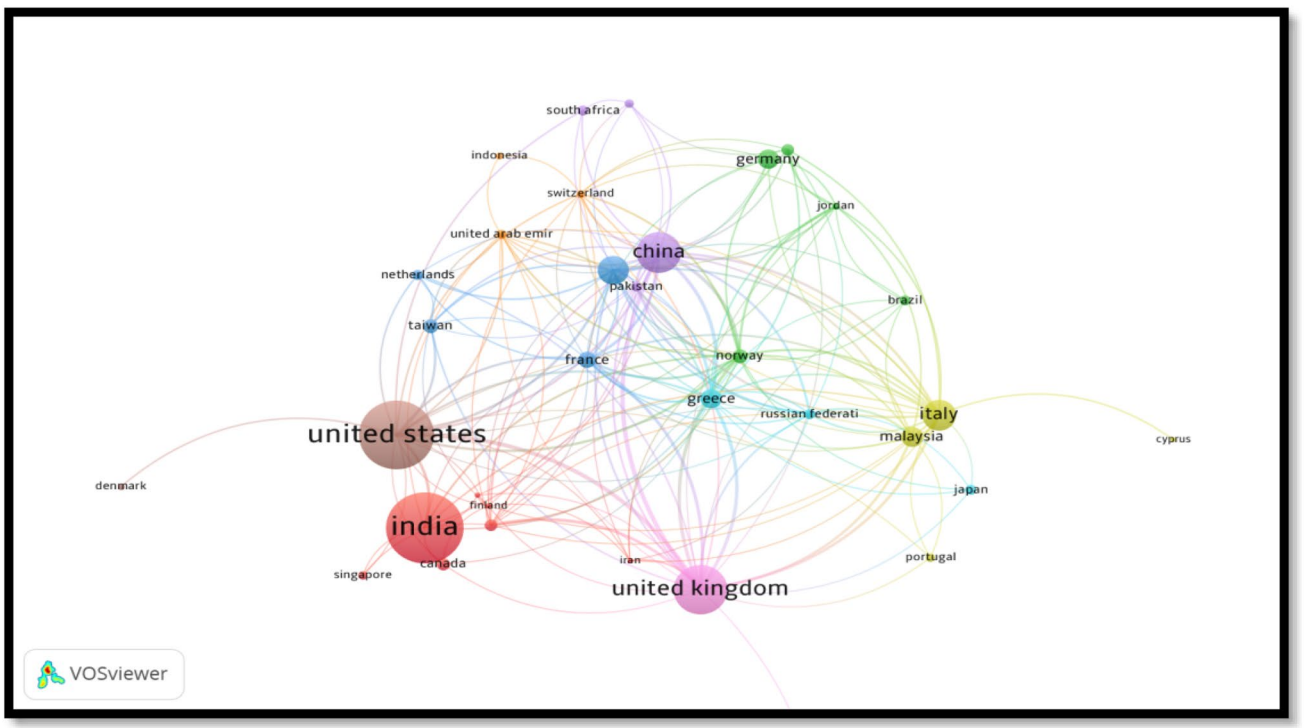

Fig. 3 Most cited countries

Network analysis

Co-citation analysis

This widely used method performs automatic clustering for big data sets and identifies cases in which two documents cite the same third work in their bibliographies. Co-citation analysis consider as a measurement used for determining the relation between cited articles (Small 1999). Figure 4 shows this analysis for the big data analytics and innovation documents in our database. We identify four main journals, namely Green network = Journal of Business Research with 378 citations and total link strength 18,652, yellow network: MIS Quarterly and International Journal of Production Economics with 267 citations and total link strength 10,150, Blue network: International Journal of Production Economics with 221 citations and total link strength 9477 and Red network: Sustainability with 217 citations and total link strength 5581.

Co-authorship analysis

Network visualization of key authors or co-authorship analysis recognizes and identifies the relationship among key authors based on citation (Pattnaik et al. 2020). Our analysis identifies 28 papers that had highest; a higher score indicates a stronger link between two documents. Figure 5 presents the co-authorship network analysis; the greater the node size and thickness, the more it indicates that this author is of great importance in the field as shown in Fig. 5 that (*Angappa Gunasekaran*): Yellow network with 319 citation is the most influential in the field of big data analytics and innovation, and then followed by (*Shahriar Akter*): green network with 266 citation.

Keyword occurrence and connectivity

We perform a keyword analysis using the software VOSviewer; Fig. 6 presents the results of the keyword analysis. Again, we see four clusters. In addition to refining the clusters, keyword analysis sheds light on research

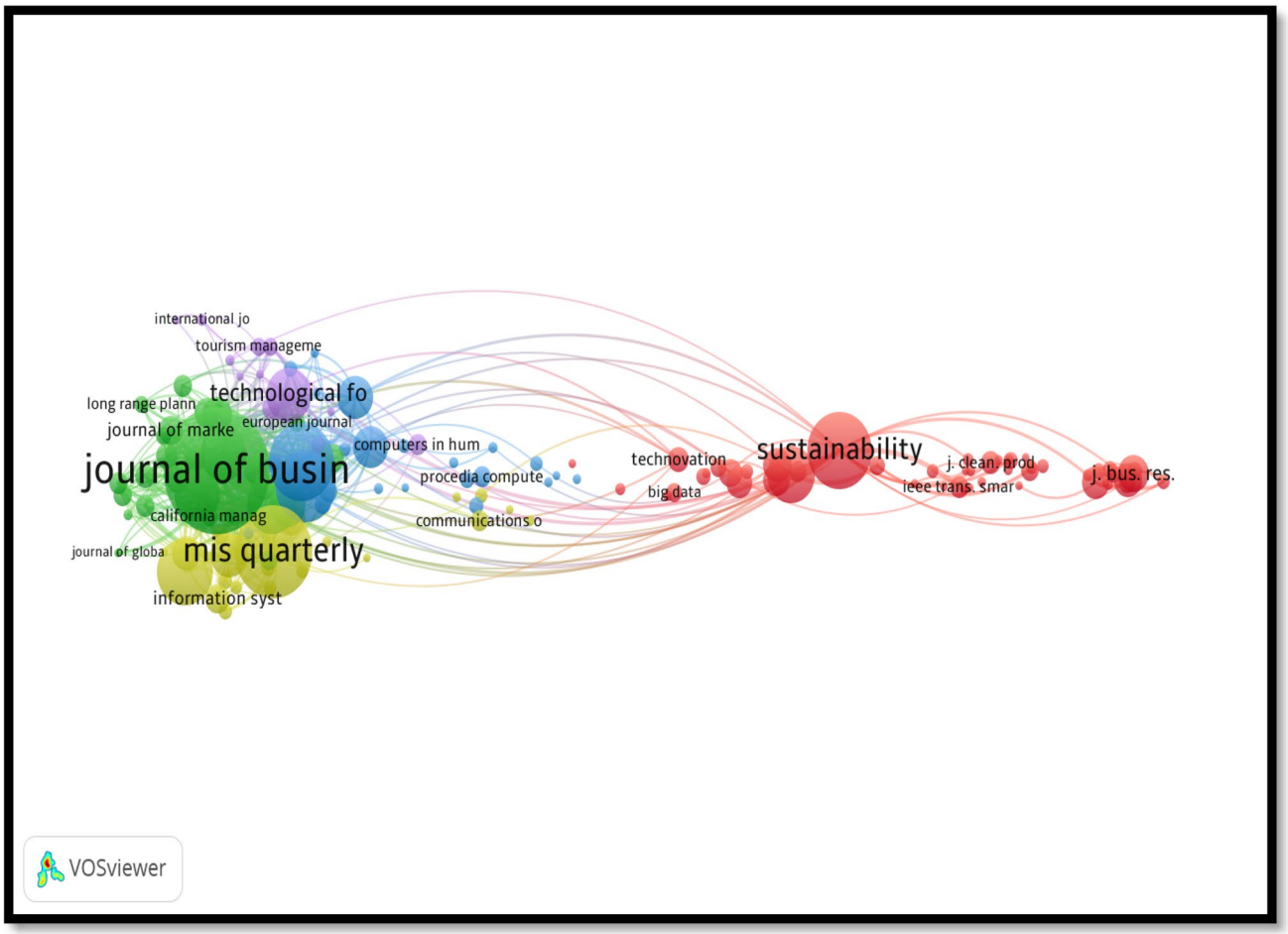

Fig. 4 Co-citations of sources

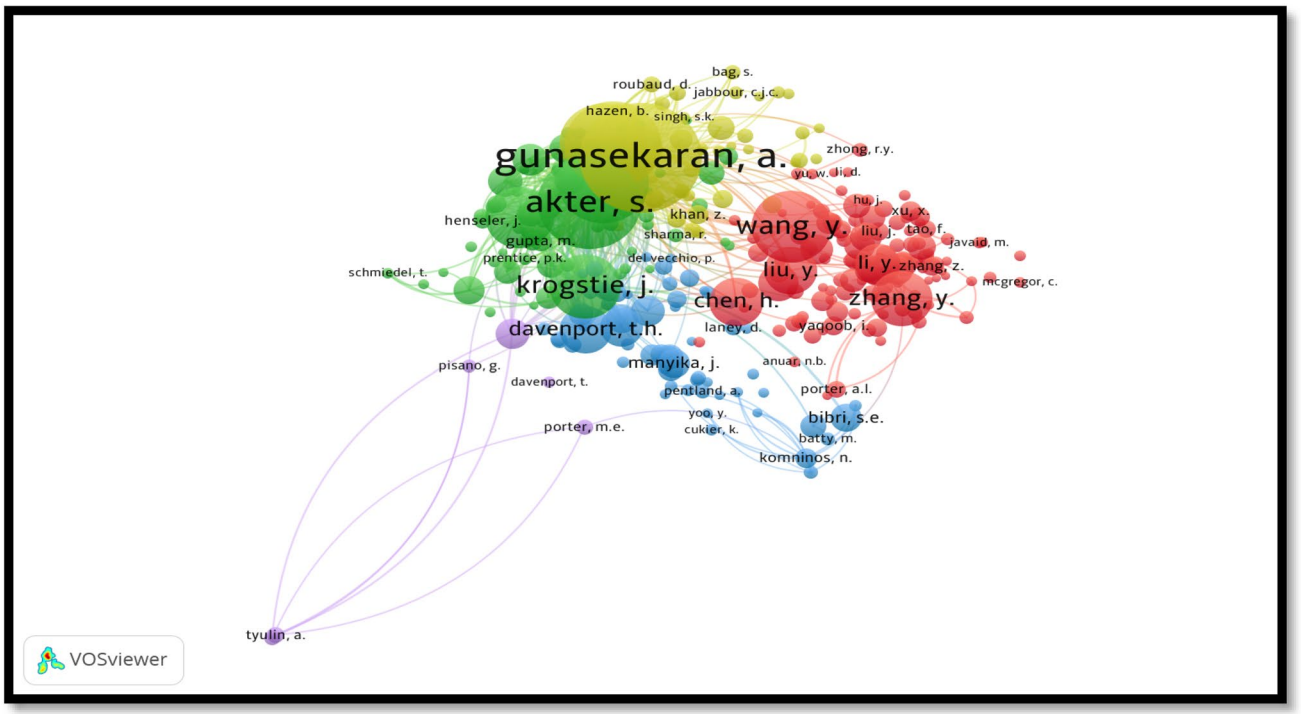

Fig. 5 Co-citation of authors

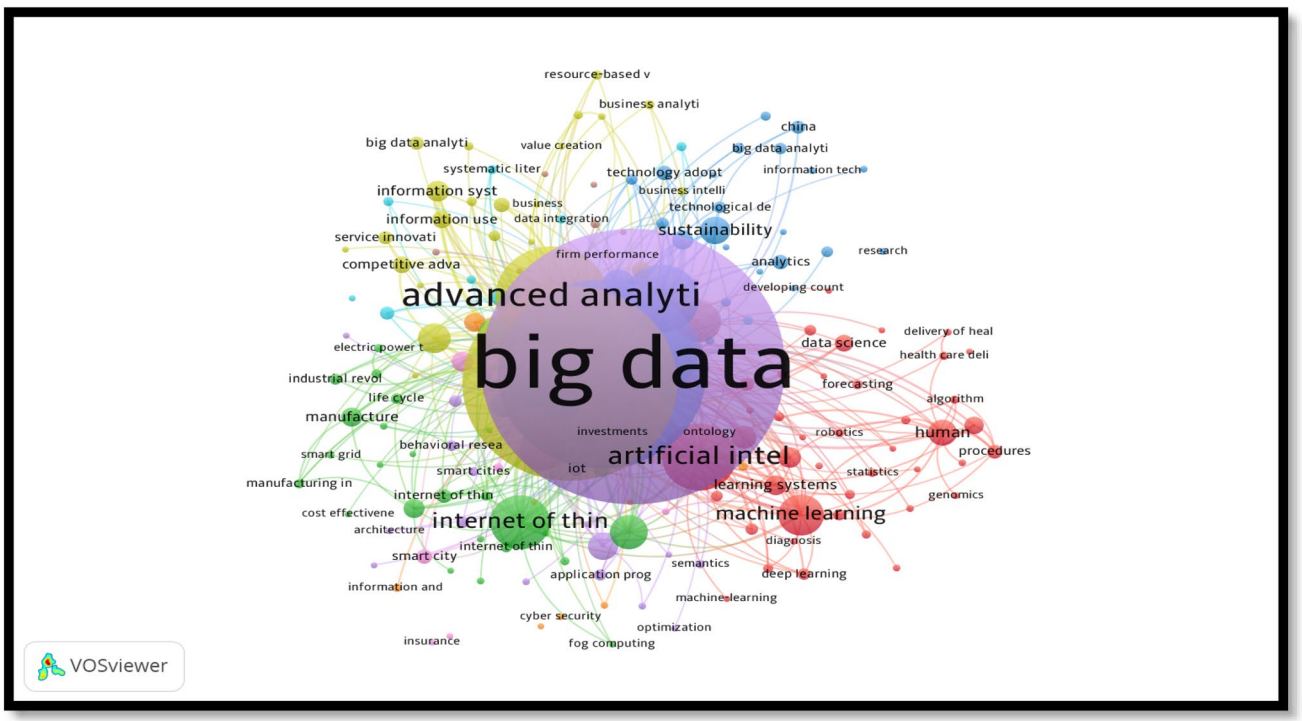

Fig. 6 Keyword occurrence and connectivity

streams. The results indicate that big data study: violet network represents the main cluster and then followed by data analytics cluster: blue network, big data analytics, and advanced analytics: yellow network. Figure 7 shows the top 20 keywords used by authors, which help along with the bibliographical coupling in identifying the streams within big data and innovation; these analyses can help to provide best direction for future research. The literature initially discusses the fundamental feature and characteristics of big data and innovation and then moves to discuss its different segments such as big data analytics and advanced analytics. Keyword occurrence and connectivity figure shows that big data analytics the most keyword used: blue side with 200 times and 28% per from total, followed by big data: brown rectangular with 159 times and 23% per from total.

Conclusion and future directions

The big data analytics and innovation in the e-commerce literature is experiencing an increasingly attention over the last years, and many scholars focus on this research from a socio-technical perspective. The researchers of this field in many occasions were highlighting the importance of the big data tools and techniques in achieving innovation outcomes, such machine learning, Hadoop, cloud computing and blockchain, mainly in the fields of industry 4.0 and healthcare. This endeavor was evident during the Covid'19 pandemics, where many researchers from the USA, India, China, UK and others focused on and applied data analytical solutions to fight the disease and establish preventive actions against it in various innovative manners to support businesses through their electronic transactions.

It can be also concluded that big data analytics and innovation in e-commerce is an interdisciplinary research field that could be explored form different perspectives and approaches, such as technology, e-commerce, economics (accounting and finance), and management. Therefore, we are proposing future research topics and questions on the basis of the analysis results and the suggestions provided by the authors in the same research field. Table 6 shows the proposed agenda of future research that is oriented to further investigate the relationship between big data analytics and innovation from various perspectives. Lastly, we identify and present several directions for future research, which will play a vital role in furthering development of this field.

It is worth to know the current trends in e-commerce, so according to Kumar et al. (2021) the increased adoption of S-Commerce with E-Commerce. The reason behind this trend is that S-Commerce offers profound benefits that come from aligning customers with business operations

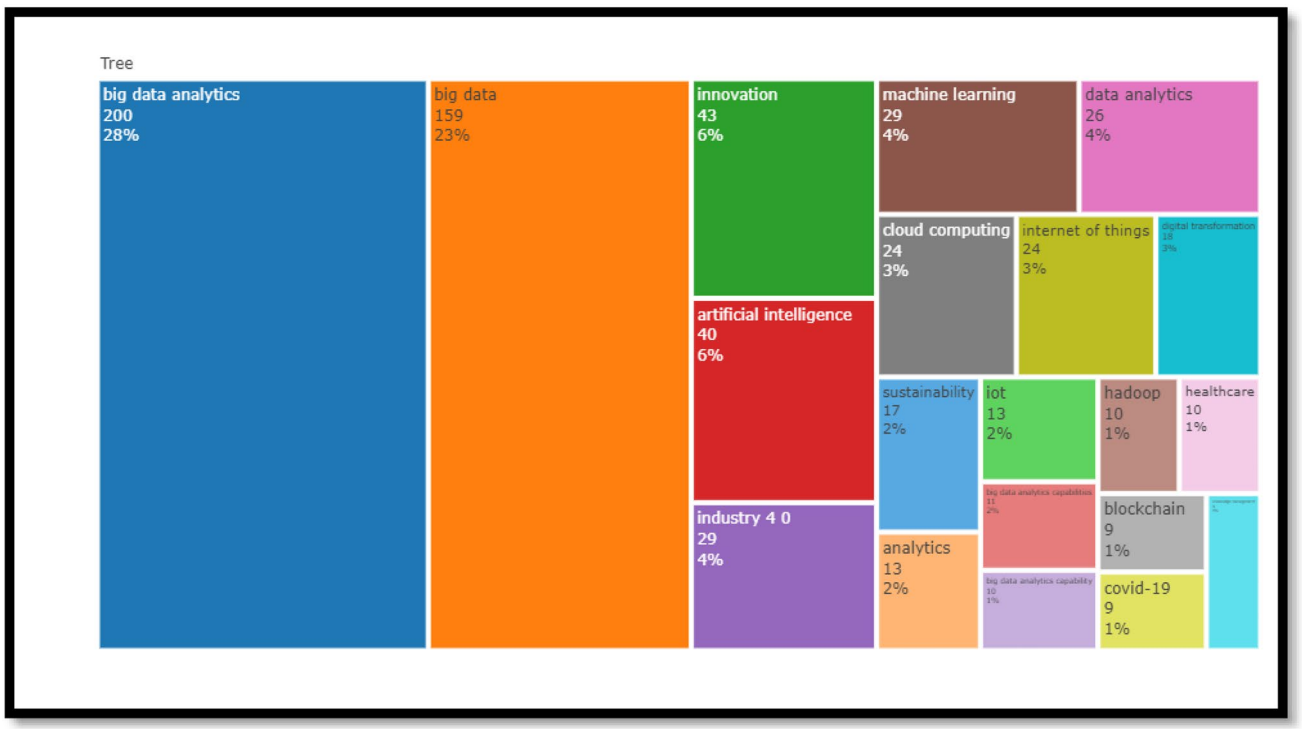

Fig. 7 Tree map for top 20 keywords used by authors

Table 6 Proposed research agenda

Research domain	Future research topics	Source
Industrial domain—Project Level	More global perspective of innovative BD Analytics Adoption through Longitudinal research	Ahmad and Mustafa (2022)
	Multi-dimensions of big data analytics, project success, and decision making in various cultures and project environments	Ahmad and Mustafa (2022)
	Exploring the importance of projects developed in global networks in developing local innovation capacities and the associated mechanisms	Tarraço et al. (2019)
Service Level	Understanding the relationship between big data analytics capabilities and green radical and incremental innovation by using longitudinal data or panel data, and in the pharmaceutical industry or the food industry sectors	Alkhatib and Valeri (2022)
	Cross-cultural studies and Longitudinal research to understand the relationship between BD analytics, Swift Trust, Supply chain coordination and risks, and sustainable competitive advantage	Behl et al. (2022)
Business and Economical Level	Understanding radical innovation culture and BD analytics values in transitional economies	Baković et al. (2016)
	A qualitative method to understand in-depth the relationships between BDAC and the value creation mechanisms in businesses	Elia et al. (2022)
	A qualitative study to reveal in-depth insight on how value is produced from BD analytics and innovation investments and financial returns	Mikalef and Krogstie (2020)
	Investigating the role of national culture on environmental innovation through the use of BDA capabilities	Ullah and Babar (2022)
	Providing mechanisms about BDA capabilities in market agility, and the role of innovation activities (generation and adoption) for entrepreneurial start-ups	Wang et al. (2022)
Health industry level	Framing a full-fledged Health Care System to address the challenges and values in n e-Health Care systems	Bhuvaneswari et al. (2021)
	Build a prognostic framework of based on big data analytics toward effective Clinical Decision Support Systems	Dash et al. (2019)
Technology industry level	Considering qualitative to involve the experiences that new firms have of managing the relationship among BD analytics as ICT capability and knowledge sharing in a Smart City	Bresciani (2017)
	Exploring in-depth the impact of AI and BDA capabilities on the legacy systems and IT working position and styles	Ayman and Shuhaiber (2022)

such as advertising and marketing and involving them in activities such as product reviewing and rating, which can help other customers in the process of making purchase decisions. From 2016 to 2018, sharing commerce continued to develop. A major trend was the technical dimension of sharing commerce sites, technological characteristics, and the tools that illustrate the sharing commerce evolution and its potential for the future. The debate about the adoption of sharing commerce by users and challenges and prospects remained throughout the period (2016–2018). Research tackled topics such as purchase intention, buying habits, shopping experiences, trust and risks, building brand loyalty, continued customer participation in sharing commerce activities, and finally public relations in the sharing economy.

Research implications and limitations

This study has several implications. Theoretically, this study exposes the big data analytics and innovation in e-commerce research endeavors in different regions (specifically North America, and South East Asia), and by many authors and in various domains and levels (healthcare, finance, industrial organizations, e-commerce and others), and indicates the main themes that have driven this field of research till date. Researchers are able now to perceive potential subjects and topics based on their countries and can identify research gaps in local and global occasions and what methodologies that researchers may consider to address those gaps. Practically, this bibliometric study can help big data analysts and scientists who are responsible to find innovative digital solutions to organizations and governments through their research and development departments. In addition, the research findings are considered an invitation to those data analysts

and innovators to contribute more to the body of the literature through high-impact industry-oriented research which can improve the adoption process of big data analytics and innovation in organizations.

This research has limitations. This study reviewed the relevant articles from only Scopus databases, due to its accessibility, availability, and comprehensiveness. As mentioned in earlier sections, some other databases do not provide automatic data export process, which may result in research outcomes inconsistencies. In addition, other databases may such the WOB include papers that are Scopus indexed, and thus, redundancies were minimized. This, over, could limit the research contribution and the generalization of the findings.

Author contributions All authors contributed equally.

Data availability Available upon request.

Declarations

Conflict of interest The authors declare no conflict of interest.

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