



Article

E-Commerce Meets Emerging Technologies: An Overview of Research Characteristics, Themes, and Trends

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Abstract

The rise of e-commerce platforms has completely revolutionized the way in which consumers interact with the market. In our digital world, due to the evolution of technology, people can purchase with ease the desired products, regardless of time and place, directly from their personal devices. This has led to a considerable improvement in users' experiences, saving both time and money and avoiding stores' congestions. At the same time, the emerging technologies, such as machine learning, artificial intelligence, augmented reality, and blockchain, registered a substantial contribution to optimizing e-commerce platforms by enhancing the efficiency of the processes, better understanding users' needs, and offering personalized solutions. Therefore, the present bibliometric investigation aims to provide a comprehensive overview of the research domain—electronic commerce exploration using emerging technologies. Based on a dataset collected from the Web of Science database, the study reveals key details of the field, research characteristics, main themes, and current trends. Within the analysis, the R-tool—Biblioshiny 4.2.1—has been used for the creation of tables, graphs, and visual representations. The high importance of the domain, together with the significant interest within academics in publishing papers around this area, is validated by the value obtained for the annual growth rate, more specifically 44.65%, as well as by the cross-validation analyses performed in VOSviewer 1.6.20 and CiteSpace 6.3.R1, along with topic analysis performed through Latent Dirichlet Allocation and BERTopic. The results of this research represent precious information for the scientific community, authorities, and even companies that are oriented to e-commerce platforms, since crucial details about the market trends, domain's impact, and key contributions are exposed.

Keywords: e-commerce; bibliometric analysis; Biblioshiny; blockchain; artificial intelligence; augmented reality; internet of things; n-gram analysis



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1. Introduction

The rapid advancement of technology has resulted in a multitude of benefits and has considerably simplified the individuals' lives. E-commerce platforms have become real tools in today's era, making the shopping experience more accessible and faster for everyone. With the rise of e-commerce platforms, most of the challenges that people faced in the past, such as physically going to the store, standing in lines, and waiting in crowded places to buy their desired products, have been reduced.

Nowadays, people can easily access a wide variety of products (food, clothes, electronics, jewelry, etc.) at any time, directly from their phones or laptops, and with just a single click they can buy the items and opt for home delivery in a short amount of time. Therefore, they save money, time, and energy while also enjoying a comfortable, quick, and straightforward shopping experience. This phenomenon has fundamentally changed the way consumers interact with the market [1].

Even though the e-commerce platforms' introduction to the online environment seems to have brought only benefits and positive effects on people's lives, it is crucial to highlight that this phenomenon has also generated a significant number of challenges in many areas, including security (data protection and secure payment processes), operations (logistics, delivery processes, and massive volume of orders), customer experience (gaining clients' trust, meeting their expectations, adapting to their needs, and handling the return processes), sustainability (eco-friendly practices), etc. Considering the scientific research, a series of aspects related to the electronic commerce area have been addressed in a comprehensive manner by orienting to a particular challenge, such as, but not limited to the following: cyber security [2], urban logistics sustainability [3], environmental impact [4], logistics service quality [5], and customer experience [6].

This fast and continuous evolution of technology undoubtedly requires a permanent adaptation from the electronic commerce point of view. The cutting-edge technologies, such as blockchain [7], artificial intelligence [8], augmented reality [9], and the Internet of Things (IoT) [10], are exceptional tools for solving most of the challenges encountered in electronic commerce platforms, having a significant contribution to enhancing processes' efficiency, understanding the users' needs, and generating personalized solution.

As a result, in the scientific literature, a series of authors have studied the importance and substantial impact generated by the integration of emerging technologies in electronic commerce platforms, using real case scenarios: relief supply chain with blockchain on a second-hand shop [11], augmented reality on fashion and beauty products e-commerce [12], sentiment analysis based on reviews on eBay [13], Internet of Things' help in e-commerce platforms for people with disabilities [14], and international e-commerce with agricultural products using blockchain [15].

Hence, taking into account the high relevance of the domain, the present paper provides a bibliometric investigation around the topic of electronic commerce combined with the use of emerging technologies. Thus, the present paper aims to contribute to the scientific community's research in this domain and also to assist authorities and companies involved in this area, to better understand the market trends, existing gaps, current issues, and adapt their strategies and processes with respect to the user behavior and needs.

Unlike previous bibliometric studies highlighted in Table 1, which provided a bibliometric approach to either e-commerce in general or to various aspects related to e-commerce, relying mostly on general issues discussed in bibliometric analysis such as the evolution of the number of published papers in time, the citations analysis, co-words analyses, or co-authorship analyses, our study integrates classical bibliometric mapping with two complementary topic modeling approaches—Latent Dirichlet Allocation (LDA) and BERTopic. Through this dual approach, which supplements the thematic maps provided by the bibliometric analysis, the thematic structures identified through the analysis are further validated. By comparing the results of the three analyses conducted in this paper, BERTopic, LDA, and thematic map, the connection between the results can easily be observed, highlighting more the research directions considered by the authors in this field.

Furthermore, by considering the focus of the studies listed in Table 1, it can be noticed that the present study differentiates itself from the papers published in the scientific literature also through the theme approached, focusing on emerging technologies-artificial

intelligence, machine learning, deep learning, blockchain, the Internet of Things, distributed ledger technology, and augmented reality-and their usage in the context of e-commerce.

While some of the papers in Table 1 offer valuable insights into e-commerce, it can be observed that in the area of emerging technologies, the selected studies focus mainly on a single emerging technology within the e-commerce field—e.g., blockchain [16], AI [17–19], recommender systems [20,21], ML [22,23]. Therefore, these studies provide limited visibility into how different emerging technologies intersect and co-evolve in the broader e-commerce research landscape. Moreover, as highlighted above, considering the analyses conducted in the above-mentioned studies, these are limited to classical bibliometric analyses focusing on statistics related to the number of papers, authors characteristics, sources analyses, not providing or revealing thematic patterns through the use of multi-faceted approaches, such as thematic maps combined with either LDA or BERTopic analyses.

Table 1. Summary of previous bibliometric research papers on e-commerce.

Reference	Focus
Franco-Castaño et al. [24]	E-commerce in general
Ferraz et al. [25]	After-sales attributes in e-commerce
Villa et al. [26]	E-commerce adoption factors
Bach et al. [27]	Evolution of distribution in e-commerce
Altarturi et al. [28]	Technological advancement applications in agricultural e-commerce
Rita and Ramos [29]	Consumer behavior and sustainability in e-commerce
Tran and Khoa [30]	Circular economy in e-commerce
Mumu et al. [31]	Trust in e-commerce
Penu et al. [32]	E-commerce and globalization
Chen et al. [33]	Cross-border e-commerce research trends
Daza et al. [34]	Sentiment analysis on e-commerce product reviews using machine learning and deep learning
Oğuz and Çetinoğlu [16]	Blockchain in e-commerce
Bawack et al. [17], Chung and Jain [18], Boukrouh and Azmani [19]	Artificial intelligence in e-commerce
Valencia-Arias et al. [20], Cardona-Acevedo et al. [21]	Artificial intelligence and recommender systems in e-commerce
Guamboa-Cruzado et al. [22]	Influence of machine learning in e-commerce
Mutemi and Bacao [23]	E-commerce fraud detection using machine learning

The choice of conducting bibliometric analysis, also known in scientific literature as a scoping literature review, has been based on the study's main objective, namely, exploring the overall structure, volume, evolution, and thematic landscape of the selected research field. It should be mentioned that this approach is well-suited for mapping large bodies of literature, identifying research trends, influential contributors, and collaboration networks, which align with the exploratory nature of our study [35–38].

On the other hand, a systematic literature review is usually used in situations in which one is interested in addressing narrowly focused research questions, often aimed at synthesizing evidence or evaluating the effectiveness of specific interventions. Given that our goal was not to assess empirical outcomes or consolidate findings across a small, well-defined set of studies, but rather to provide a macro-level overview of the field's development, a bibliometric analysis represents a more suitable and logical methodological

choice. This difference in approaches between a bibliometric analysis and a systematic literature review has been further highlighted by Block and Fisch [35] in their study.

That being stated, the present study aims to explore the research domain associated with emerging technologies in e-commerce in greater detail by providing the answers to the following key research questions:

- Which sources are listed at the top of the authors' preferences for publishing the manuscripts around electronic commerce and emerging technologies, and what is their impact within the scientific community, considering multiple factors, such as the volume of academic publications, the H-index indicator, or even Bradford's law?
- What insights can be uncovered according to the authors' analysis and their production over time?
- Which are the most relevant affiliations in the area of electronic commerce and emerging technologies, and how can the scientific production with respect to the countries be characterized?
- What is exposed regarding the degree of collaboration within this domain, taking into account both the country collaboration map and the authors' collaboration network?
- Based on the review of the top 10 most cited papers included in the data collection set, what insights can be drawn?
- Using the information discovered during word analysis, what are the key details that should be highlighted?

As can be observed, in order to provide more insight into the analysis, it has been decided to perform a review of the top 10 most cited papers. Furthermore, a series of analyses, such as Latent Dirichlet Allocation (LDA) and BERTopic, will be used for shaping the research topics in this field.

The paper is organized into six distinct sections. Section 1, is focused on offering an overview of the research domain, providing general details about electronic commerce emerging technologies, and highlighting the importance of integrating them so as to optimize platforms and processes and to enhance users' experience and satisfaction. Section 2 presents the analysis steps, more specifically how the data was collected the plan for the bibliometric investigation, along with the tools and materials involved. Section 3 consists of the actual bibliometric analysis, in which the previously collected dataset is examined in depth from multiple perspectives. Section 4 presents all the insights exposed in the analysis phase and compares them with other bibliometric studies. Also, the main research directions identified in the dataset are discussed in connection with the selected papers. Section 5 provides an objective perspective of the work performed in this article, discussing the aspects that should be considered for future research directives. Section 6 underlines once again the work performed in this paper, summarizes the main ideas, highlights the need for continuous research, and emphasizes the importance of integrating emerging technologies in electronic commerce platforms so as to offer customers a safe and efficient shopping experience.

2. Materials and Methods

The main purpose of this section is to present an overview of the analysis steps, discuss the most important aspects considered in the investigation focusing especially on the materials and methods employed.

As delimited in Figure 1, the analysis can be divided into two separate phases: dataset extraction and bibliometric analysis. By reviewing the current existing scientific literature, one can notice that this approach was preferred by many academics in various bibliometric studies, which covered different domains (e.g., construction risks [39], agent-based modeling [40], and green bonds [41]). Nevertheless, the bibliometric analysis has been used

in various studies associated the e-commerce, such as, but not limited to the following: factors involved in e-commerce adoption [26], trends in electronic marketing [42], consumer marketing strategy and e-commerce [43,44], and after sales attributes in e-commerce [25], as well as in other studies from the economic area, such as, but not limited to the following: eye tracking in the food market [45], blockchain technology in the tourism industry [46], consumer privacy research [47,48], and IoT technology in business and management [49].

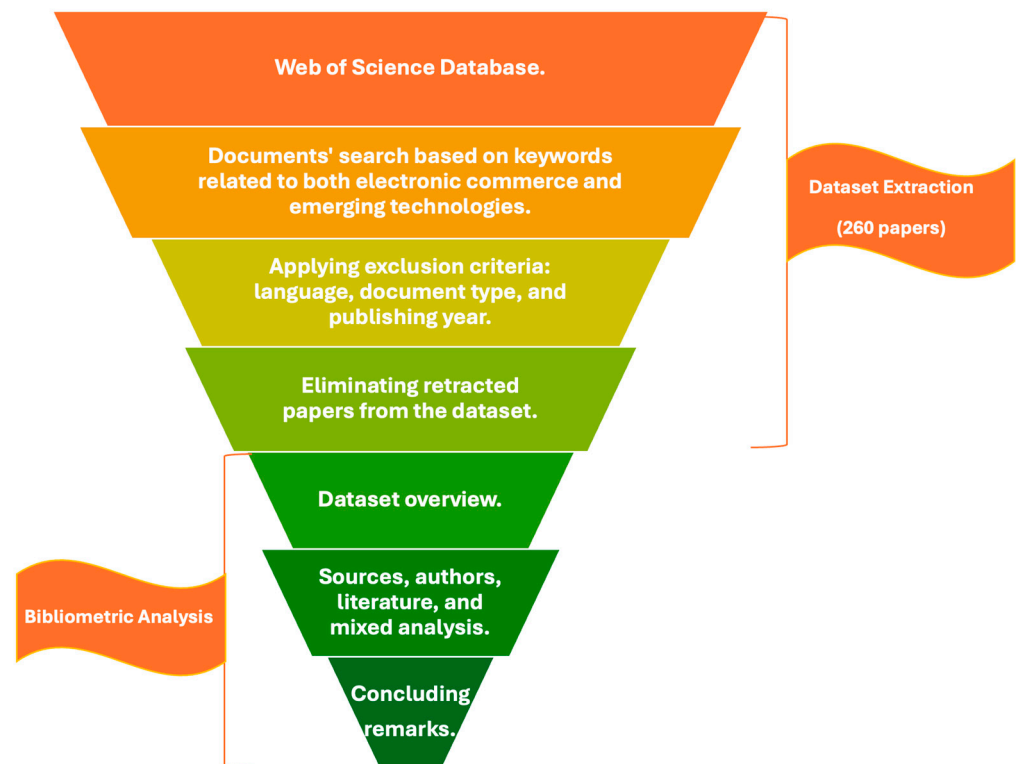


Figure 1. Analysis steps.

As for the first part—dataset extraction—at the top of the pyramid depicted in Figure 1, the Clarivate Analytics' Web of Science Core Collection database (WoS) [50] was placed, from where all the documents were collected, based on keyword searches. Furthermore, multiple exclusion criteria were considered in this extraction step (language, document type, and publishing year). Lastly, from the dataset obtained, the retracted papers were eliminated.

The second part consisted of the actual bibliometric investigation. The dataset was analyzed in depth through different perspectives, starting by offering an overview of the articles and continuing in greater detail with sources, authors, the literature, and mixed analysis. The results were discussed, and concluding remarks were outlined. The insights gathered through this analysis represent a solid basis for future directives and improvements in this field of research.

The following two subsections are dedicated and focused on each phase.

2.1. Dataset Extraction

In this investigation, the authors' decision was to collect the data exclusively from the Web of Science database [50]. Initially, one may ask why the scientists opted to use this particular database instead of another one or even a combination of the results from multiple databases. The answer to this question is supported by multiple arguments, all listed below.

First of all, Web of Science is a broadly used database, simple to operate, and highly popular within the scientific community. This increased visibility, compared to other competitors (e.g., IEEE and Scopus), results from the large number of documents included here, written by authors from all over the world, addressing a wide diversity of topics and subjects [51]. The option for the Web of Science database when conducting bibliometric analysis in the detriment of other databases for scientific papers has been highlighted more in the works conducted by Cobo et al. [52], Bakir et al. [53], and Mulet-Forteza et al. [54].

Furthermore, by investigating the work of other scientists that conducted different bibliometric analyses, it is observed that in many papers addressing diverse domains (e.g., gray systems [55], neutrosophic research [56], the COVID-19 pandemic [57], and Twitter [58]), the datasets are collected exclusively from the Web of Science database, an argument that further strengthened the decision adopted in this manuscript.

In this manuscript, the primary tool used was the Biblioshiny R-tool, proposed by Aria and Cuccurullo [59]. This tool assisted in the process of tables and figures' generation and facilitated academics' work by enabling them to directly import data into it, downloaded in raw format from the Web of Science database.

For some of the investigations included in this paper, a cross-validation of the results with other bibliometric software (VOSviewer, CiteSpace) was conducted to enhance the robustness of the findings. Furthermore, for cross-validation purposes as well as for enhancing more the research conducted over the considered research field, thematic analyses have been conducted using Latent Dirichlet Allocation (LDA) and BERTopic.

In accordance with the articles written by Liu [60] and Liu [61], a dataset is pertinent for a bibliometric investigation only if the authors had full access to resources in the Web of Science database (all 10 indices), as in our case:

- Science Citation Index Expanded (SCIE);
- Social Sciences Citation Index (SSCI);
- Arts & Humanities Citation Index (A&HCI);
- Emerging Sources Citation Index (ESCI);
- Conference Proceedings Citation Index—Science (CPCI-S);
- Conference Proceedings Citation Index—Social Sciences and Humanities (CPCI-SSH);
- Book Citation Index—Science (BKCI-S);
- Book Citation Index—Social Sciences and Humanities (BKCI-SSH);
- Current Chemical Reactions (CCR-Expanded);
- Index Chemicus (IC).

Lastly, behind the decision of using a sole database for gathering the data collection set is also found another solid argument: in the bibliometric investigation, there are various individual analyses conducted (e.g., most cited countries)—the use of multiple databases would have caused issues and difficulties in determining the hierarchy. Nevertheless, the information stored in the Web of Science database related to each paper might differ from the ones stored in the case of other databases—e.g., the Web of Science database offers information related to “keywords plus”, which are a particular type of keywords extracted based on the most used words in the references of each stored paper—which is not available in other databases.

The data selection steps are all presented in Table 2, while a full description of the considered steps is provided in the following section.

In the first exploratory step, the authors searched for the documents that contain in the title specific keywords related to the field of interest—e-commerce and emerging technologies. These terms were chosen based on their direct relevance to the domain under investigation, and significant attention was given to the keywords used for filtering in other analogous bibliometric manuscripts to ensure an accurate selection and align-

ment with previous studies. For instance, the “e-commerce” term has been encountered in most of the studies featuring bibliometric analyses in this field [16–20,23,34,62]. As for the terms related to the emerging technologies, their choice is supported by various works from the field that analyze their use in the context of commerce-related fields, such as for “artificial intelligence” [17–19,62,63], “machine learning” [20,22,23,34,63], “deep learning” [20,34], “blockchain” [16,62,64–66], “internet of things” [62], “distributed ledger technologies” [65,66], and “augmented reality” [62].

Table 2. Data selection steps.

Exploration Steps	Filters on Web of Science	Description	Query	Query Number	Count
1	Title	Contains specific keywords related to electronic commerce	(TI = (e-commerce)) OR TI = (electronic_commerce)	#1	14,644
		Contains specific keywords related to emerging technologies	(((((TI = (artificial_intelligence)) OR TI = (machine_learning)) OR TI = (blockchain)) OR TI = (Internet_of_thing*)) OR TI = (emerging_technolog*)) OR TI = (deep_learning)) OR TI = (distributed_ledger_technolog*)) OR TI = (augmented_reality)	#2	351,153
		Contains specific keywords related to both electronic commerce and emerging technologies	#1 AND #2	#3	426
2	Language	Limit to English	(#3) AND LA = (English)	#4	419
3	Document Type	Limit to Article	(#4) AND DT = (Article)	#5	290
4	Year published	Exclude 2025	(#5) NOT PY = (2025)	#6	290
5	Non retracted papers	Eliminate from the dataset the retracted papers	(#6) AND Retracted (Exclude—Search within all fields)	#7	260

In this study, both general and field-specific words are considered, to guarantee a balanced coverage, while the use of base terms followed by a wildcard (e.g., *emerging_technolog**) ensured the retrieval of all derivatives. Boolean operators such as ‘OR’ and ‘AND’ were applied to maximize the results’ accuracy (initially there were retrieved all the papers related to electronic commerce, then all the works related to emerging technologies, and finally ‘AND’ operator was applied for intersecting the results).

Although the keywords correspond closely with the research topic and were carefully selected with respect to their frequency in other high-impact similar papers from the academic literature, some omissions may exist, and relevant articles may have been ignored due to the use of English terminology/alternative vocabulary. By acknowledging this limitation, we have further conducted an analysis where, besides the “e-commerce” and “electronic commerce” keywords, we have used the “electronic retail” keyword. As a result of this new addition, the number of papers obtained in step #1 in Table 2 has increased by 24 papers. Even though the inclusion of the new term had a small influence on the number of papers extracted in step #1, continuing with the remainder of the steps in Table 2, it has been observed that the number of papers associated with the remainder of the steps has not changed, as none of the 24 new papers deal with issues related to emerging technologies. By isolating these 24 papers, it has been observed that most of them discuss issues related

to electronic retail in various countries or issues related to customers, prices, or brand equity. Thus, based on this observation, we expect that the expansion of the terms will have little influence on the results. Furthermore, the selection of the terms used in the paper is supported by various bibliometric papers, as presented above for each term we have used.

The initial query returned a number of 14,644 works that include in their title keywords related to electronic commerce (“e-commerce” and “electronic commerce”). The next query filtered through the documents and returned 351,153 papers that have in their title one of the keywords related to emerging technologies (“artificial intelligence”, “machine learning”, “blockchain”, “Internet of Thing”, “emerging technology”, “deep learning”, “distributed ledger technology”, and “augmented reality”). The last query intersected the two previously obtained results, obtaining a total of 426 papers that address exclusively a topic around the area of e-commerce, together with emerging technologies.

It shall be noted that the query has been made using the singular form of the considered search terms and that in order to include in the results also the plural forms of the search keywords, an asterisk (“*”) has been added to the end of the singular form. Furthermore, as we were interested in the combination of words used for searching the database, rather than by the presence of both individual words in the title of the paper, the used keywords have been “united” through the use of an underline, which ensured that the results contain the sequence of the search words and only the individual words. For example, the keyword “electronic_commerce” written in this manner in the search query ensures that the results will have “electronic commerce” as a sequence in the title of the papers, and not only the individual words “electronic” and “commerce”, eventually separated by some other words.

The second exploratory step was about limiting the dataset to English-written papers, considering that it is a global language known by most of the population, especially by academics and target readers of this manuscript. As predicted, after applying this restriction, only 7 documents were removed from the dataset. This exclusion criterion was also found in other papers by Stefanis et al. [67], Gorski et al. [68], and Fatma et al. [69].

The next exploratory step was about limiting the dataset to only works marked as “article” in the Web of Science database. Consequently, the dataset dropped considerably to 290 papers. This step was discussed in more detail by Donner [70], and it is important to mention that in the Web of Science database, all the relevant research studies are indexed as “articles”—and that conference proceedings are also included here [71]. As Donner [70] highlighted, when conducting a bibliometric analysis, it is important to refer to a particular type of document (e.g., “article”, “review”, and “book chapter”, etc.) as each document category is more prone to receive a comparable number of citations. As a result, mixing the types of papers in bibliometric analysis is not recommended, as it can lead to the situation in which some papers are listed as top contributors in terms of number of citations, but their merit in being listed in such a top is not fully due to their content but partially due to the type of paper one is referring to—as it is known that, for example, review papers can gather more citations than normal research articles due to the type of research conducted in these papers.

The fourth exploratory step excluded from the dataset the articles that have the year of publication 2025. As the dataset has been extracted at the end of 2024, namely in the last month of the year, there are cases in which some journals have already published and indexed papers for the year 2025. Adding these papers to the dataset would have influenced the “annual growth rate” indicator by falsely diminishing it, as the number of papers published in the year 2025 would have been extremely low compared to the previous year [72]. In our case, after applying this restriction, the number of papers was not affected.

After obtaining the dataset composed of 290 papers, we have conducted a visual check on the dataset in order to observe if the filters used have been properly applied. During this step, we have observed that there were a series of papers marked as “retracted”. As the “retracted” message has been observed more often than in the case of other bibliometric analyses we have conducted, we have been curious to find out how many of the papers in the dataset were in this situation. As a result, it has been observed that 30 papers were marked as “retracted”, and as the number was high compared to the dimension of the dataset, representing 10.34%, we have decided to conduct an additional exploratory step, through which we have eliminated from the dataset the retracted papers. As a result, the collection was reduced by 30 papers, and the final dataset contains 260 papers to be analyzed through bibliometric analysis. In terms of topics, it has been observed that the retracted papers were dealing with similar topics as the papers retained in the dataset, such as, but not limited to, the use of IoT in e-commerce logistics, IoT or blockchain in cross-border e-commerce, and strategic decision-making and planning in e-commerce through the use of AI.

Therefore, having described all the above steps, the final data collection set consists of 260 English articles that address a topic around e-commerce combined with the use of emerging technologies, none of them being retracted from the journals in which they have been initially published. In the next pages, these manuscripts will be examined in depth through various facets through the use of bibliometric analysis, as presented in the following.

2.2. Bibliometric Analysis

The second phase, as its title suggests, involves the bibliometric analysis of the extracted dataset. The purpose of this investigation is to highlight insights and aspects that can contribute to a better comprehension of the field of interest, namely the e-commerce domain associated with emerging technologies, developing enhanced strategies, and establishing the foundation of possible future research directives.

The authors opted to work with Biblioshiny, an R-tool used for generating interactive graphs and figures, helpful for observing the hidden trends, details, lacks, and possible improvements in the domain. This decision was followed by various authors in similar bibliometric-oriented studies [26,40,56,72–75]. Furthermore, for some of the analyses, a comparative examination was also included to uncover possible differences or similarities between the results generated by other bibliometric software (VOSviewer, CiteSpace).

Figure 2 presents the five facets, along with their components, through which the bibliometric analysis will be performed.

The first part of the analysis refers to the dataset overview, where general details about the data collection set are underlined: timespan, sources, citations, authors, documents, collaborations, and many more.

The second perspective is focused on sources, in which the most relevant journals are presented, along with their influence and impact within the scientific community. The H-index indicator Bradford’s law are just some examples of analyses performed in this section.

Furthermore, the following facet is about authors, highlighting the top scientists in the studied domain, affiliations, scientific production, countries, collaboration within countries, and authors.

The next section is oriented to the papers, where the most globally cited documents are presented and summarized, together with the most frequent words, trigrams, and bigrams. Apart from these, there are included co-occurrence networks for the terms and thematic

maps. In addition to the classic bibliometric analyses, an LDA and BERTopic analysis has been conducted for the purpose of further discovering the research topics.

Lastly, the relationship between categories is revealed based on mixed analysis, which includes three-field plots.



Figure 2. Bibliometric analysis facets.

3. Dataset Analysis

This section consists of the actual bibliometric analysis. The final dataset related to electronic commerce and emerging technologies, extracted from the Web of Science database, will be analyzed in depth from multiple perspectives, using the tables and figures generated with the R-tool's help, Biblioshiny. VOSviewer and CiteSpace were also involved for cross-validating some of the results.

This chapter includes five distinct sections, each being focused on a particular topic of the dataset's investigation, listed here with respect to the order of discussion: dataset overview, sources, authors, the literature, and mixed analysis.

3.1. Dataset Overview

Main information about data is presented in Table 3. The dataset contains 260 articles published in 140 different sources, within a relatively large period of time, namely 2004–2024.

Contrary to expectations, the number of documents is relatively small, considering the long timespan—21 years.

One can easily notice the discrepancy between the number of sources (140 sources) and the number of documents (260 documents). This remark underlines the fact that most of the scientists prefer to publish their papers in certain journals that focus on the area of electronic commerce and emerging technologies.

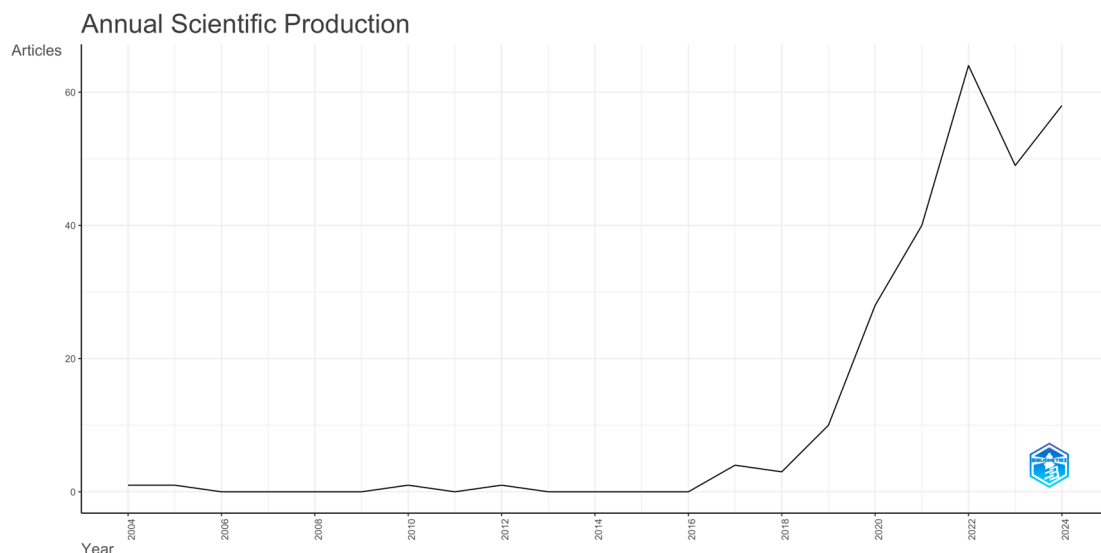
Table 3. Main information about data.

Indicator	Value
Timespan	2004:2024
Sources	140
Documents	260
Average years from publication	2.19
Average citations per documents	14.74
Average citations per year per document	3.753
References	10,022

The value obtained for average years from publication is 2.19, which highlights that the vast majority of the papers included in the data collection set are recent studies.

The high impact of this field within the scientific community is proved by the values registered for average citations per document (14.74 citations per document) and average citations per year per document (3.753 citations per year per document). Another proof of the domain's significance results from the substantial value recorded for references—10022.

The annual scientific production evolution is captured in Figure 3. As easily observed, the domain of electronic commerce combined with at most a single paper published per year. Starting in 2017, the field gained increasing attention among academics, reflected by a steady growth in publication output. This upward trend can be attributed, at least in part, to the broader adoption of Industry 4.0 technologies after 2010, which amplified interest in digital transformation and e-commerce integration, followed by the post-2020 publication increases, which were both due to the COVID-19 pandemic and to the rapid advancement of the emerging technologies that have facilitated the analysis of large amounts of data as well as the obtaining of insights into the customer shopping experience and the transformation of the customers' experience by providing personalized suggestions based on the customers' behaviors and characteristics. As illustrated in the graph, the number of manuscripts surged, reaching a peak of 64 publications in 2022.

**Figure 3.** Annual scientific production evolution.

The number of publications' increase in this domain can be interpreted as an outcome of the technological advancements and development of e-commerce platforms in recent years. Furthermore, the annual growth rate is 44.65%, proving again the high involvement of scientists in this field of research.

Figure 4 presents the annual average article citations per year evolution in the area of electronic commerce and emerging technologies, with a minimum value of 0.1 citations per year registered in 2004 and a maximum of 16.4 citations per year recorded in 2017.

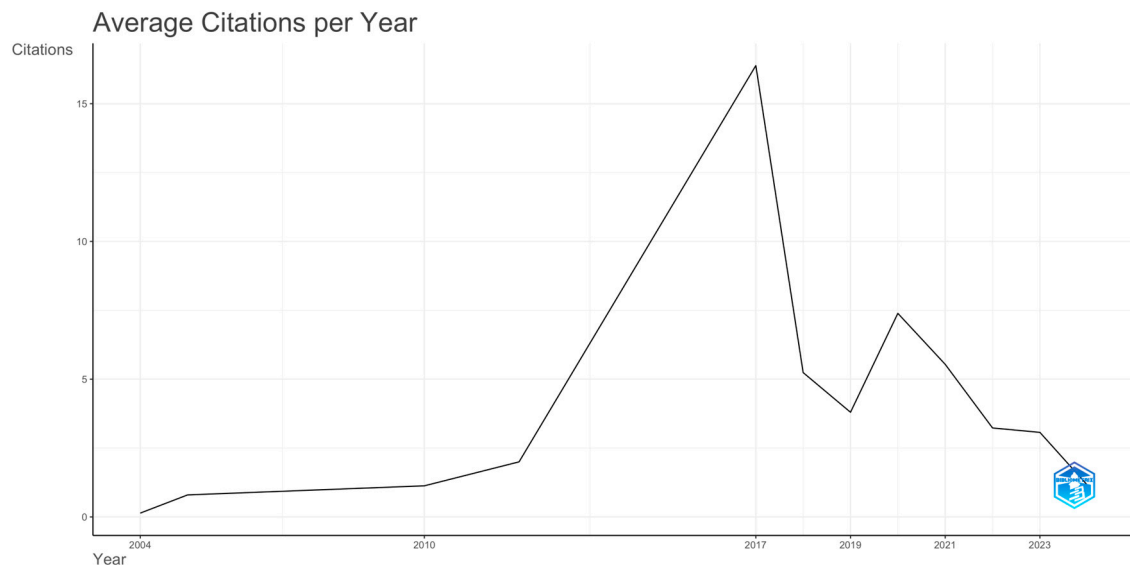


Figure 4. Annual average article citations per year evolution.

It is clearly visible an upward trend between the period covered by the years 2004–2017 and a declining trajectory starting with 2017. A possible explanation could be that even though the number of publications has increased since 2017, as discussed previously, many of them did not have time to be read by the researchers and cited in the latest published papers.

Table 4 includes the values recorded for two important indicators: keywords plus (379 keywords plus) and author's keywords (791 author's keywords). An average value of 1.46 can be determined in the case of the keywords plus by the total number of keywords plus documents (260 documents), suggesting that in this data collection set there is a succinct lexicon.

Table 4. Document contents.

Indicator	Value
Keywords plus	379
Author's keywords	791

It is also visible that the number of author's keywords is doubled in contrast to the keywords' plus. The average value of these terms per document is 3.04, a result obtained in the same manner—the division between authors' keywords and number of documents.

Table 5 is focused on the information regarding the authors of the papers included in the dataset. By analyzing the first two indicators, one important remark arises: since the number of authors (732) is less than the number of author appearances (804), it means that some of the scientists are involved in the creation of multiple manuscripts from the dataset.

Going further with the discourse, the value recorded for the authors of single-authored documents (52) highlights the fact that only 7.1% of the academics opted to conduct individual research in this domain.

At the opposite pole, based on the value registered for the authors of multi-authored documents indicator (680), it is proved that 92.9% of the scientists preferred to collabo-

rate in writing papers around the topic of electronic commerce combined with emerging technologies.

Table 5. Authors.

Indicator	Value
Authors	732
Author appearances	804
Authors of single-authored documents	52
Authors of multi-authored documents	680

Table 6 further continues the discussion related to authors, this time being more oriented to their collaborations.

Table 6. Authors collaboration.

Indicator	Value
Single-authored documents	55
Documents per author	0.355
Authors per document	2.82
Co-authors per documents	3.09
Collaboration index	3.32

It can be observed that the scientists who have written papers as single authors have performed it for an average of approximately 0.95, a value obtained by dividing the following indicators: authors of single-authored documents (52) and single-authored documents (55).

The documents per author indicator recorded a modest value, namely 0.355, which results from the difference between the number of authors and documents around the topic of electronic commerce and emerging technologies included in the dataset.

The high interest in collaboration within this investigated field is additionally supported by the values registered for the next three indicators: authors per document (2.82), co-authors per document (3.09), and collaboration index (3.32).

3.2. Sources

The most relevant sources that published a minimum of six papers in the field of electronic commerce and emerging technologies are ranked in Figure 5 according to the number of citations.

The first two places in the hierarchy are occupied by two journals, each with twelve papers published in the domain under investigation: *Mobile Information Systems* and *Sustainability*. The third position is held by *Wireless Communications & Mobile Computing*, with ten papers.

Other relevant sources are listed here with respect to the number of published documents: *Computational Intelligence and Neuroscience* and *IEEE Access* (each with eight articles), *Electronic Commerce Research* (seven articles), *Journal of Intelligent & Fuzzy Systems*, and *Journal of Organizational and End User Computing* (each with six articles).

One can easily notice that the academics decided to publish their research in specific sources, which are mainly oriented to technology, electronic commerce, and communication.

Figure 6 captures a similar investigation, this time conducted using CiteSpace software, in which the journals are depicted using yellow circles, the most influential journals are labeled in red, while the lines between the nodes show the co-citation links, with blue/green lines signifying that the co-citation relationship has been around for a long time, and

yellow/orange/red lines signifying that the is newly formed or strengthening in recent years. The most popular journals with respect to the number of citations in the analyzed domain are similar to the findings uncovered by Biblioshiny (e.g., *Sustainability*, *IEEE Access*).

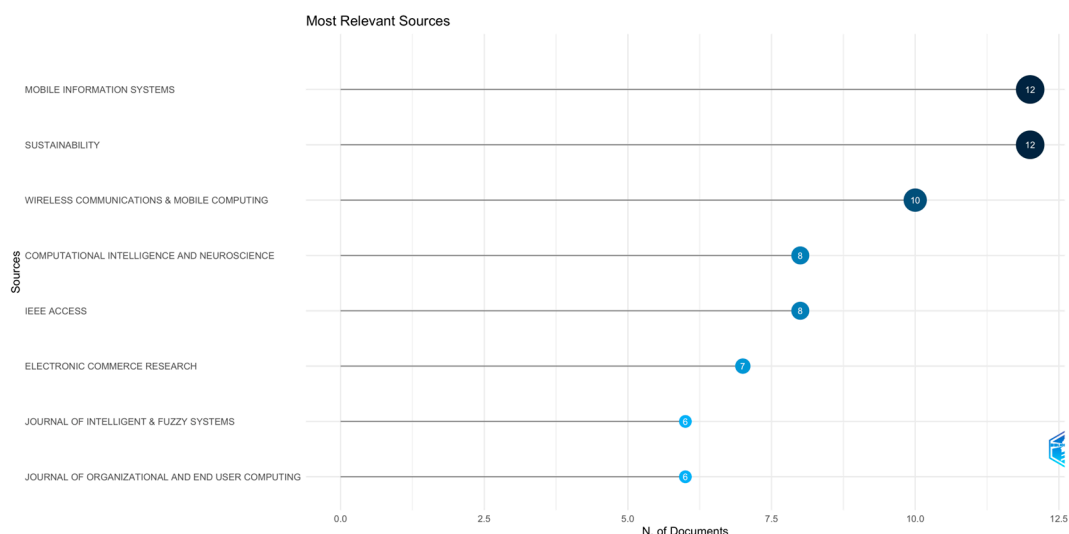


Figure 5. Top eight most relevant journals.

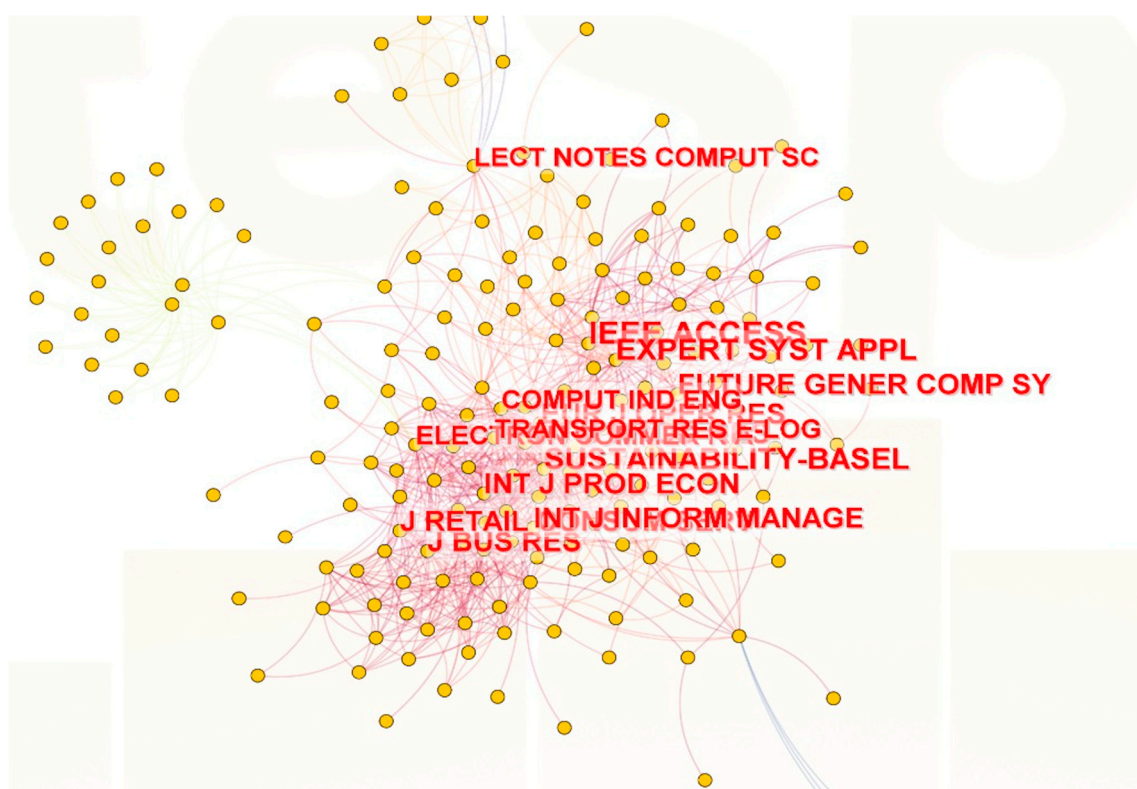


Figure 6. Most relevant journals—CiteSpace.

Figure 7 provides details regarding Bradford's law on source clustering. This type of analysis is very important for a bibliometric study because it offers a productivity classification of the journals [76]. Thereby, three main zones are outlined: Zone 1 (in the core, comprising frequently cited sources, very productive), Zone 2 (in the center, consisting of moderately productive sources), and Zone 3 (outside, including irrelevant, not productive sources).

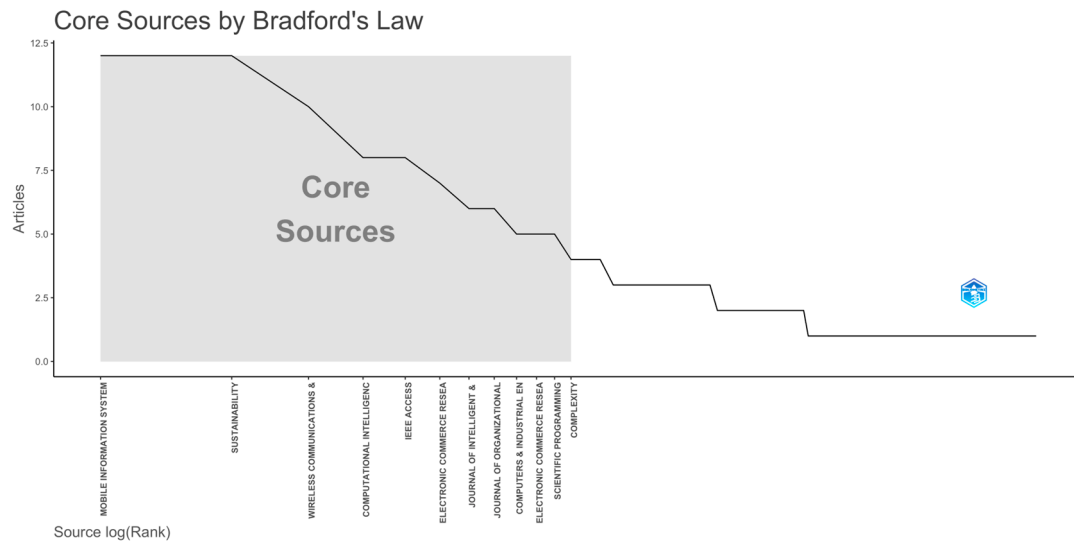


Figure 7. Bradford's law on source clustering.

In this study related to electronic commerce and emerging technologies, the sources found in Zone 1 are listed here in order: *Mobile Information Systems*, *Sustainability*, *Wireless Communications & Mobile Computing*, *Computational Intelligence and Neuroscience*, *IEEE Access*, *Electronic Commerce Research*, *Journal of Intelligent & Fuzzy Systems*, *Journal of Organizational and End User Computing*, *Computers & Industrial Engineering*, *Electronic Commerce Research and Applications*, *Scientific Programming*, and *Complexity*.

The sources' significance is further analyzed based on the H-index indicator, as captured in Figure 8. From a theoretical perspective, the higher the value obtained by a given source for the H-index metric, the more significant and influential the source is within academics.

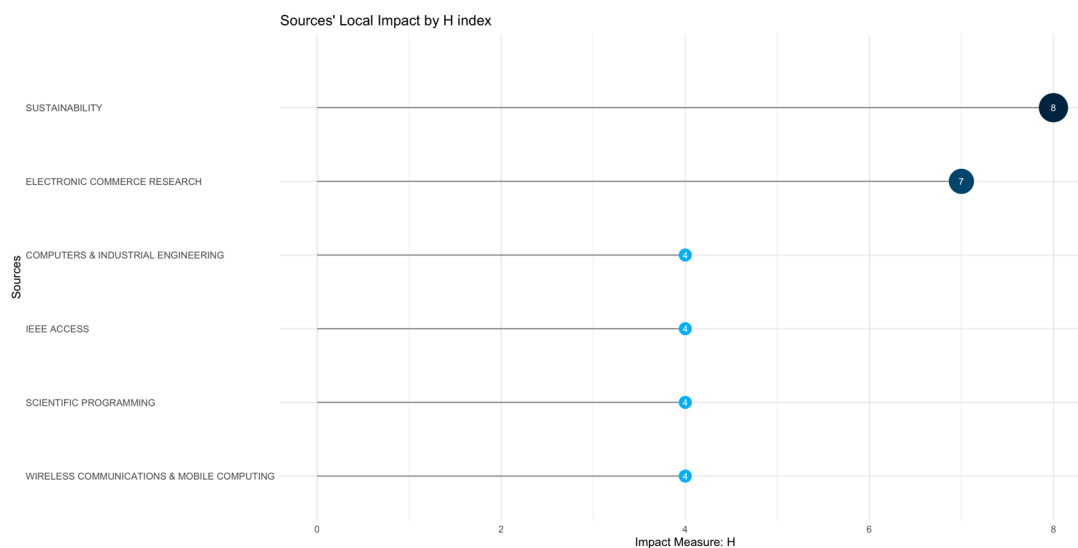


Figure 8. Journals' impact based on H-index.

The hierarchy in Figure 8 is performed with respect to the number of published papers, and from the top were excluded all the sources that did not contribute to the scientific community with at least four articles.

It is not surprising that most of the sources found in Zone 1, according to Bradford's law, are also listed here in the top based on the H-index indicator: *Sustainability*, *Electronic*

Commerce Research, Computers & Industrial Engineering, IEEE Access, Scientific Programming, and Wireless Communications & Mobile Computing.

According to Figure 9, the greatest growth (cumulative), based on the number of papers, was noticed in the case of the following journals: *Computational Intelligence and Neuroscience, IEEE Access, Mobile Information Systems, Sustainability, and Wireless Communications & Mobile Computing.*

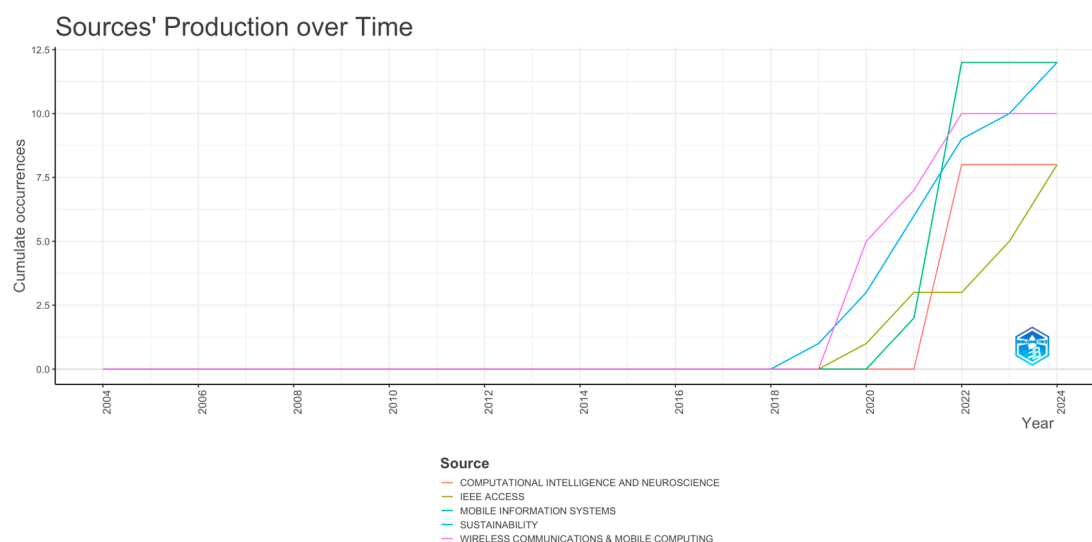


Figure 9. Journals' growth (cumulative) based on the number of papers.

3.3. Authors

The top of the most relevant authors with respect to the number of documents is illustrated in Figure 10 and includes only the scientists that published a minimum of three manuscripts with a topic around electronic commerce and emerging technologies.

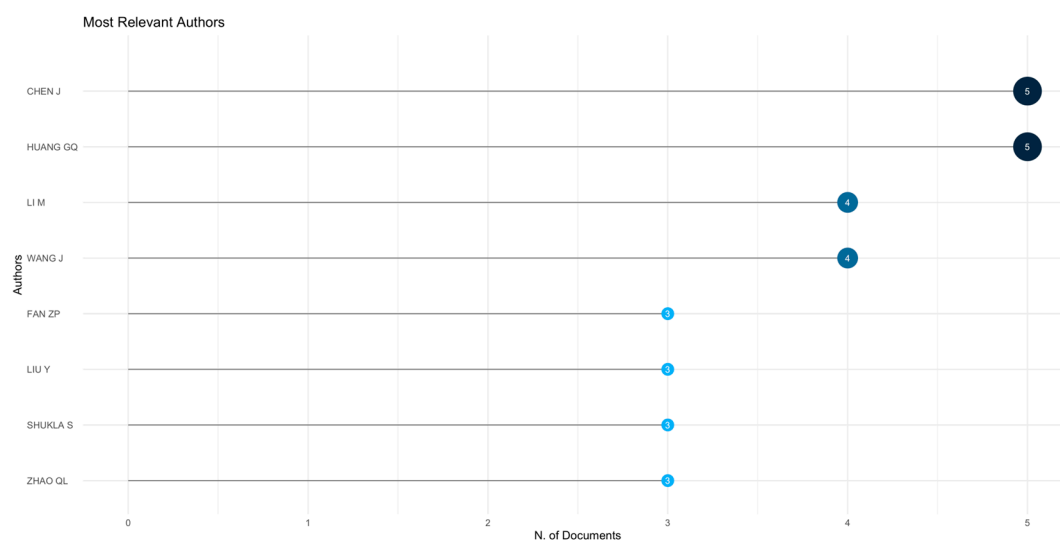


Figure 10. Top eight authors based on number of documents.

In the first two places are found Chen J. and Huang G.Q., each with five papers, followed by Li M. and Wang J., both with four articles.

The authors that published three papers are listed here in alphabetical order as follows: Fan Z.P., Liu Y., Shukla S., and Zhao Q.L.

Going further with the discourse about authors, Figure 11 provides details related to their production over time in the domain of electronic commerce combined with the use of emerging technologies.

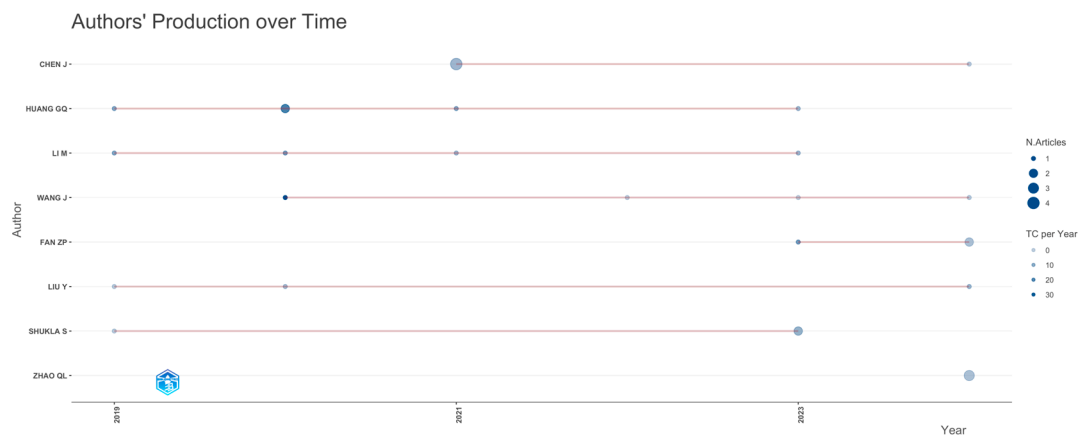


Figure 11. Top eight authors’ production over time.

In the below hierarchy, there were taken into consideration only the authors that were involved in writing at least three papers (the timeframe covers the period between 2019 and 2024). Chen J. is found at the top of the list, with five articles in the research domain under investigation, and in terms of years, the most productive one was 2024, with seven published papers.

One observation that arises here is that most of the authors started to be interested in this area and publish more papers in 2019, which may be a result of the technology’s evolution, artificial intelligence’s advancements, and the development of optimized electronic commerce platforms. Furthermore, the COVID-19 pandemic also had a significant impact on the rapid progress of these factors, caused by the transition to online space.

The top of the most relevant affiliations can be observed in Figure 12, in which only the ones with at least four published articles in the domain of electronic commerce and emerging technologies were included.

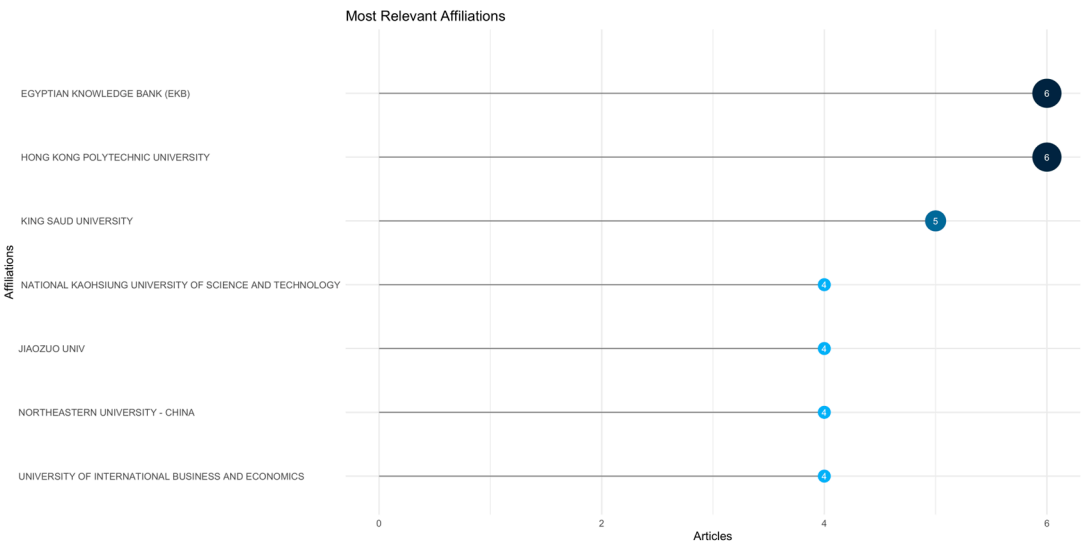


Figure 12. Top seven most relevant affiliations.

The leadership position is held by the Egyptian Knowledge Bank (WKB) and Hong Kong Polytechnic University, each with six articles. Next in the rank, the King Saud University is positioned with five papers, followed by other four universities, each

with four manuscripts: the National Kaohsiung University of Science and Technology; Jiaozuo Univ; Northeastern University, China; and the University of International Business and Economics.

Figure 13 depicts the top 12 most relevant corresponding authors' countries. In the below graph, there were listed only the countries with a minimum of three published papers, and based on the agenda, for each country there are provided the numbers for single-country publications—SCPs (marked in green), along with multiple-country publications—MCPs (marked in orange).

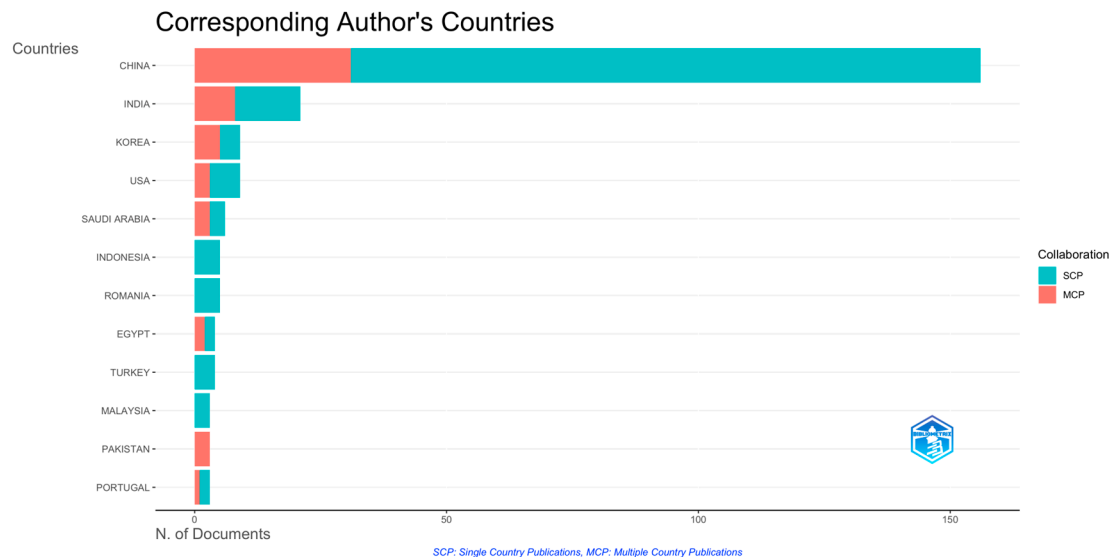


Figure 13. Top 12 most relevant corresponding author's country.

China is situated in the first position with 156 articles, recording top values for both metrics—SCP (125 documents) and MCP (31 documents)—followed at a significant difference by India (21 articles, SCP = 13 documents, and MCP = 8 documents) and Korea (9 articles, SCP = 4 documents, and MCP = 5 documents).

For the entire list, please consider the information in Figure 13.

Figure 14 illustrates a visual representation of the worldwide map, in which the intensity of the color denotes the level of scientific productivity, with various shades of blue symbolizing the intensity of scientific production, darker shades showing an intense production, while the grey areas represent no scientific production identified in the extracted dataset with respect to the considered research field.

In other words, a high involvement in the domain of electronic commerce associated with emerging technologies is noticed in the countries colored in dark blue (e.g., China, India, and the USA). At the opposite pole, the countries colored in gray indicate a low/nonexistent involvement (e.g., Vietnam, Ukraine, Tanzania). Shades of light blue are found in the countries with medium involvement (e.g., Canada, Finland, Austria).

Figure 15 provides a top with the countries that gathered at least 45 citations in the domain of electronic commerce and emerging technologies. As expected, the first position is occupied by China, with an impressive number of 2050 citations, followed at a substantial difference by the USA, with 706 citations, and then by India, in third place, with 249 citations.

For the entire list, please see Figure 15.

Figure 16 provides insights related to the collaboration between countries. As in the case of Figure 14, the color intensity for each country denotes the level of scientific productivity in that country, ranging from light blue (low scientific productivity) to dark blue (high scientific productivity), with gray signifying no scientific productivity, while the

red lines signify the collaborations between countries for the papers written in the area of e-commerce and emerging technologies, with the depth of the line signifying the intensity of the collaboration between the two connected countries.

Country Scientific Production

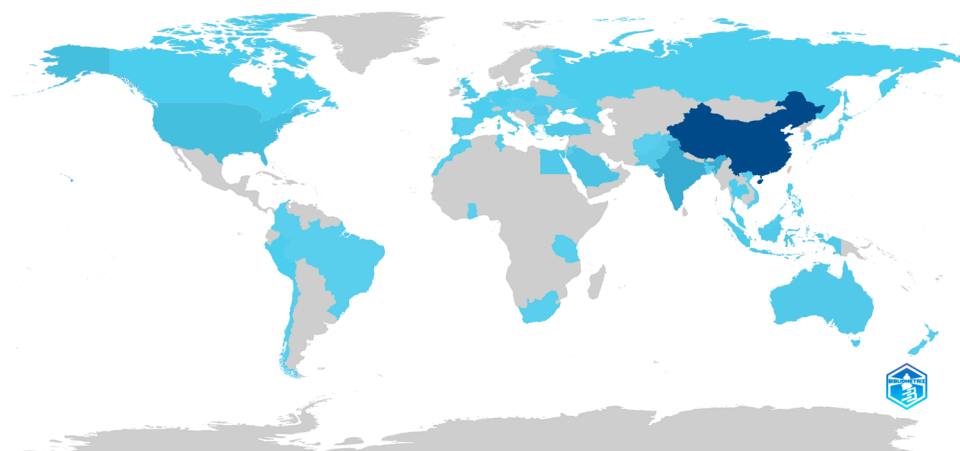


Figure 14. Scientific production based on country.

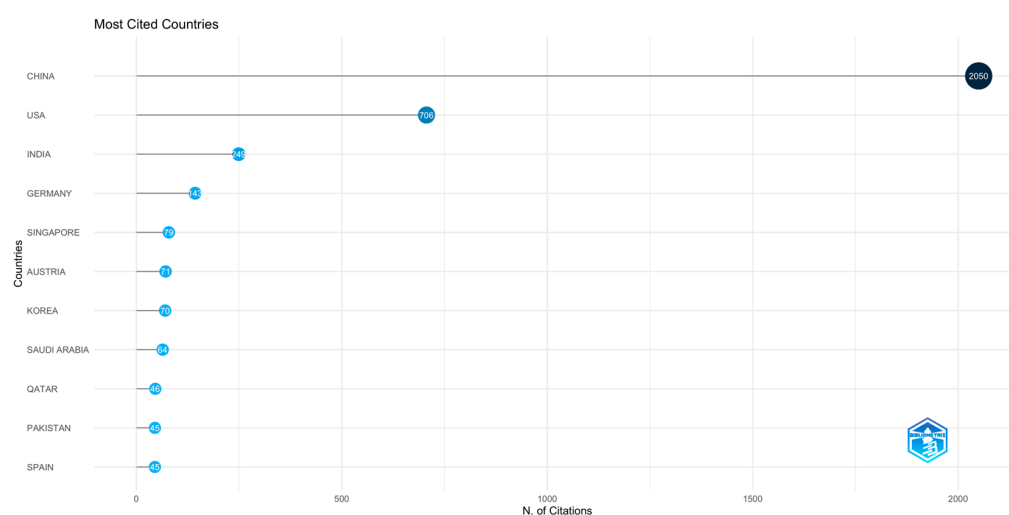


Figure 15. Top 11 countries with the most citations.

Country Collaboration Map

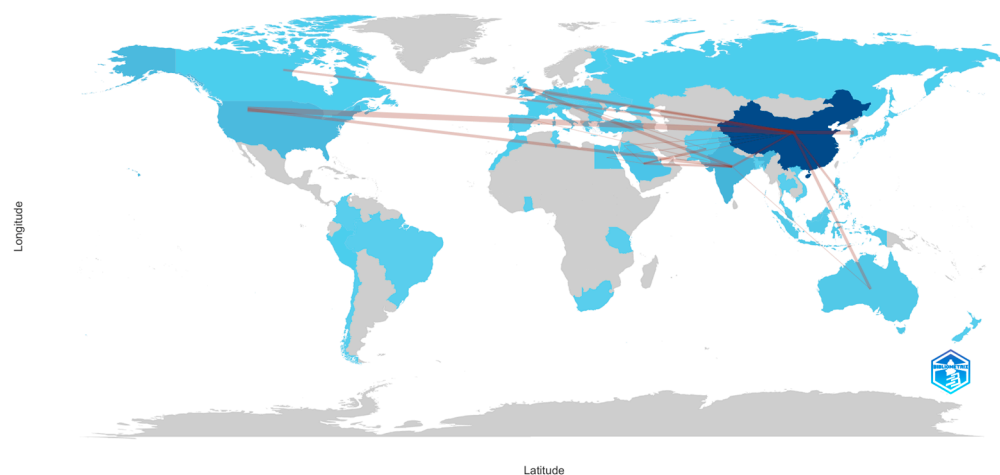


Figure 16. Country collaboration map.

An analogous investigation of the collaboration between countries was also conducted using another popular bibliometric software, namely VOSviewer, in Figure 17. In this density map, the various color shades are used for depicting the intensity of the research activity and collaboration, with yellow spots indicating a high activity, green areas showing a medium activity, and blue signifying a low activity. The results are similar and suggest the same insight: China is the country that registered the highest number of collaborations in the domain (marked in the illustration by an intense lighting) and recorded numerous partnerships with India, the USA, Australia, etc.

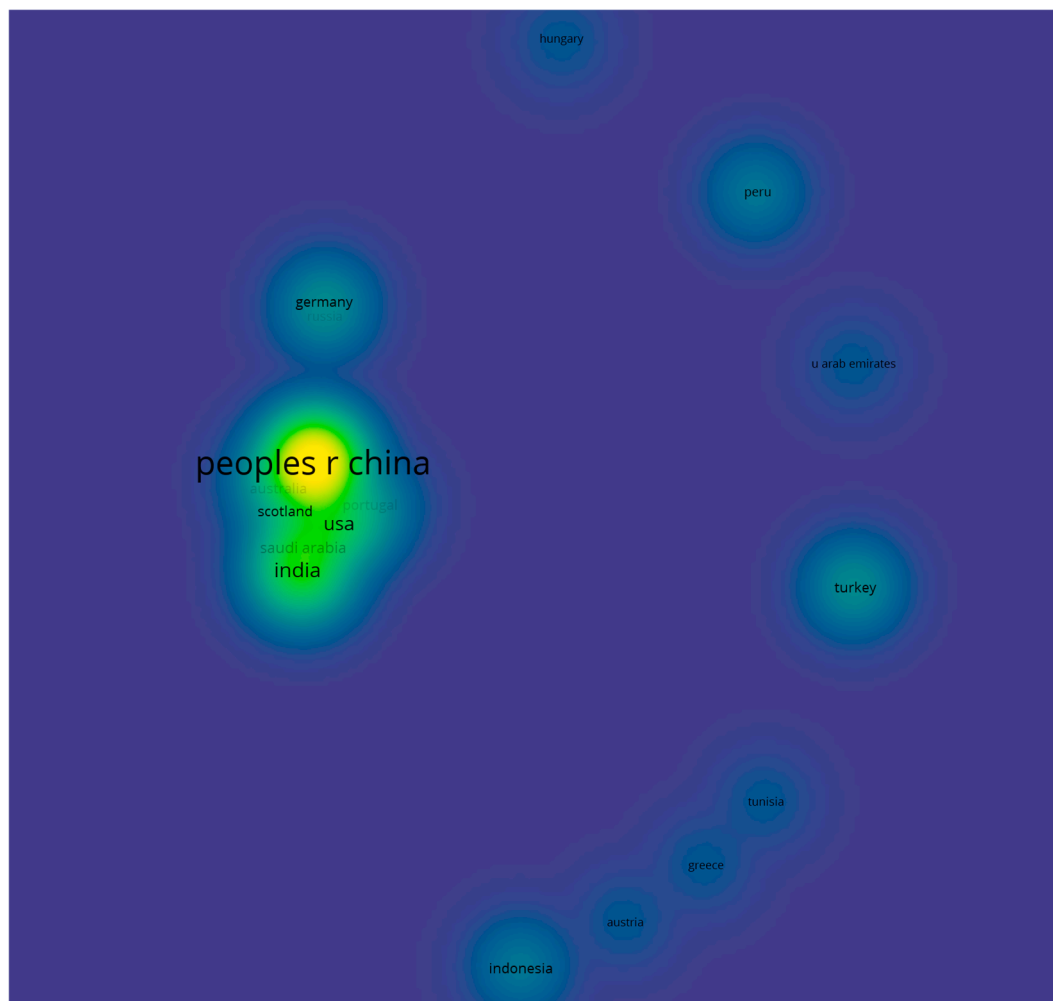


Figure 17. Country collaboration map—VOSviewer.

With the assistance of CiteSpace software, the same examination was captured in Figure 18. In this figure, each circle represents a country, while the size of the labels of the circles highlights the most productive countries in terms of publications. The lines in the figure represent collaborations between countries, based on co-authorship of publications, with dense line meaning stronger collaborations. The position of the nodes is based on their network structure: countries that collaborate more frequently are placed closer together. The results do not differ: China occupies the central position within the country collaboration map and registers the highest number of partnerships with countries like India and the USA.

Thus, it should be mentioned that it is not a surprise, based on the previous findings, that the degree of countries' collaboration within the domain of electronic commerce and emerging technologies is substantial.



Figure 18. Country collaboration map—CiteSpace.

The country that registered the largest number of collaborations is China, which had partnerships in writing documents with 22 countries, including the USA, Korea, Australia, Canada, India, the Netherlands, the Philippines, and the United Kingdom.

The interested readers can obtain more insights in Figure 18.

Figure 19 offers readers a colored illustration that includes the authors collaboration network in the research domain addressed in this study—electronic commerce associated with emerging technologies. As a result, 9 clusters emerged.

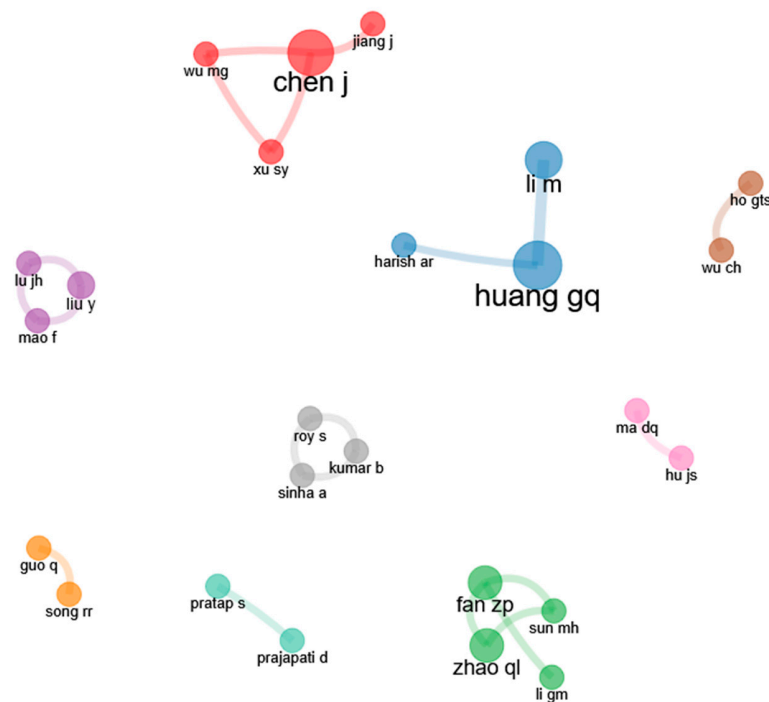


Figure 19. Top 50 authors collaboration network.

By considering the papers written by each author included in a cluster and listed in the database, the following research themes emerge:

- Cluster #1: colored red, consisting of four authors (Chen J., Jiang J., Wu M.G., and Xu S.Y.). The collaborative research efforts of these authors primarily focus on the intersection of e-commerce platforms, emerging technologies, and supply chain optimization [77–80]. The work addresses critical challenges such as logistics inefficiencies, trust and security issues, and counterfeit product management by leveraging innovative technologies like blockchain, IoT, and mobile communication systems. The contribution of the papers included in the dataset is particularly valuable for enhancing the operational capabilities of small and medium enterprises (SMEs), promoting sustainability, and fostering trust in e-commerce ecosystems [77–80]. The selected studies provide both theoretical frameworks and practical solutions that advance the integration of technological innovations in global commerce [77–80];
- Cluster #2: colored blue, composed of three authors (Huang G.Q., Li M., and Harish A.R.). The main research topic of the group of authors is on the innovative application of blockchain technology and its integration with cyber-physical systems, IoT, and other advanced frameworks to address critical challenges in e-commerce logistics and financing [81–85]. Furthermore, the authors' work highlights the following areas of contribution: logistics financing for SMEs, digital asset tokenization and traceability, reputation and privacy systems, and resource sharing in e-commerce logistics real estate (EcLRE) [81–85];
- Cluster #3: colored green, composed of four authors (Fan Z.P., Zhao Q.L., Sun M.H., and Li G.M.). The research conducted by this group of researchers focuses on the strategic adoption and impact of blockchain technology (BT) in e-commerce supply chains, with a particular interest in decision-making, consumer trust, and privacy protection [86,87]. Thus, among the key contributions made by this group of researchers, one can highlight the following research directions: blockchain in dual-channel supply chains, privacy protection and sales mode selection, and authentication technology for luxury e-commerce [86,87]. The research provides guidance for manufacturers, e-commerce platforms, and luxury retailers on leveraging blockchain technology to enhance product traceability, consumer trust, and privacy protection while balancing operational costs and competitive dynamics. The findings made by the authors in their research underscore blockchain's transformative potential to improve both consumer experiences and supply chain efficiency [86,87];
- Cluster #4: colored violet, featuring the following authors: Lu J.H., Liu Y., and Mao F. The authors focus on utilizing advanced machine learning and deep learning models to address critical challenges in e-commerce product quality management and sentiment analysis [88,89]. Among the key contributions, one can name the development of a model based on the BERT deep learning framework designed for extracting the multi-dimensional features from large-scale e-commerce reviews for identifying the consumers' sentiments [89] and the product quality risk assessment across vast datasets and supporting decision-making [88];
- Cluster #5: colored gray, featuring the following authors: Roy S., Kumar B., and Sinha A. The cluster of authors have focused their research on applying machine learning and big data analytics to evaluate and improve the usability and security of e-commerce websites, emphasizing user experience and operational efficiency [90,91]. The research is valuable for e-commerce businesses and platform designers who desire to enhance user satisfaction, platform security, and operational scalability by adopting data-driven and machine learning approaches. The research made by the authors

- in this cluster underscores the potential of AI-driven analytics in transforming the usability and customer-centricity of e-commerce ecosystems [90,91];
- Cluster #6: colored brown, composed by Ho G.T.S. and Wu C.H. The authors have focused on the application of machine learning and IoT-enabled technologies to optimize e-commerce logistics and demand forecasting, with a strong focus on real-time adaptability and operational efficiency [92,93]. As a result, two main research directions have been observed for this group of authors, namely real-time order demand prediction and IoT-enabled delivery planning for perishables [92,93];
 - Cluster #7: colored pink, formed by Ma D.Q. and Hu J.S. The authors conducted their research in the area of strategic adoption and integration of blockchain technology within e-commerce platforms and supply chains [94,95]. The authors have addressed issues related to optimizing sales and anti-counterfeit strategies and blockchain for closed-loop supply chains (E-CLSC) [94,95]. The work conducted by this group of authors is particularly important as it provides a valuable framework for e-commerce platforms to integrate blockchain technology effectively, addressing issues like anti-counterfeit traceability, sustainability, and consumer trust [94,95];
 - Cluster #8: colored turquoise, made by Pratap S. and Prajapati D. The two mentioned authors have conducted their research in the area of developing advanced frameworks integrating blockchain technology, IoT, and sustainability principles to optimize e-commerce supply chains and foster a circular economy [96,97]. The main research directions embraced by the authors are blockchain and IoT-embedded virtual closed-loop supply chain (VCLSC) and IoT-enabled sustainable B2B supply chain [96,97].
 - Cluster #9: colored orange, composed by Guo Q. and Song R.R. The research conducted by the two mentioned authors is in the area of leveraging deep learning and blockchain technologies to enhance the efficiency, security, and user experience of e-commerce platforms [98,99]. The mentioned studies included in the dataset provide a cutting-edge approach to e-commerce platform optimization, combining artificial intelligence for precise image recognition with blockchain frameworks for secure and decentralized platform operations. The research offers actionable strategies for improving data security, cost efficiency, and customer experience while fostering innovative business models in the e-commerce ecosystem [98,99].

3.4. Analysis of the Literature

As the title suggests, this section is dedicated to the analysis of scientific literature, and it is divided into three main subsections.

The first subsection is oriented to the overview of the top 10 most cited papers included in the data collection set. More specifically, for each paper found in the hierarchy, there are provided general details, such as the name of the first author, the year of publication, the source in which the manuscript was published, its reference, along with details about the scientists: the number of the authors involved and their country of origin. These details are interesting for understanding the collaboration within the domain and the cultural diversity of the papers. Furthermore, there is also offered information related to articles' impact and visibility in the scientific community, based on some metrics: total citations (TC), total citations per year (TCY), and normalized TC (NTC). While the TC and TCY metrics are easy to understand few words should be dedicated to the NTC indicator [100]. This indicator is determined by dividing the number of citations a paper included in the dataset has by the average number of citations received by all the papers included in the dataset and published in the same year as the analyzed paper. As a result, an NTC of 4, for example, shows that the analyzed paper has received 4 times more citations than the

average citations received by the papers published in the same year as the analyzed paper included in the dataset.

The second section examines each article separately, focusing on both the methods used within the analysis and the data collection set, along with presenting the main purpose of the investigation. At the end, the manuscripts are summarized to provide readers with an overall look at the work, discuss the key concepts, and emphasize the findings that were reached.

Lastly, the third section is dedicated to word analysis, focusing on the keywords plus authors' keywords, bigrams, and trigrams, including illustrations for word clouds, co-occurrence networks, and thematic maps.

This type of investigation is crucial for understanding the content of the papers, key themes addressed, most preferred technologies, areas that require improvements, and many more.

3.4.1. Top 10 Most Cited Papers—Overview

Table 7 presents the top 10 most global cited documents from the data collection set, related to both electronic commerce and emerging technologies.

Table 7. Top 10 most global cited documents.

No.	Paper (First Author, Year, Journal, and Reference)	Number of Authors	Region	Total Citations (TC)	Total Citations per Year (TCY)	Normalized TC (NTC)
1	Yim MYC, 2017, <i>Journal of Interactive Marketing</i> , [101]	3	USA	476	59.50	3.63
2	Liu ZY, 2020, <i>International Journal of Information Management</i> , [102]	2	China	177	35.40	4.79
3	Yang L, 2020, <i>IEEE Access</i> , [103]	4	China, UK	174	34.80	4.71
4	Kowalczyk P, 2021, <i>Journal of Business Research</i> , [104]	3	Germany	135	33.75	6.09
5	Zhang D, 2021, <i>International Journal of Information Management</i> , [105]	3	China, Singapore	98	24.50	4.42
6	Ren SY, 2020, <i>Transportation Research Part E: Logistics and Transportation Review</i> , [106]	4	China, Hong Kong, USA	88	17.60	2.38
7	Lahkani MJ, 2020, <i>Sustainability</i> , [107]	4	China, Poland, Russia	86	17.20	2.33
8	Moriuchi E, 2021, <i>Journal of Strategic Marketing</i> , [108]	4	USA	81	20.25	3.66
9	Chandra S, 2018, <i>Journal of Electronic Commerce Research</i> , [109]	2	Singapore	79	11.29	2.15
10	Tsang YP, 2021, <i>International Journal of Production Research</i> , [110]	5	Hong Kong	77	19.25	3.48

By carefully investigating the papers listed at the top, one can notice an interesting remark: all the papers involve multiple authors, reaching up to five scientists per work, belonging to regions from all over the world. This aspect confirms the initial observation regarding the significant level of collaboration in the domain under research, along with the high cultural diversity within the works.

Going further with the discussion, the papers are placed at the top based on their impact on the scientific community. More specifically, three distinct indicators related to the number of citations are computed: total citations (TC)—with values between 77 and

476; total citations per year (TCY)—with values between 11.29 and 59.50; and normalized TC (NTC)—with values between 2.15 and 6.09.

The foremost position belongs to the manuscript written by Yim et al. [101] (TC = 476, TCY = 59.50, NTC = 3.63), followed at a significant difference by the ones written by Liu and Li [102] (TC = 177, TCY = 35.40, NTC = 4.79) and Yang et al. [103] (TC = 174, TCY = 34.80, NTC = 4.71). The entire list can be seen in Table 7.

These indicators provide crucial information related to the relevance of electronic commerce and emerging technologies' domain, the visibility and the importance of the papers published in this area, outlining the authors' level of interest in conducting studies around this subject.

As for this bibliometric investigation, it is clearly visible a high tendency of publishing papers around this subject, which is a result of the significant relevance of the field due to the technology's rapid evolution, the trend of digitalization, and the shift in activities to the virtual space.

3.4.2. Top 10 Most Cited Papers—Review

As discussed above, in this section each of the top 10 most globally cited papers included in the data collection set, listed in Table 8, will be analyzed and summarized, focusing on the key aspects: main findings, purpose, methods used, and data involved.

Table 8. Brief summary of the content of top 10 most global cited documents.

No.	Paper (First Author, Year, Journal, Reference)	Title	Methods Used	Data	Purpose
1	Yim MYC, 2017, <i>Journal of Interactive Marketing</i> , [101]	Is Augmented Reality Technology an Effective Tool for E-commerce? An Interactivity and Vividness Perspective	Interactivity and vividness evaluation. Analysis of Covariance (ANCOVA). Structural Equation Modeling (SEM). Cronbach's Alpha. Composite Reliability (CR). Convergent and Discriminant Validity Tests. Harman's Single Factor Test. Sentiment analysis. Text analysis.	Two datasets including a total of 1059 responses from USA college students. First dataset involved 258 students, while the second dataset involved 801 students.	Analyze the effectiveness of augmented reality technology for e-commerce platforms and compare it to traditional web-based product presentations.
2	Liu ZY, 2020, <i>International Journal of Information Management</i> , [102]	A blockchain-based framework of cross-border e-commerce supply chain	Blockchain Framework. Core Algorithms and Methods (information anchoring method, key distribution method, information encryption algorithm, anti-counterfeiting method).	Digital documents, IoT data, transaction records, traceability tags, and smart contract execution records used for evaluating the framework.	Propose a novel framework based on blockchain for enhancing product traceability and transaction security in cross-border electronic commerce supply chain. Improve the sentiment analysis of products' reviews from e-commerce platforms, by developing an efficient model, namely SLCABG, based on sentiment lexicon and deep learning algorithms.
3	Yang L, 2020, <i>IEEE Access</i> , [103]	Sentiment Analysis for E-Commerce Product Reviews in Chinese Based on Sentiment Lexicon and Deep Learning	Sentiment lexicon. Convolutional Neural Network (CNN). Attention-based Bidirectional Gated Recurrent Unit (BiGRU).	100,000 book reviews gathered from Dangdang.	
4	Kowalczyk P, 2021, <i>Journal of Business Research</i> , [104]	Cognitive, affective, and behavioral consumer responses to augmented reality in e-commerce: A comparative study	Mean comparisons. Structural Equation Modeling (SEM). Multi-group Analysis (MGA).	The answers from an online questionnaire about IKEA (AR application versus mobile website), filled in by 400 students at a German University, between November and December 2018.	Compare consumer responses to AR versus web-based product presentations in electronic commerce associated with IKEA's company.

Table 8. Cont.

No.	Paper (First Author, Year, Journal, Reference)	Title	Methods Used	Data	Purpose
5	Zhang D, 2021, <i>International Journal of Information Management</i> , [105]	Artificial intelligence in E-commerce fulfillment: A case study of resource orchestration at Alibaba's Smart Warehouse	Case analysis (resource orchestration, interaction and co-evolution of AI and human capabilities)	Data from secondary sources—early 2018 (media, company websites, articles from Internet). Primary data (25 interviews from employees and managers in Alibaba's Smart Warehouse) Other notes, videos, photos during interviews.	Investigate the way in which AI is used to improve business processes in Alibaba's Smart Warehouse.
6	Ren SY, 2020, <i>Transportation Research Part E: Logistics and Transportation Review</i> , [106]	Intelligent service capacity allocation for cross-border-E-commerce related third-party-forwarding logistics operations: A deep learning approach	S2SCL (Sequence-to-Sequence architecture based on Convolutional Neural Networks—CNN, and Long Short-Term Memory networks -LSTM).	Real daily logistics service demand (LSD) data, gathered between 2017 and 2018, from a 3PFL company which operates in Hong Kong.	Propose a novel approach based on deep learning (S2SCL) and proving its efficiency on allocating service capacity in international electronic commerce.
7	Lahkani MJ, 2020, <i>Sustainability</i> , [107]	Sustainable B2B E-Commerce and Blockchain-Based Supply Chain Finance	Blockchain.	Data from Alibaba's reports.	Prove the efficiency of logistics and digital documentation by implementing a B2B blockchain model in Alibaba company.
8	Moriuchi E, 2021, <i>Journal of Strategic Marketing</i> , [108]	Engagement with chatbots versus augmented reality interactive technology in e-commerce	Cronbach's Alpha. Structural Equation Modeling (PLS-SEM). Variance Inflation Factor (VIF). Stone-Geisser's Q ² Test. Heterotrait-Monotrait Ratio (HTMT).	The dataset consists of 68 undergraduate students' (with ages between 18 and 24) answers about their perceptions and feelings related to augmented reality versus chatbot technologies.	Discuss the effects of chatbots and augmented reality (AR) in electronic commerce on customers' engagement and decision-making.
9	Chandra S, 2018, <i>Journal of Electronic Commerce Research</i> , [109]	Exploring Factors Influencing Organizational Adoption of Augmented Reality in E-Commerce: Empirical Analysis Using Technology–Organization–Environment Model	Partial Least Squares (PLS). Latent Structural Equation Modeling (SEM).	A survey with 107 responses from managers who work for companies in India, Singapore, and the USA. The questions were related to their willingness to adopt AR within their organizations.	Explore the willingness of implementing AR within electronic commerce companies, by asking for managers' standpoints, and propose an efficient model that has the power to maximize the organizations' processes and sales.
10	Tsang YP, 2021, <i>International Journal of Production Research</i> , [110]	Integrating Internet of Things and multi-temperature delivery planning for perishable food E-commerce logistics: a model and application	Internet of Things-based multi-temperature delivery planning system (IoT-MTDPS). Two-phase multi-objective genetic algorithm optimizer (2PMGAO). Fuzzy logic.	Real data relevant for analyzing the perishable food electronic commerce logistics: environmental conditions, GPS locations, traffic details, customers, orders etc.	Propose an efficient IoT-MTDPS model for optimizing perishable food e-commerce logistics.

With respect to the number of citations, the first position in the hierarchy is occupied by Yim et al. [101]. The article is focused on investigating augmented reality technology (AR) and its effectiveness in electronic commerce compared to web-based presentations. The study involved two phases, one for each dataset. The first dataset comprised the answers from 258 USA college students, who evaluated two popular products, namely sunglasses and watches, through AR and the web. This helped to better understand how consumers' behavior and decisions are influenced in each approach. The second dataset included a higher number of students compared to the previous one (801 answers from students) and analyzed the consumers' evaluation through AR based on interactivity and vividness. The results demonstrated that AR registered a higher positive impact than web

presentation in terms of purchase intention, buyer experience, novelty, and immersion. The AR's impact is substantial, but it may decrease as time passes, since the novelty effect disappears. The authors encourage future researchers to focus on investigating AR on mobile devices and further analyze its impact on sales, companies, and consumers.

The following article is the one written by Liu and Li [102], and its main goal is to offer a modern framework based on blockchain technology, which aims to combat the current challenges associated with product traceability in cross-border electronic commerce supply chains. Through a multi-chain structure, different types of data, such as digital documents, IoT data, transaction records, traceability tags, and smart contract execution records, are securely managed. Data integrity and fake products' prevention are achieved by using information anchoring, along with encryption algorithms. Furthermore, the effectiveness of the framework based on blockchain is proved by attack scenarios.

The manuscript belonging to Yang et al. [103] brings to the readers' attention a novel model known as SLCABG. Its main goal is to improve users' satisfaction through sentiment analysis of the products' reviews sent on electronic commerce platforms. The specified model is built on a sentiment lexicon and involves the integration of CNN and Bidirectional Gated Recurrent Unit (BiGRU) based on attention. The efficiency of the model is tested on a dataset that consists of 100,000 book reviews gathered from a Chinese e-commerce platform called Dangdang: 50,000 positive reviews (the ones between three and five stars) and 50,000 negative reviews (the ones with one or two stars). The results obtained suggest an improved performance in terms of sentiment and context features' extraction and classification compared to other existing sentiment analysis models. This model can be considered an important tool for improving the user experiences on electronic commerce platforms, while in terms of future research directives, a first step could be represented by refining the model to allow the classification of sentiment into more detailed categories, not only positive and negative, as in the current research.

Kowalczyk et al. [104] conducted a comparative study in which they investigated the impact of AR and web-based presentations on consumers, focusing, as the title suggests, on cognitive, affective, and behavioral responses. The experiment involved a number of 400 students at a German university, who filled in an online questionnaire about their experience and satisfaction using the IKEA Place AR application and the IKEA mobile website. Based on the findings exposed by the study, it was noticed that AR presentations had a greater impact on affective responses but unfortunately did not satisfy pre-purchase information needs. On the other hand, web-based presentations are more useful from a cognitive perspective. For future work, a recommended direction would be to further analyze the AR's effects on post-purchase satisfaction or even product return rates.

The article written by Zhang et al. [105] is focused on artificial intelligence and investigates its integration in Alibaba's Smart Warehouse, along with AI's impact on improving business operations-reducing human labor improving delivery processes. The framework discussed in this paper is based on resource orchestration, while the dataset used was gathered from two sources: one from media, company websites, and articles from the Internet, and the second from an interview with 25 Alibaba employees. The purpose of this paper is to better comprehend the resources needed for an efficient AI integration within organizations and provide the optimal steps for a successful implementation. The authors highlight the importance of the domain and the high necessity of adapting AI based on companies' needs.

The following article belonging to Ren et al. [106] exposes a novel method that is based on deep learning mechanisms, called S2SCL. The name of the framework originates from its sequence-to-sequence architecture based on Convolutional Neural Networks (CNN) and Long Short-Term Memory networks (LSTM). The study involves real daily logistics service

demand (LSD) data, collected over a period of one year, namely between 2017 and 2018, from a 3PFL company that operates in Hong Kong. The model's performance and efficiency related to demand forecasting and cost of logistics are proved based on a comparison with two other traditional models (ARIMA and PSO-ELM). Future work directives may be oriented at applying this model further in other areas, such as resource management.

Lahkani et al. [107] are discussing in their paper a business-to-business blockchain model and its substantial impact on the supply chain processes in the Alibaba company, being mainly oriented to the examination of two areas: logistics and digital documentation. The study uses data from Alibaba's public reports and proves a high efficiency of blockchain integration, on both logistics and digital documentation, highlighting an increase in the effectiveness of more than 70%. The authors emphasize the importance of embracing blockchain technology and its considerable benefits to companies, especially in the long term, in terms of transparency, supply chain, and risk management.

Moriuchi et al. [109] contributed to the scientific community with an article about the influence that augmented reality (AR) and chatbots have on consumers' engagement and shopping decisions on electronic commerce platforms. The dataset consisted of the answers from 68 undergraduate students, with ages between 18 and 24, and included their perceptions, experiences, and feelings related to these technologies. During the analysis step, it involved the SmartPLS tool with the structural equation modeling (SEM) method, Stone-Geisser's Q2 test, and the heterotrait-monotrait ratio (HTMT). The methods showed that AR technology had a greater impact on customers' shopping decisions compared to chatbots.

Chandra and Kumar [109] discuss in their paper the factors that influence managers' willingness to adopt augmented reality (AR) technology within their electronic commerce organizations using the TOE (Technological, Organizational, and Environmental) framework. To understand this phenomenon, a survey was conducted including the managers from companies that operate in India, Singapore, and the USA, and based on this, after the data was filtered, there were collected 107 usable responses. The analysis involved the SmartPLS 2.0 tool, partial least squares (PLS), and the latent structural equation modeling (SEM) method. The results of the study expose that the primary factors that impact the AR adoption within companies are technological competence, relative advantage, top management support, and consumer readiness. Furthermore, it was noticed that the managers' knowledge and financial strength were not considered among the most significant factors for AR adoption. At the end of the paper, the authors provided some details related to limitations and future research directives for interested readers.

The last paper from the top 10 hierarchy with respect to the number of citations is the one belonging to Tsang et al. [110]. The authors bring to readers' attention a new and efficient Internet of Things-based multi-temperature delivery planning system (IoT-MTDPS) for optimizing perishable food e-commerce logistics. In other words, the IoT sensors were used for monitoring key factors in delivery processes (e.g., temperature, humidity, GPS location), while the optimal delivery routes were identified and established with the help of the multi-objective optimization algorithm (2PMGAO), which maximized the profit, delivery time, and clients' satisfaction and reduced the costs. Moreover, fuzzy logic was further used for updating the routes when certain incidents in traffic occurred. The results of the system proved its high efficiency at a logistics company from Hong Kong.

3.4.3. Words Analysis

The words analysis aims to investigate the articles' content in depth, focusing on the most frequent keywords plus authors' keywords, bigrams, trigrams, and providing co-occurrence networks and thematic maps.

Through this section, the authors' main desires are to discuss the most important aspects present the key themes addressed and hidden trends in order to enhance the readers' understanding of the domain associated with electronic commerce and emerging technologies.

Table 9 provides the top 10 most frequent words in keywords plus. Initially, by simply analyzing the words included in the table, an observation arises: the papers from the dataset are focused on multiple dimensions of electronic commerce, especially on exploring the use of modern technologies, with performant algorithms and frameworks, to optimize the platforms' efficiency and management.

Table 9. Top 10 most frequent words in keywords plus.

Words	Occurrences
model	26
technology	15
impact	14
information	13
management	13
system	11
performance	10
framework	8
algorithm	7
classification	7

In Table 9, the next words are listed, with respect to the number of occurrences: "model" (26 occurrences), "technology" (15 occurrences), "impact" (14 occurrences), "information" and "management" (each with 13 occurrences), "system" (11 occurrences), "performance" (10 occurrences), "framework" (8 occurrences), and "algorithm" and "classification" (each with 7 occurrences). By analyzing the keywords listed in Table 9, it can be noted that the prominence of the word "model" indicates a strong emphasis on conceptual frameworks or methodologies. Furthermore, the use of keywords such as "technology", "impact", and "information", or "management" suggests a focus on the technological implications, outcomes, and data management aspects of the studies, while the use of terms such as "system", "performance", and "framework" reflects interest in operational efficiency and structural design for the papers cited in the documents included in the dataset. Nevertheless, the occurrence of "algorithm" and "classification" points out the importance of computational methods and categorization in the selected research associated with the area of e-commerce and emerging technologies.

Table 10 presents the top 10 most frequent words, this time in authors' keywords. After the words' examination, it can be deduced that the authors focused in their manuscripts on electronic commerce platforms, more specifically on the way in which advanced technologies (artificial intelligence, Internet of Things, and blockchain) can influence their evolution, security, and match with users' preferences and needs.

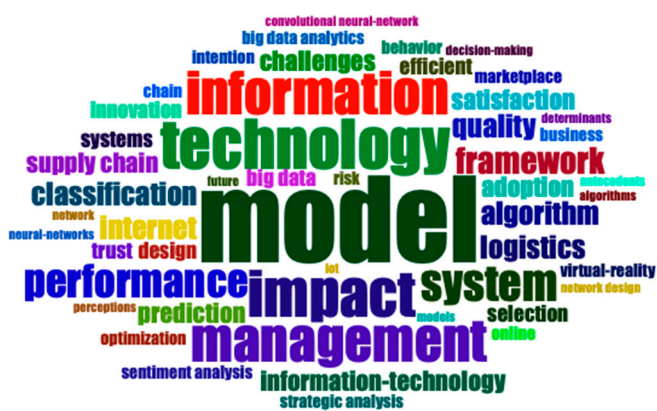
The words are enumerated here, according to their frequency of occurrence: "e-commerce" (80 occurrences), "machine learning" (38 occurrences), "blockchain" (35 occurrences), "deep learning" (28 occurrences), "artificial intelligence" (18 occurrences), "internet of things" (16 occurrences), "electronic commerce" (14 occurrences), "blockchain technology" and "sentiment analysis" (each with 12 occurrences), and "augmented reality" (10 occurrences).

Figure 20 provides two word clouds, one based on the top 50 keywords plus another one on authors' keywords. The size of the word in the illustration is directly determined by its number of occurrences. In other words, the larger the size, the greater the number of

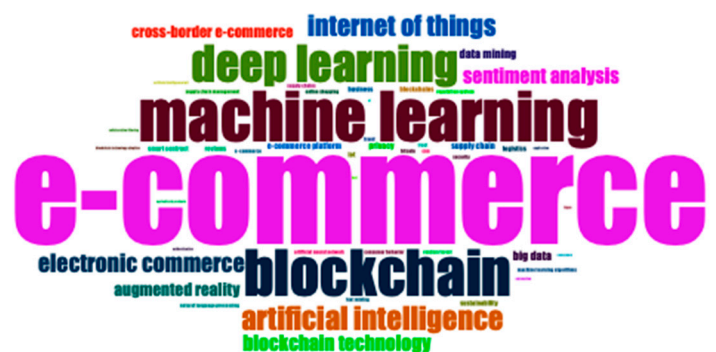
word appearances in the data collection set with papers around electronic commerce and emerging technologies.

Table 10. Top 10 most frequent words in authors' keywords.

Words	Occurrences
e-commerce	80
machine learning	38
blockchain	35
deep learning	28
artificial intelligence	18
internet of things	16
electronic commerce	14
blockchain technology	12
sentiment analysis	12
augmented reality	10



(A) Top 50 words based on keywords plus



(B) Top 50 words based on authors' keywords

Figure 20. Top 50 words based on keywords plus (A) and authors' keywords (B).

Table 11 depicts the top 10 most frequent bigrams in abstracts and titles. Therefore, in the case of abstracts, the first place is occupied by “supply chain” with 112 occurrences followed by “blockchain technology”—82 occurrences, and “machine learning”—73 occurrences.

Table 11. Top 10 most frequent bigrams in abstracts and titles.

Bigrams in Abstracts	Occurrences	Bigrams in Titles	Occurrences
supply chain	112	deep learning	50
blockchain technology	82	machine learning	41
machine learning	73	artificial intelligence	39
deep learning	72	cross-border e-commerce	26
cross-border e-commerce	61	supply chain	23
e-commerce platform	58	e-commerce platform	21
e-commerce platforms	57	blockchain technology	20
artificial intelligence	53	augmented reality	17
agricultural products	44	e-commerce logistics	14
online shopping	40	learning model	12

In the case of bigrams from titles, the top appears as follows: “deep learning”—50 occurrences; “machine learning”—41 occurrences; and “artificial intelligence”—39 occurrences.

Considering the terms listed in Table 11, it can be observed that they match either dominant themes related to logistics and the application of blockchain in enhancing transparency

and efficiency or the use of advanced AI techniques in the area of e-commerce (e.g., terms such as “supply chain”, “blockchain technology”, “deep learning”, “machine learning”), or focus on the technological integration of driving innovation into e-commerce (e.g., “deep learning”, “machine learning”, “artificial intelligence”), or simply refer to e-commerce-specific themes (e.g., “e-commerce platform(s)”, and “cross-border e-commerce”). Nevertheless, emerging topics such as diversification in e-commerce research (e.g., “agricultural products”, “augmented reality”) can be highlighted through the use of extracted bigrams.

For the entire list, please check Table 11.

Table 12 includes the hierarchy of the most frequent trigrams found in abstracts and titles.

Table 12. Top 10 most frequent trigrams in abstracts and titles.

Trigrams in Abstracts	Occurrences	Trigrams in Titles	Occurrences
e-commerce supply chain	27	e-commerce supply chain	11
artificial intelligence ai	20	deep learning model	9
augmented reality ar	12	machine learning approach	8
supply chain management	12	cross-border e-commerce logistics	4
machine learning ml	10	e-commerce platform based	4
convolutional neural network	9	e-commerce product reviews	4
data mining technology	9	blockchain technology adoption	3
deep learning model	9	closed-loop supply chain	3
machine learning methods	9	cross-border e-commerce supply	3
blockchain technology adoption	8	deep learning algorithm	3

As for the trigrams in abstracts, the foremost position is held by “e-commerce supply chain”—with 27 occurrences, subsequently followed by “artificial intelligence ai”—20 occurrences, and “augmented reality ar” and “supply chain management”, each with 12 occurrences.

In the case of titles, the first positions in the top are occupied by “e-commerce supply chain”—11 occurrences, “deep learning model”—9 occurrences, and “machine learning approach”—8 occurrences.

Based on the extracted trigrams, the focus on supply chain in the researchers associated with e-commerce and emerging technologies can be observed through the use of the trigrams “e-commerce supply chain”, “supply chain management” and “closed-loop supply chain”. The presence of AI and ML in the selected studies is demonstrated by the occurrence of the following trigrams: “artificial intelligence AI”, “deep learning model”, “machine learning methods/approach”, “convolutional neural network”, and “data mining technology”. Even in the case of the trigrams, the emerging technologies and the cross-border e-commerce can be observed—as it results from the occurrence of the following trigrams: “augmented reality AR”, “blockchain technology adoption”, “cross-border e-commerce logistics” and “cross-border e-commerce supply”.

The complete list can be seen in Table 12.

The co-occurrence network for the terms in the author’s keywords is captured in Figure 21, according to which four main clusters can be noticed:

- Cluster 1 (red): e-commerce, machine learning, deep learning, internet of things, iot, data mining, artificial intelligence, big data, random forest, e-commerce, artificial neural network, automation, online shopping, artificial intelligence (ai), augmented reality, machine learning algorithm, logistics, collaborative filtering.
- Cluster 2 (blue): blockchain, supply chain management, cross-border e-commerce, blockchain technology, sustainability, e-commerce platform, supply chain, consumers, agricultural products, trust, application, smart contract, bitcoin, reputation system.

- Cluster 3 (purple): sentiment analysis, bert, bigru, text mining, natural language processing, cnn, fraud, reviews, authentication.
- Cluster 4 (green): electronic commerce, privacy, supply chains, consumer behavior, blockchains, security, business, and blockchain technology adoption.

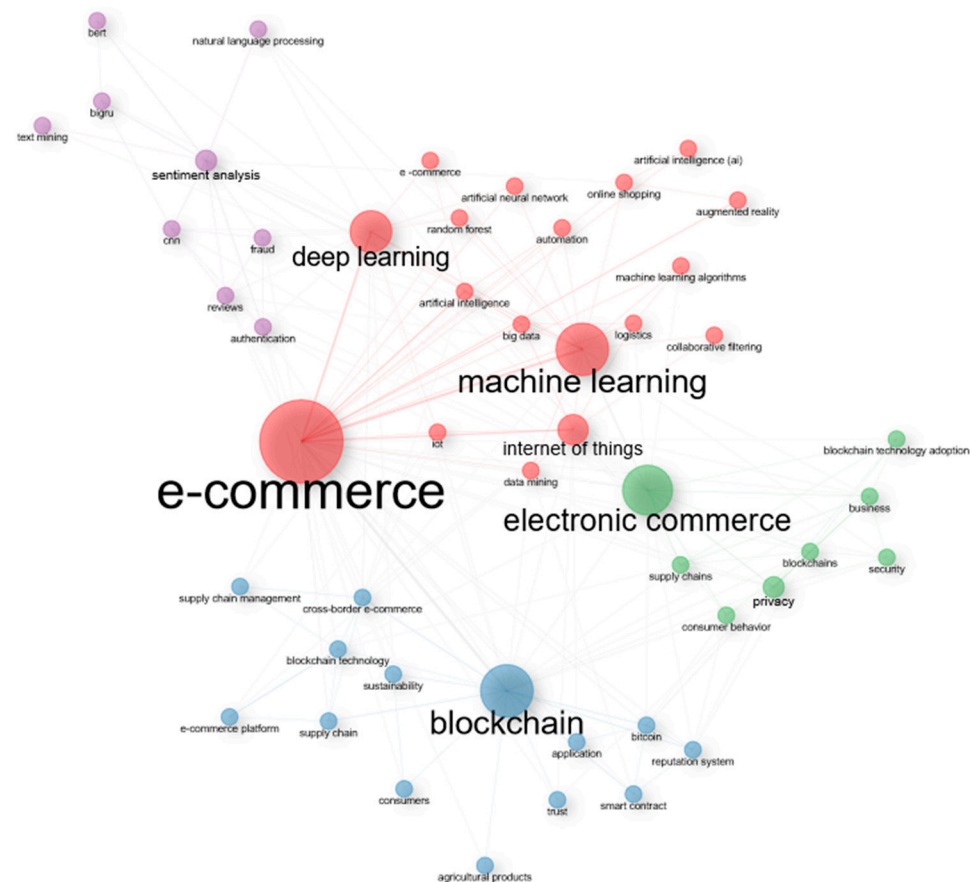


Figure 21. Co-occurrence network for the terms in author's keywords.

By carefully investigating these terms, some important aspects become visible.

The first cluster focuses on the electronic commerce area and its integration with cutting-edge technologies (artificial intelligence, the Internet of Things, and augmented reality) so as to combat the current difficulties in logistics and improve efficiency and buyers' experiences.

The second cluster is oriented to the benefits associated with the efficient integration of blockchain technology in supply chains and electronic commerce platforms, highlighting real-world applications, such as the management of agricultural products.

The following cluster is related to sentiment analysis using different natural language processing algorithms for detecting users' satisfaction and fraudulent intents based on reviews.

The last cluster is directed towards electronic commerce, consumer behavior, and supply chains, being focused on blockchain technology's impact in areas such as security and privacy.

Going further with this discussion, a parallel examination was conducted in Figure 22 using VOSviewer. In this figure the lines are used for connecting keywords that appear together in the same articles, while the colors of the lines correspond to the cluster colors of the nodes they connect. In this case only the terms that reached a minimum of three occurrences in the dataset were included.

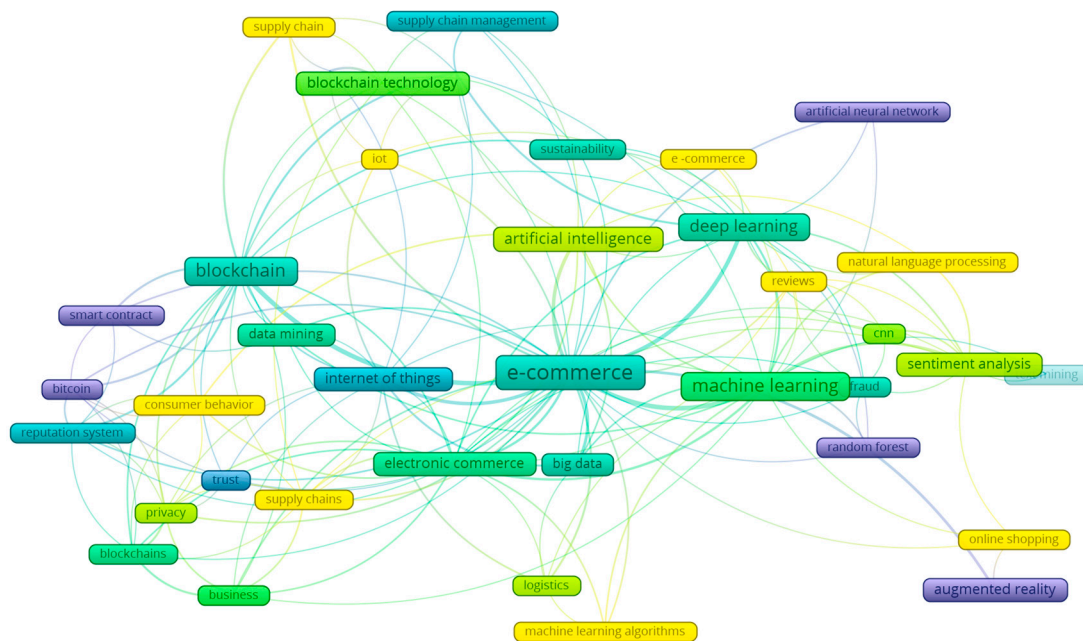


Figure 22. Co-occurrence network for the terms in author's keywords using VOSviewer.

A close comparison between the co-occurrence network generated by Biblioshiny (Figure 21) and the one obtained from VOSviewer (Figure 22) uncovers the same authors' keywords: "e-commerce", "blockchain", "machine learning", "deep learning", "internet of things", "sentiment analysis", "privacy", "natural language processing", "supply chains" etc., proving again that the papers included in the dataset are significant for the research topic and are strongly oriented towards emerging technologies, cutting-edge algorithms, and the e-commerce field.

Figure 23 brings to attention a thematic map based on the author's keywords. As delimited in the below figure, there are four main themes outlined.

In the case of niche themes, no elements are included. On the other side, motor themes contain topics related to electronic commerce associated with front-line technologies and their efficiency in understanding consumer behavior and privacy challenges, including the following keywords: "artificial intelligence", "consumer behavior", "e-commerce", "electronic commerce", "privacy", and "blockchains".

At the intersection between emerging or declining themes and basic themes, there are found words associated with online shopping evolution due to the implications of artificial intelligence and augmented reality ("augmented reality", "online shopping", and "artificial intelligence").

The basic themes reflect the connection between e-commerce platforms, emerging technologies, and efficient cutting-edge algorithms, with a high emphasis on sustainability, consumers' reviews, and trust, including the following words: "reviews", "sustainability", "consumers", "machine learning", "data mining", "artificial neural network", "blockchain technology", "e-commerce platform", "authentication", "deep learning", "sentiment analysis", "cross-border e-commerce", "e-commerce", "blockchain", and "internet of things".

The second thematic map is captured in Figure 24 and is based on titles. This time, niche themes are oriented to the optimization and growth of electronic commerce, improving user engagement and purchase experience by using analytics and augmented reality. The included terms are listed as follows: "analytics", "assessment", "sustainability", "purchase", "ar", "experience", "growth", "utilization", "interactivity", "vividness", "warehouse", "demand", "fulfillment", "reputation", "anonymous", "verifiable", "user", "engagement", and "optimizing".

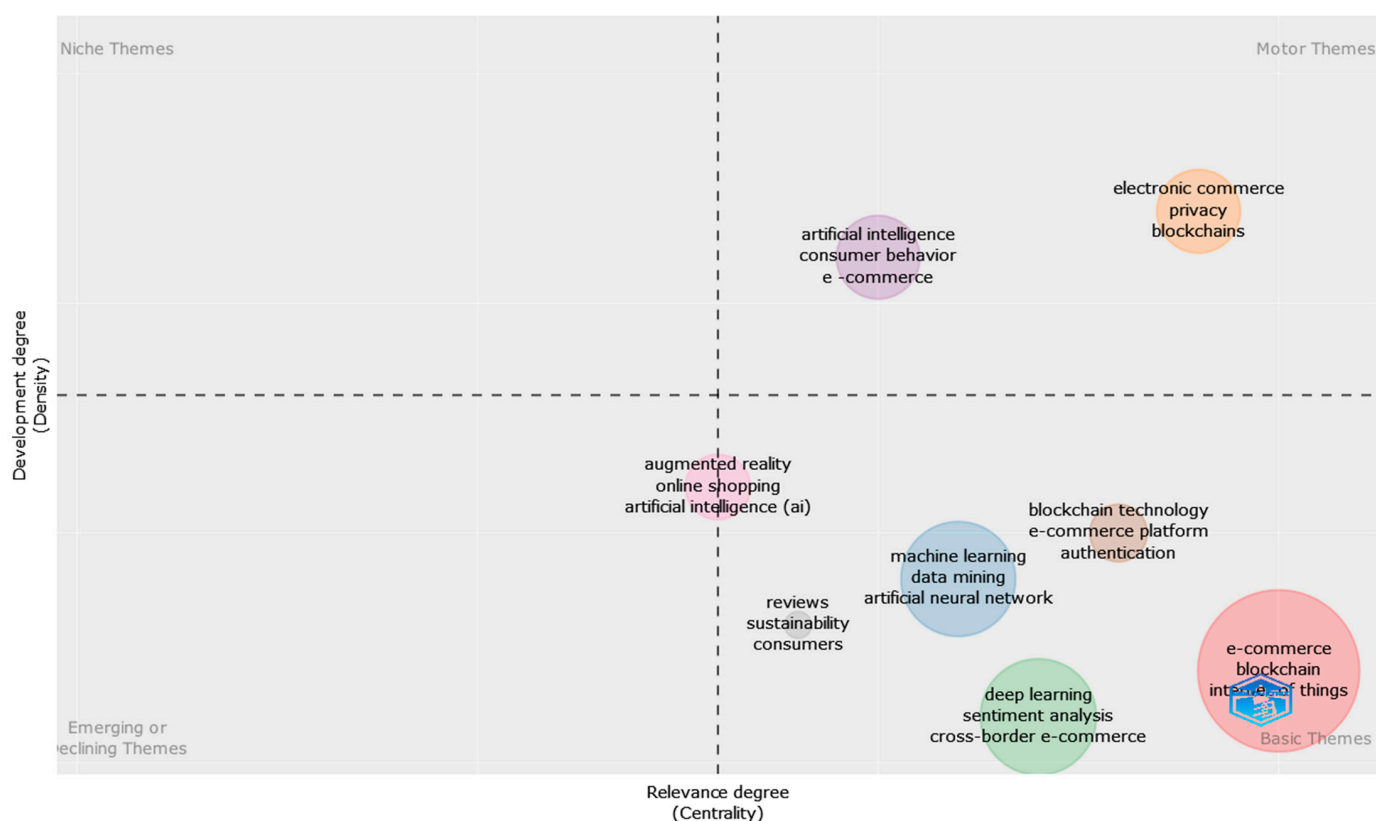


Figure 23. Thematic map based on author's keywords.

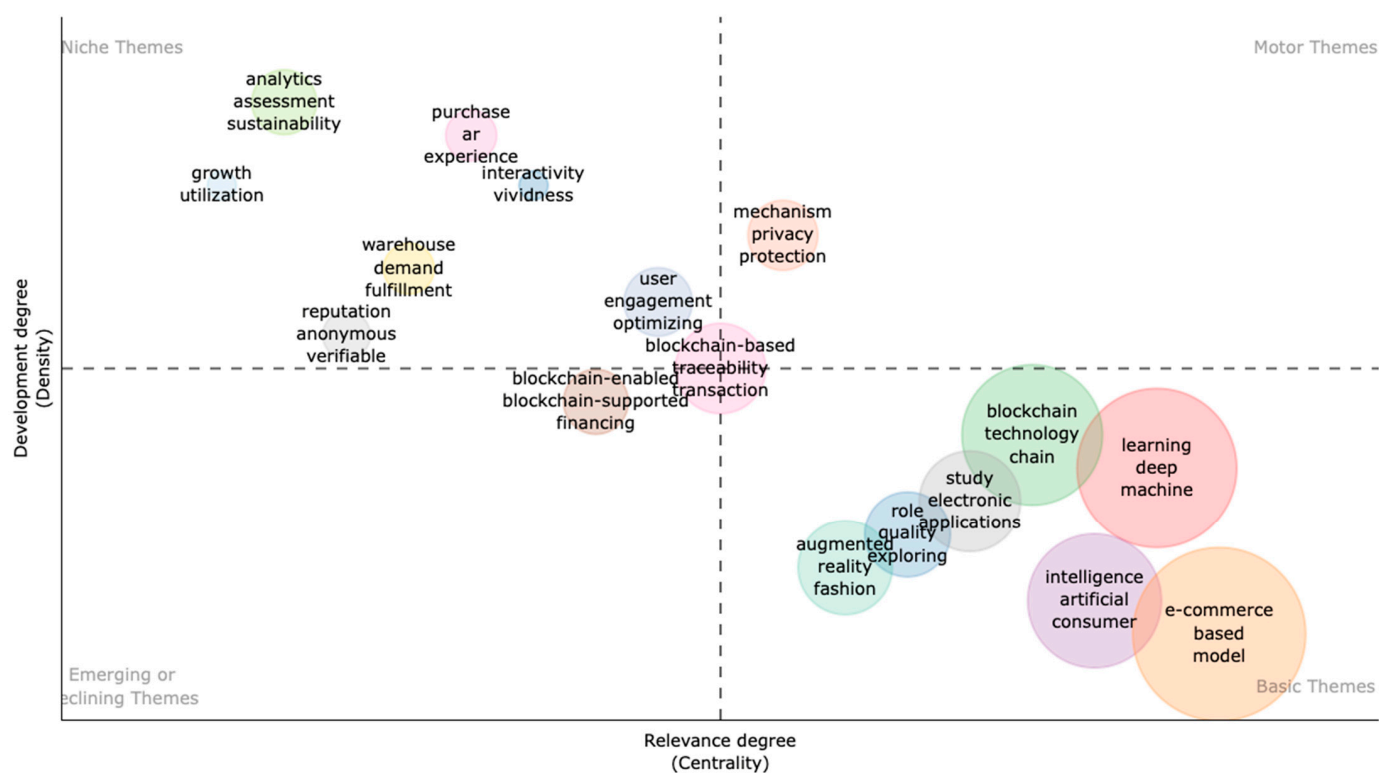


Figure 24. Thematic map based on titles.

Motor themes comprise “mechanism”, “privacy”, and “protection”. Based on these terms, one can easily notice that they are focused on improving the secure mechanisms in electronic commerce platforms.

Basic themes inspect further the benefits of incorporating artificial intelligence, blockchain, and augmented reality in electronic commerce platforms, especially fashion-oriented, for enhancing the user experience: “blockchain technology”, “chain”, “learning”, “deep”, “machine”, “study”, “electronic”, “applications”, “role”, “quality”, “exploring”, “augmented reality”, “fashion”, “intelligence”, “artificial”, “consumer”, “e-commerce”, “based”, and “model”.

Emerging or declining themes are focused on the blockchain’s benefits in financial processes: “blockchain-enabled”, “blockchain-supported”, “financing”.

In the middle, the following terms are observed: “blockchain-based”, “traceability”, and “transaction”. More specifically, all four themes have in common a key aspect: the transactions’ security through blockchain.

Additional to the thematic maps presented above, a topic analysis has been conducted using Latent Dirichlet Allocation (LDA) [111] and BERTopic [112], based on both the article titles and abstracts.

LDA is a generative probabilistic model that can discover latent (i.e., hidden) topics within a document corpus. To improve the detection accuracy, a preprocessing step was applied before LDA modeling, during which the text was converted to lowercase, while punctuation and the generic stopwords included in the Gensim (<https://radimrehurek.com/gensim/>, accessed on 14 January 2025) Python 3.13 library were removed. Additionally, since LDA treats semantically equivalent expressions such as “e-commerce” and “electronic commerce” as distinct entities, a term normalization step has been performed. Bigrams and trigrams have also been included in order to capture meaningful multi-word expressions. In the following, a grid search approach has been conducted in order to determine the number of clusters and the values for the alpha and eta parameters that would provide a good balance between a relatively low number of clusters and a high coherence score. Based on the results of the grid search, the number of clusters has been set to 3, with both alpha and eta parameters being set to 1.

In the case of BERTopic, the minimum cluster size and the minimum samples parameter of the HDBSCAN algorithm have been adjusted iteratively, with the same purpose of obtaining a relatively small number of clusters that provide good coherence. The final parameter values selected were 50 for minimum cluster size and 20 for minimum samples.

Through the use of LDA, three distinct topics have been identified, as presented in Figures 25–27. Based on the position of the three topics, it can be stated that they are well separated, which suggests a clear thematic differentiation among them.

As can be observed from Figures 25–27, the right side of the figures provides the top 30 most relevant terms, highlighting the semantic focus of each cluster.

Topic 1, depicted in Figure 25, consists of a series of dominant keywords, such as *product*, *consumer*, *customer*, *user*, *review*, *recommendation*, *platform*, *trust*, *sentiment*, and *purchase*, which refers to studies featuring how platforms personalize offerings and build consumer trust. The papers included in this topic are gravitating around the consumer interaction with e-commerce platforms, putting an accent on user experience, behavior, trust, and product review systems, while the specific terms of AI and ML—e.g., *recommendation*, *review*, and *sentiment*—point out the applications of these methods in recommender systems and sentiment analysis.

Topic 2, depicted in Figure 26, features a series of keywords such as *cross_border_e_commerce*, *blockchain*, *transaction*, *security*, *traceability*, *logistics*, *supply_chain*, *network*, *value*, and *agricultural_product*, which can be connected with themes related to innovations in secure digital infrastructure and blockchain-based logistics management. Based on these terms, it can be stated that the main focus of the papers included here is dealing with technological infrastructure, especially the role of blockchain in securing transactions and ensuring

transparency in global and cross-border e-commerce. Furthermore, by considering the terms such as traceability, supply_chain, and security, this hypothesis is further supported.

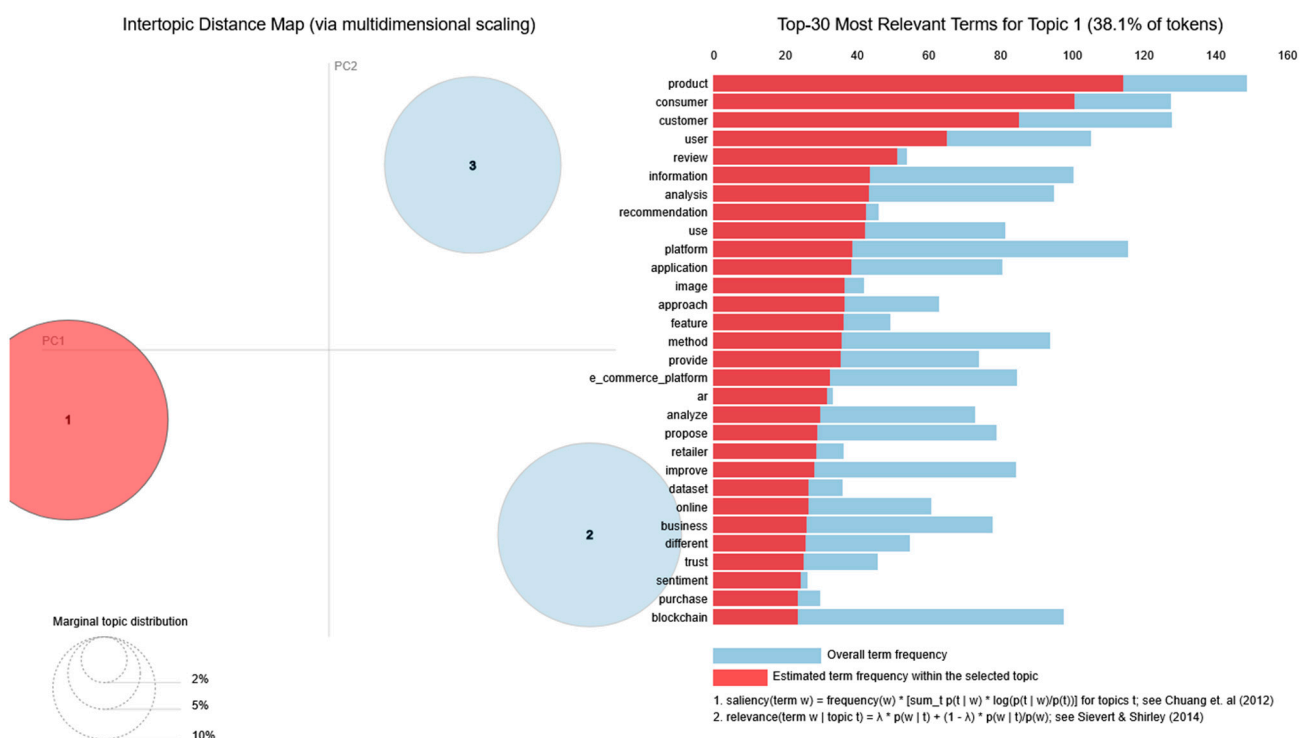


Figure 25. LDA results for Topic 1 [113,114].

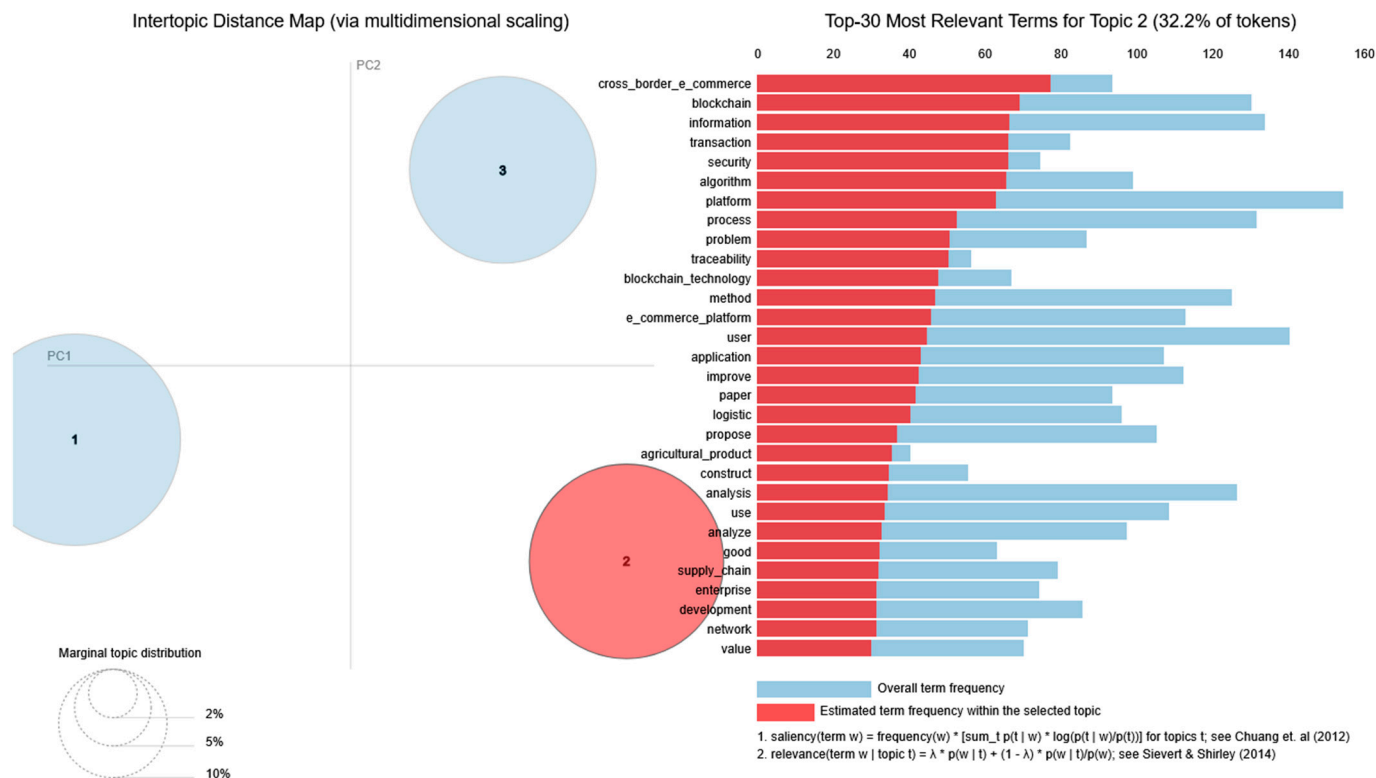


Figure 26. LDA results for Topic 2 [113,114].

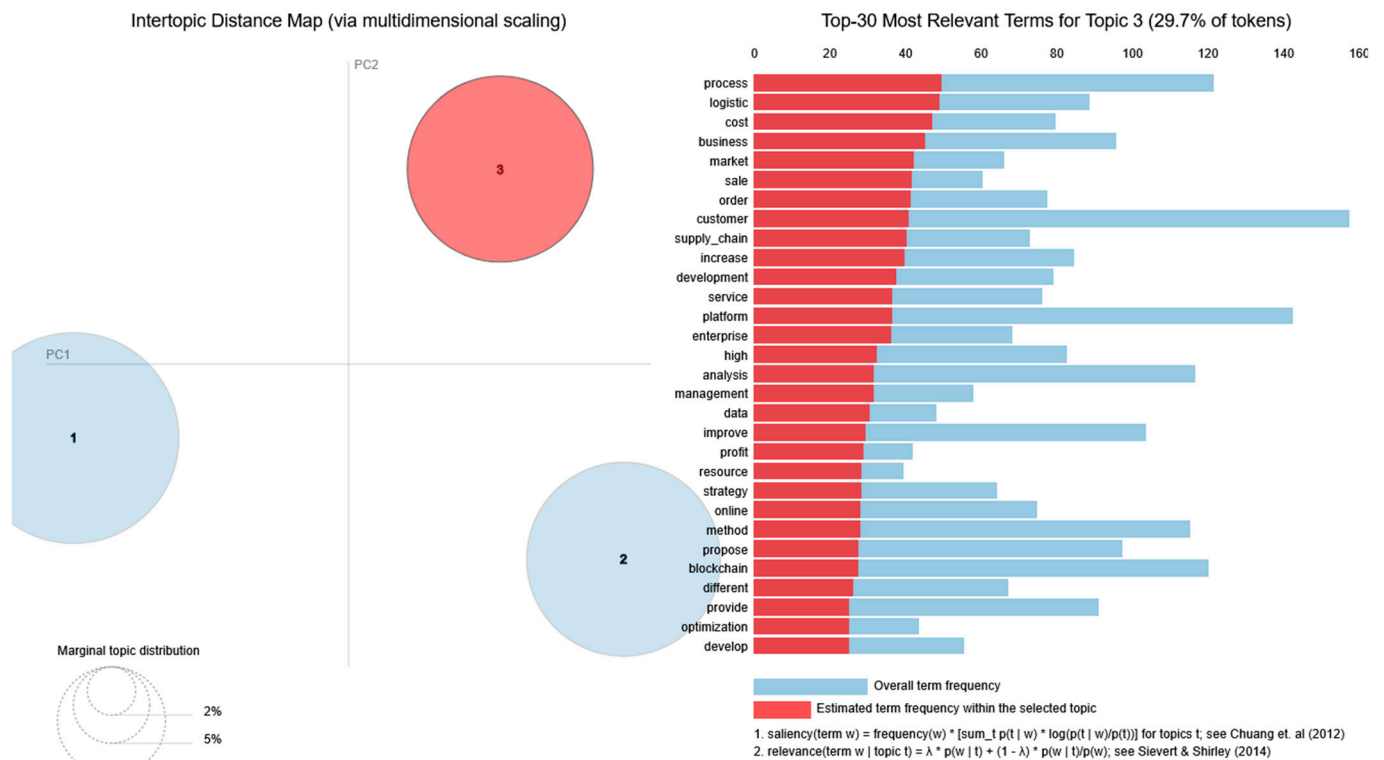


Figure 27. LDA results for Topic 3 [113,114].

Lastly, Topic 3, presented in Figure 27, includes studies that approach e-commerce from a business administration or operations research perspective. This idea is supported by the occurrence of the following keywords in the top 30 most relevant terms: *process*, *logistics*, *business*, *market*, *sale*, *management*, *strategy*, *optimization*, *cost*, *resource*, and *profit*. As mentioned, this topic is dedicated to managerial and operational aspects of e-commerce, including cost optimization, logistics, and strategic decision-making. Additionally, the focus of some of the papers included in this topic is on value creation and efficiency, further supported by the occurrence of the key terms *profit*, *optimization*, *management*, and *strategy*. Also, it can be stated that this topic indicates a strong thematic uniqueness and a good separation from the previous two topics, even though there are terms—such as *platform* and *analysis*—that appear in all the identified topics. This small overlap in the terms among the three identified topics can be put in connection with shared methods and general vocabulary used for applications solving in the selected papers.

Based on LDA, a tripartite structure of research topics emerges: Topic 1—User Behavior and Experience in E-Commerce, Topic 2—Blockchain and Security in E-Commerce Supply Chains, and Topic 3—Business and Management Perspectives on E-Commerce.

By comparing the results with the ones obtained in the thematic map in Figure 23, it can be noticed that Topic 1 matches one of the topics listed as motor themes, namely the one depicted in purple, characterized by keywords such as *artificial intelligence*, *consumer behavior*, and *e-commerce*. Topic 2 can be put in connection with both basic and motor themes, due to the occurrence of similar keywords, such as *blockchain*, *privacy*, *authentication*, and *platform*, while Topic 3 gravitates around elements from motor themes identified in Figure 23.

In terms of BERTopic, the results in Figure 28 have been obtained. Thus, four topics are identified (represented by circles), and the most salient words have been extracted for each of them. Figure 29 provides an insight into the top 5 keywords associated with each topic, the red colored circles representing the considered topic in each case. With all these,

in order to better characterize the extracted topics, the top 10 keywords have been used, which are discussed in the following.



Figure 28. Topics map through BERTopic.

The first topic, identified as Topic 0, deals with elements related to the use of machine learning models and deep learning techniques for analyzing customer behavior, product features, and data patterns, being characterized by keywords such as *model*, *learning*, *data*, *deep*, *machine*, *deep learning*, *analysis*, *product*, and *customer*. By comparing the characteristics of this theme with the results obtained through LDA and thematic maps based on the author's keywords, it can be observed that Topic 0 matches elements from LDA Topic 1, as well as some of the basic themes regarding the use of ML, DL, and data, thus further supporting the results obtained through the bibliometric analysis conducted on the extracted dataset.

Topic 1 in BERTopic features a series of keywords such as *blockchain*, *technology*, *blockchain technology*, *chain*, *supply*, *platform*, *traceability*, and *information*, which supports the belongingness of this theme with the papers dealing with the application of blockchain in enhancing transparency, traceability, and trust in e-commerce supply chains. In terms of connectedness with the results obtained through LDA and thematic maps based on author's keywords, it can be observed that Topic 1 in BERTopic clearly matches LDA Topic 2, as well as elements related to motor themes in thematic maps based on author's keywords, namely the ones related to *blockchain*, *privacy*, and *electronic commerce*, as well as basic themes, the ones related to *e-commerce platforms* and *authentication*.

Topic 2 in BERTopic features keywords such as *logistics*, *internet*, *things*, *internet of things*, *distribution*, *supply chain*, which highlights that the papers associated with this topic are dealing with the role of IoT (Internet of Things) in optimizing logistics and supply chain distribution systems within e-commerce. This topic can be connected with both LDA Topic 2 and LDA Topic 3 through the focus of the applications, namely *logistics* and *supply*

chain, and with basic themes in thematic map based on author's keywords through the methodology used, relying on the *Internet of Things*.

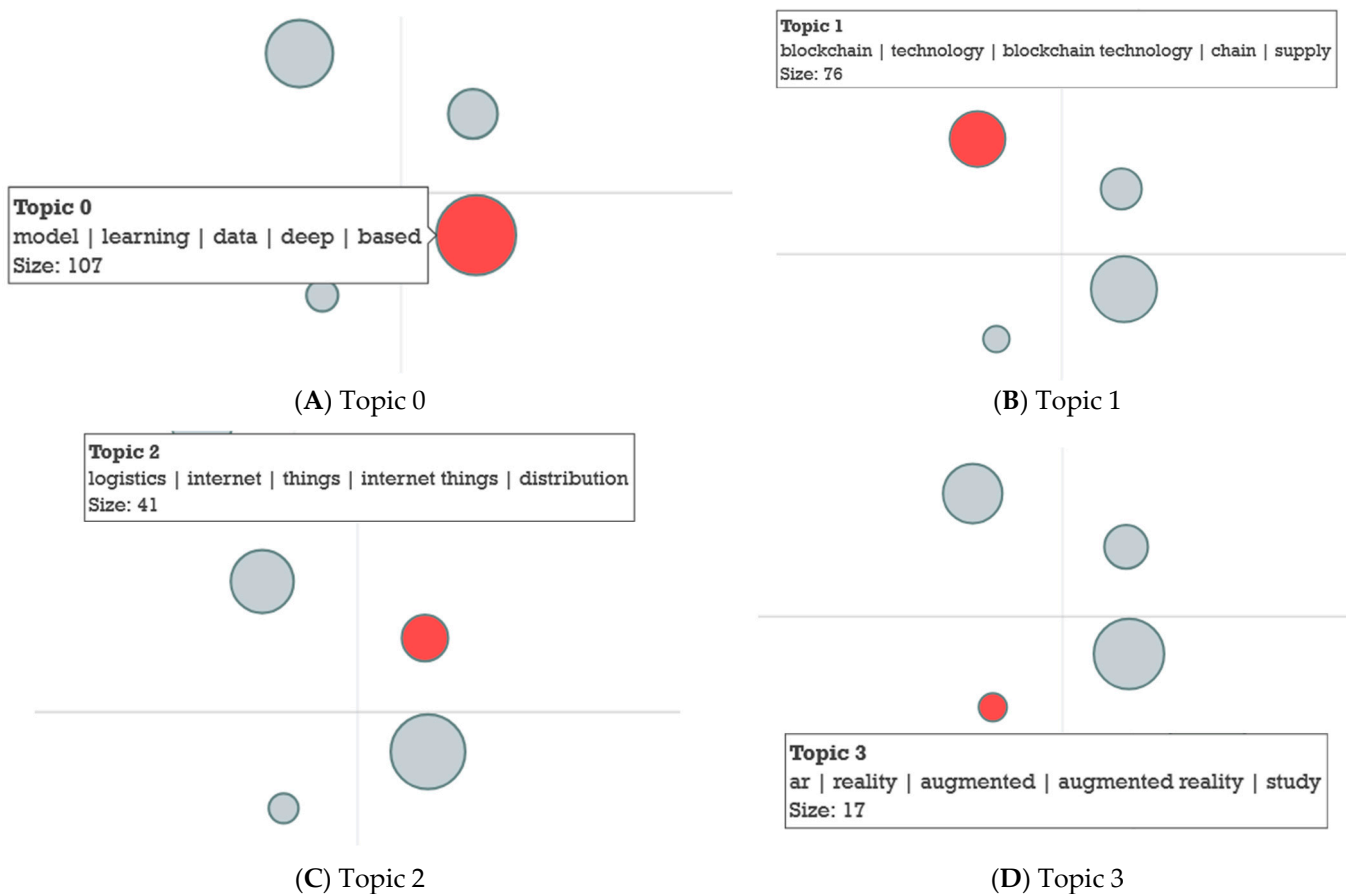


Figure 29. BERTopic composition.

The last topic in BERTopic, Topic 3, is characterized by keywords such as *augmented reality*, *ar*, *product*, *consumers*, *intention*, and *study*. This topic explores the way through which the augmented reality is used to enhance product visualization, affect consumer intention, and personalize shopping experiences. Comparing with the results of LDA and thematic map based on author's keywords, it can be mentioned that BERTopic 3 contains a part of the papers associated with LDA Topic 1, namely the part related to customer intention, while in terms of thematic maps based on the author's keywords, it matches themes in the emerging and basic themes areas.

Through the above considerations, it can be observed that the four identified BERTopics refer to the following: Topic 0—Machine Learning and Customer Analytics, Topic 1—Blockchain Applications in Supply Chains, Topic 2—IoT and Logistics in E-Commerce, and Topic 3—Augmented Reality and Consumer Engagement.

Considering the BERTopics, it can be observed a clear differentiation between the methods used in the e-commerce studies, as each of the topics gravitates around one of the elements associated with AI and emerging technologies.

Comparing the results of the three analyses, BERTopic, LDA, and thematic map, it can be stated that the connection between the results is visible, and it reinforces the research directions considered by the authors in this field.

As a result, it can be observed a prominence of the clusters that combine blockchain and IoT, which can be put in connection with prior work on technology adoption in supply chains, where integrated solutions offer both operational and trust-enhancing benefits.

One can refer to the Technological–Organizational–External (TOE) framework, which can enhance e-commerce adoption, as shown in the scientific literature [113–115].

Furthermore, cross-comparing the clusters associated with the topics revealed through the LDA and BERTopic analyses provided above can reveal several intersections. For example, the LDA Topic 1—User Behavior and Experience in E-Commerce can be connected with BERTopic 0-Machine Learning and Customer Analytics and BERTopic 3-Augmented Reality and Consumer Engagement due to their focus on understanding and influencing the consumers' behavior in the context of e-commerce through both data-driven analytics and immersive AR experiences. Also, it can be observed a strong thematic map between the LDA Topic 2—Blockchain and Security in E-Commerce Supply Chains and BERTopic 1-Blockchain Applications in Supply Chains, as both of them focus on blockchain integration for transparency, trust, and security in supply chain contexts. Nevertheless, the LDA Topic 3—Business and Management Perspectives on E-Commerce can be put in connection with BERTopic 2-IoT and Logistics in E-Commerce, as both refer to business-related issues that can be addressed through advancements in emerging technologies.

3.5. Mixed Analysis

This last section aims to discuss mixed analysis and investigate the relationship between multiple categories, more specifically countries, authors, journals, affiliations, and keywords, with the intent of highlighting hidden details and interesting aspects and providing a better comprehension of the domain.

Figure 30 depicts a three-fields plot focused on the connection between countries (left), authors (middle), and journals (right). By quickly analyzing this representation, some useful aspects become visible.

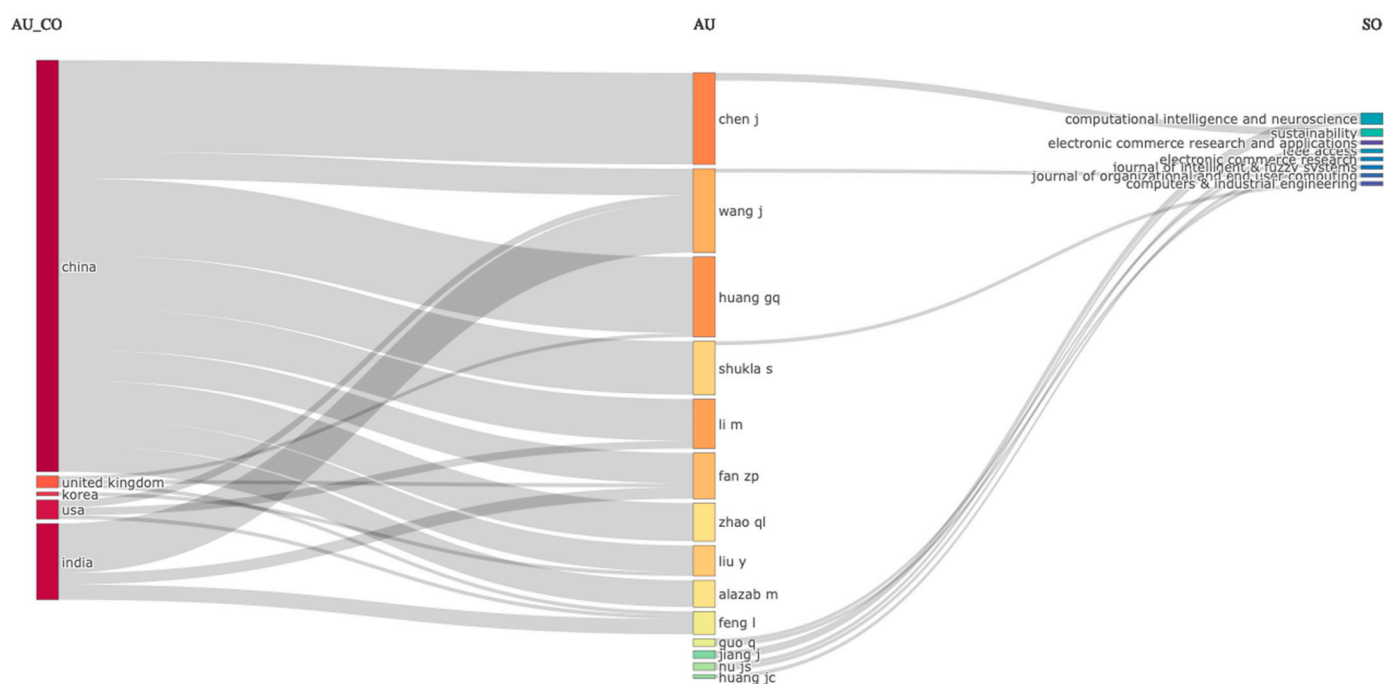


Figure 30. Three-fields plot: countries (left), authors (middle), journals (right).

China is situated in first place when discussing authors' countries of origin, followed by India and the USA. This further proves the findings presented in the above subsections.

Based on the number of published manuscripts written around the area of electronic commerce and emerging technologies, the first positions in the top are occupied by Chen J. and Wang J.

The authors' most preferred sources for articles' publication in the domain under research are closely linked to technology and electronic commerce: *Computational Intelligence and Neuroscience*, *Sustainability*, *Electronic Commerce Research and Applications*, *IEEE Access*, *Electronic Commerce Research*, *Journal of Intelligent & Fuzzy Systems*, *Journal of Organizational and End User Computing*, and *Computers & Industrial Engineering*.

It is also noticed the substantial degree of collaboration between authors, observing a significant cultural diversity among written works. In other words, the research conducted in various papers is based on the collaborations between scientists from all over the world.

Furthermore, the authors tend to publish their papers in different journals rather than focusing on a particular one.

The second three-field plot is presented in Figure 31, this time having in the center of attention the connection between the other three categories, namely: affiliations (left), authors (middle), and keywords (right). The University of Hong Kong is the one that had the most substantial contribution in publishing papers related to electronic commerce and emerging technologies, and as previously stated, the most involved authors are Chen J. and Wang J.

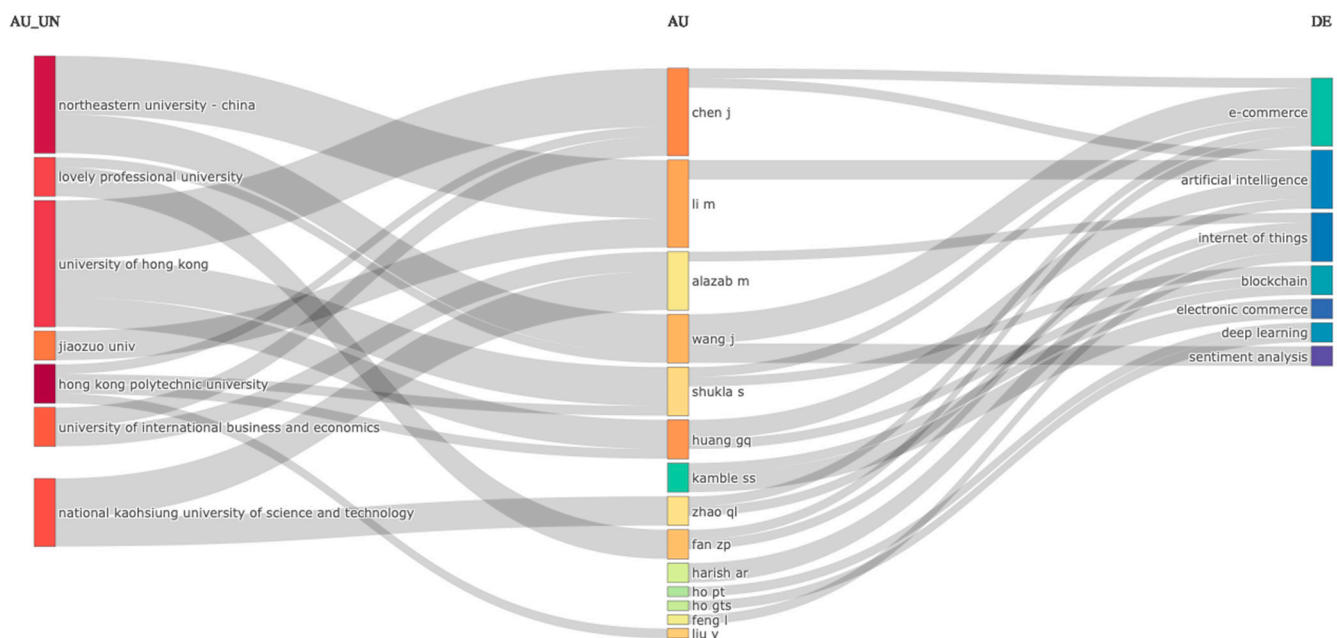


Figure 31. Three-fields plot: affiliations (left), authors (middle), keywords (right).

The keywords with the greatest number of occurrences within the data collection set are as follows: “e-commerce”, “artificial intelligence”, “internet of things”, and “blockchain”.

Going further with the investigation, another interesting aspect is exposed. There are authors linked to multiple universities, and on the other hand, one can notice academics that are not connected to any of the affiliations listed in the illustration.

4. Discussion

This section's main purpose is to focus on all the insights and information uncovered in the previous chapter, where the bibliometric investigation was conducted.

As previously stated, the manuscript aims to offer to the scientific community an analysis around a cutting-edge field from our modern digital world, more specifically the electronic commerce exploration using emerging technologies. The high relevance of the domain, together with the increased academics' involvement and interest, is further supported by the value obtained for annual growth rate—44.65%.

Guided by this desire, the research followed some predefined steps for the collection of a comprehensive and relevant dataset. We opted to use the Web of Science database, where multiple filters were applied. The search of specific keywords related to both electronic commerce and emerging technologies in titles (“e-commerce”, “electronic commerce”, “artificial intelligence”, “machine learning”, “blockchain”, “Internet of Thing”, “emerging technology”, “deep learning”, “distributed ledger technology”, “augmented reality”), language limitation to English, document type restriction (only documents marked as articles were considered), exclusion of the papers having 2025 marked as the year of publication, and removal of retracted papers.

The final dataset included 260 papers, published in 140 sources, within a long period of time, more precisely, 21 years (2004–2025). These articles were analyzed in detail through various perspectives with the help of Biblioshiny, VOSviewer, and CiteSpace, which assisted the authors in the creation of graphs, tables, and figures.

The bibliometric investigation was divided into five distinct facets, listed in the following order: dataset overview, source analysis, author analysis, paper analysis, and finally, mixed analysis. Each section includes diverse visual representations (e.g., scientific production based on countries, country collaboration map, word clouds, co-occurrence network, etc.), multiple hierarchies (e.g., the most cited countries, most prolific authors, most relevant affiliations, etc.), and provides the interpretation of various metrics (e.g., H-index, average years from publications, collaboration index, etc.).

In the next sub-section, there will be provided answers to the questions highlighted in the Introduction, summarizing the key details obtained in this bibliometric analysis, while in the second sub-section, a discussion is provided with regard to the main directions highlighted by analyzing the papers included in the dataset, doubled by discussing some representative papers for each identified direction.

4.1. Summary of the Bibliometric Analysis and Top 10 Most Cited Papers

The most relevant sources in the field of electronic commerce and emerging technologies are *Mobile Information Systems* and *Sustainability*, both with six papers. The authority and substantial impact of a journal are directly influenced by the number of academics that choose to publish their work in it. At the same time, the most important proof of a source’s significance is represented by its presence among the first places in the hierarchies found in various bibliometric studies, conducted around distinct topics, published in different periods, by the authors from all over the world, affiliated with diverse universities. By reviewing the existing scientific literature, it was noticed that the papers ranked first in the current bibliometric analysis were also placed in top positions in other bibliometric studies performed by other authors, addressing varied subjects: sentiment analysis and emotion understanding [116], social media research with natural language processing [74], renewable energy communities [100], agent-based modeling [40], and construction risks [39].

Furthermore, the *Sustainability* journal occupies the first position in the top for the H-index indicator, being also placed in Zone 1 according to Bradford’s law on source clustering. This demonstrates again its influential position and high productivity within the scientific community.

After conducting the authors’ analysis, it was observed that the most relevant scientists with respect to the number of published documents are Chen J and Huang GQ, each contributing to the scientific literature with five manuscripts that address a topic around electronic commerce and emerging technologies.

Regarding the authors’ production over time, it was discovered that the interest in publishing papers within this domain became more pronounced starting with the year 2019, due to the evolution of technology and the transition to digital environments, probably

also accelerated by the COVID-19 global pandemic. In addition to these details, another remark is that the most productive year was 2024.

Going further with the discussion, the most popular affiliations in the studied domain are Egyptian Knowledge Bank (WKB) and Hong Kong Polytechnic University, each with six articles.

The most relevant corresponding authors' countries are China (156 articles) and India (21 articles), their high involvement in the field of electronic commerce associated with emerging technologies also being proved by the country's scientific production analysis. Apart from the substantial contribution in terms of published papers, those countries were also found among the most cited countries in this area: China—2050 citations, and India—249 citations.

In terms of partnerships, this domain registered a high degree of collaboration, a hypothesis evidenced by the fact that 92.9% of the scientists preferred to collaborate in writing their papers with both authors from their home origin and from other places around the world. According to the country collaboration map, it is observed that the largest number of collaborations was registered by China, which had partnerships with no less than 22 countries, including the USA, India, Korea, and Australia.

The high involvement recorded by China and India is also noticed in other bibliometric studies found in the scientific literature around diverse topics: sentiment analysis and COVID-19 [117], fake news and machine learning [118], eco-innovation and sustainable development [69], and travel and tourism marketing [54].

The analysis of the top 10 most cited papers exposed some key insights and helped in offering a better understanding of this research domain. All the manuscripts are discussing electronic commerce platforms, focusing on the effects generated by the integration of cutting-edge technologies (blockchain, augmented reality, artificial intelligence, and the Internet of Things) compared to traditional approaches. The authors demonstrate the effectiveness of these powerful algorithms and the high necessity of implementing them in e-commerce platforms by using real datasets gathered from globally recognized companies (e.g., Alibaba and IKEA), clients' reviews, or even surveys addressed to different categories of people (e.g., students and managers). While some scientists focused on conducting comparative studies, others proposed novel analysis models (e.g., S2SCL and IoT-MTDPS) intended to improve and optimize the e-commerce platforms and logistics operations, helpful for understanding the users' needs, developing enhanced strategies, implementing customized solutions, increasing the sales, etc.

The following examination performed on the dataset was the words' analysis. According to this, some hidden details were highlighted: the papers were oriented to exploring the use of modern technologies in electronic commerce platforms, focusing on the way in which these advanced algorithms can influence their evolution, increase their security, and improve clients' satisfaction and preferences.

These aspects are further proved by thematic maps that uncovered the main topics approached in the following manuscripts: "e-commerce", "blockchain", "authentication", "augmented reality", "online shopping", and "privacy" etc.

4.2. Research Directions

Considering the papers included in the dataset, a series of research directions can be highlighted, as discussed in the following. The directions have been grouped based on the specific aspects of e-commerce identified in the papers, while the discussion emphasizes the use of emerging technologies.

4.2.1. E-Commerce Supply Chain Management

In the area of e-commerce supply chain management, it has been observed that the use of emerging technologies has facilitated the security, efficiency, and transparency of the processes. Each of the well-known emerging technologies has brought its contribution.

For example, blockchain has been used in optimizing and improving the performance of the e-commerce supply chain in the area of fresh food [119], in measuring the supply chain performance [120] ensuring the traceability in the case of cold chain supply chain [121], or in improving supply chain coordination [122].

AI has been used in the area of predictive modeling, with results in sales forecasting and marketing improvement [120,123] and in inventory prediction [122], while together with IoT, has been employed for optimizing supply chain operations [123]. Furthermore, IoT has been used for supply chain process optimization [124] and in creating an embedded sustainable supply chain in the textile industry [125], while together with blockchain, has been employed in providing sustainable and efficient closed-loop supply chains [126].

4.2.2. E-Commerce Logistics and Delivery Optimization

In terms of logistics and delivery optimization through the use of emerging technologies, a series of papers have addressed the issue of employing IoT in various areas related to e-commerce, such as, but not limited to, developing a multi-temperature delivery planning system for optimizing logistics operations in perishable food e-commerce [93], proposing an IoT-enabled logistics cloud platform to improve e-commerce distribution efficiency [127], and proposing an e-commerce logistic system based on intelligent tracking [128].

Furthermore, in combination with AI, IoT has been used for enhancing logistics distribution paths in cross-border e-commerce [129] and in node layout optimization [130], while AI as a standalone emerging technology has been used in examining its effects in improving logistics efficiency [131] and in logistics operation enhancements and distribution network optimization in the case of cross-border e-commerce [132].

4.2.3. E-Commerce Platform Trust and Consumer Experience

Emerging technologies such as blockchain improve trust in e-commerce platform use through secure transactions and authentication mechanisms, which contribute to the avoidance of information disclosure risk, significantly improving the users' service experience [87,94,128]. Also, blockchain serves a similar purpose in the case of platforms designed for small and medium enterprises, representing a useful means to address security and trust issues [75,129]. Treblmaier and Sillaber [7] further discuss the impact of blockchain on e-commerce, putting an emphasis on the consumer issues.

Also, augmented reality has served as a means to improve the e-commerce experience from the customers' point of view. Kim et al. [130] highlighted the importance of augmented reality-based product display in comparison with a picture-based product display, noting that the former generates greater vividness and interactivity and enhances the website quality from the consumer's perspective. The positive role of augmented reality in consumers' engagement and interactive shopping experiences is further emphasized in various studies, both in general [131–133] and in particular when focusing on specific areas such as beauty and fashion products [12].

5. Limitations

This section aims to discuss the main limitations found in the paper and to offer an objective perspective on the work performed.

For the investigation, 260 English documents marked as 'article', published within a relatively large timestamp, namely 2004–2024, were selected and analyzed.

The dataset was selected exclusively from the Web of Science database and included only the papers related to both electronic commerce and emerging technologies. The first limitation that arises here is associated with the decision to use a sole database for dataset extraction, rather than using multiple sources, such as Scopus or even IEEE. As also mentioned in the first pages of the manuscript, the authors opted for this alternative, having in mind arguments based on other research in the scientific literature. The Web of Science database is a widely used and up-to-date database that includes a huge collection of works written around numerous domains, representing a preferred choice for most of the authors that conduct bibliometric investigations. Its intuitive interface eases the academics' work, while the possibility of importing raw files directly into Biblioshiny, VOSviewer, and CiteSpace facilitates the entire process of the manuscript's creation.

Furthermore, this bibliometric investigation involves some individual analyses shaped with respect to the number of citations (e.g., the most cited countries/papers, etc.). For instance, Table 13 was created to highlight the discrepancy between citations for the top 10 reviewed papers, considering some popular databases. It is clearly visible that the combination of data from multiple sources would have introduced certain challenges and confusion in shaping the mentioned hierarchies. One might wonder at this point what the actual relevance of a specific scientific paper is and which number of citations should be allocated to it.

Table 13. Example of various numbers of citations based on the selected databases.

Paper	Number of Citations in Various Databases		
	ISI WoS (Used in Present Manuscript)	Scopus	IEEE
Yim et al. [101]	476	-	-
Liu et al. [102]	177	305	-
Yang et al. [103]	174	439	394
Kowalczuk et al. [104]	135	236	-
Zhang et al. [105]	98	167	-
Ren et al. [106]	88	125	-
Lahkani et al. [107]	86	142	-
Moriuchi et al. [108]	81	138	-
Chandra et al. [109]	79	157	-
Tsang et al. [110]	77	106	-

Based on the analysis of the top 10 most cited papers, it has been observed that only the paper belonging to Yang et al. [103] is present in all three databases, but a visible discrepancy among the number of citations in each of these databases can be observed: 174 citations in ISI WoS, 439 citations in Scopus, and 394 citations in IEEE.

Another remark is that IEEE contains a more limited set of articles, more specifically only the publications affiliated with it (1 out of 10 manuscripts from the top 10 most cited papers), while Scopus reflects greater completeness and diversity in terms of included academic contributions (9 out of 10 papers from the ranking). This proves once again the substantial coverage of scientific literature in the case of the ISI WoS database.

While ISI WoS has comprehensive coverage across disciplines and is widely adopted in bibliometric research, we acknowledge the limitations derived from not using IEEE and Scopus databases, which might be more oriented towards technology-oriented works. With all these, an additional argument that further supports the decision of selecting the data exclusively from WoS should be mentioned, and it is associated with the Keywords Plus

analysis. This type of investigation is provided only by ISI WoS, while the other databases (Scopus, IEEE) do not support it. Relevant examinations such as thematic maps, word clouds, and three-field plots would not have been possible without a close examination of the Keywords Plus.

This limitation is acknowledged, but it was considered the optimal solution for avoiding challenges in building the hierarchies based on the number of citations, for instance, or even misinterpretation of the results. Additionally, it must be specified here that Biblioshiny is intended to operate with a single database at a time. The competitors are not underestimated, and future researchers are encouraged to conduct similar studies in this area, using datasets from Scopus or IEEE or trying to create an appropriate dataset with the papers collected from multiple sources.

The second limitation of this work is associated with the first exploratory step depicted in Table 2, more specifically, the search of certain keywords in titles of the papers related to both electronic commerce and emerging technologies. Even if this search is crucial for obtaining a relevant dataset for the investigation, certain papers may have been excluded due to the lack of consideration for all terms or differences in terminology.

Another limitation can be represented by the language exclusion criterion. In the dataset, the authors decided to include only the English-written papers, considering that most of the academics and target readers of this manuscript understand this global language. Even if the dataset was not very affected by this rule, some papers with relevant content may have been ignored from the analysis.

Document type criterion is also a limitation that generated a consistent decrease in the data collection set. Only the documents marked as 'articles' in the Web of Science database were included in the analysis, a fact that may have led to the loss of some relevant work that might slightly affect the conclusions of this research.

Another limitation is related to the time span. As 2025 was ongoing at the time of the analysis, the year has been excluded from the analysis, as its inclusion would have altered the results of some of the analyses. For example, if the dataset extraction had been performed in August 2025 and had included the papers indexed in ISI WoS up to this date (excluding the retracted papers), a total number of 322 papers would have been included in the dataset. From these 322 papers, 321 papers are associated with the 2004–2025 period and 1 paper with 2026. Considering the dataset made by 322 papers and determining the annual growth rate, a value of 0% would have resulted due to the 1 paper published in 2026. Furthermore, by considering only the 321 papers published and indexed in ISI WoS prior to August 2025, the annual growth rate would have been 39.43%, smaller than the one recorded in the paper when only the period before 2025 has been considered, namely 44.65%, as the small number of papers published and indexed in ISI WoS in 2025 would have negatively affected this rate, as the 2025 year is not completed yet. Also, the average citations per year per document indicator value would have dropped unjustifiably due to the 2025-year inclusion from 3.753 to 3.549.

The last limitation that should be mentioned here is related to the removal of 30 retracted papers from the dataset. The authors started from the premise that certain mistakes or errors were noticed in these papers, which is why they considered that it would be better to exclude them from the analysis at the moment of writing this article so as not to affect the validity of the results.

Having all these in mind, the listing of these limitations was not supposed to highlight the drawbacks of this paper but to present in an objective manner the way the present analysis was conducted and to provide the necessary details for future researchers that want to extend further this study. The domain of electronic commerce associated with

emerging technologies is a topic of high interest in today's era and should be treated with priority not only by academics but by authorities too.

6. Conclusions

Considering all the details exposed in the previous sections, the current bibliometric investigation aims to contribute to the scientific community with a work conducted around a topic of high importance in our digital world: electronic commerce platforms and their integration with cutting-edge technologies.

The latest technologies, such as blockchain, artificial intelligence, augmented reality, and IoT, have significant effects on e-commerce platforms. These technologies improve the e-commerce platforms effectiveness, solve the security issues, better protect the personal data, optimize key processes, and enhance users' experience and loyalty by adapting to their needs and desires and by offering personalized solutions.

In this bibliometric investigation, the data was collected exclusively from the Web of Science database, according to some predefined filters (the presence of specific keywords in papers' titles, language, document type, year of publication, etc.). The 260 selected manuscripts, published within a period of 21 years (2004–2024), in 140 distinct sources, were analyzed in depth with the help of Biblioshiny, VOSviewer, and CiteSpace through multiple facets: dataset overview, sources, authors, papers, and mixed analysis.

The investigation revealed that the domain registered an annual growth rate of 44.65%, suggesting its high interest and relevance within the scientific community.

The hierarchies were created with respect to the number of published papers in the field of electronic commerce combined with the use of emerging technologies, highlighting the following findings:

- The most relevant sources are *Mobile Information Systems*, and *Sustainability*, both with six papers.
- The most productive authors are Chen J. and Huang G.Q., each contributing to the scientific community with five articles.
- The most popular affiliations are Egyptian Knowledge Bank (WKB) and Hong Kong Polytechnic University, both with six papers.
- The most significant corresponding authors' countries are China (156 articles) and India (21 articles).

Furthermore, it was noticed a high degree of collaboration among the authors, including both national and international partnerships.

The analysis of the top 10 most cited papers offered an overview of the main aspects discussed and the topics addressed. The manuscripts are oriented to the exploration of emerging technologies (blockchain, augmented reality, artificial intelligence, and the Internet of Things) and their integration in electronic commerce platforms. Some of the authors performed comparative studies, while others proposed and proved the efficiency of some modern analysis models on optimizing platforms and logistics operations, together with understanding the users' needs and increasing their satisfaction. The datasets used were collected from multiple places (companies' data, surveys, reviews, etc.). Each article provided interesting results and highlighted future research directives.

Some key themes addressed in this area are unmasked by thematic maps and listed as follows: "e-commerce", "blockchain", "authentication", "augmented reality", "online shopping", and "privacy" etc.

Based on the analysis conducted in the paper, some practical implications for firms can be highlighted, and these are related to ensuring the integration of multiple technologies into business. As observed from the cluster analysis, some technologies benefit from potential synergies, such as AI and AR for front-end engagement and blockchain and IoT

for back-end transparency. Furthermore, with the advancement of ML, firms could focus more on using real-time personalization engines that better match the customers' needs and expectations when recommending a certain product.

Moreover, due to the new trends related to sustainability in supply chains, the blockchain and IoT frameworks can enhance traceability, which can be helpful, especially in the case of the customers highly interested in these aspects.

From a policy point of view, advancements can be made in the area of data protection and interoperability, as well as preserving consumers rights in immersive commerce and encouraging the development of innovative ecosystems with the help of emerging technologies.

In terms of future research directions, given the observed multi-technology adoption pathways, one can focus on how the introduction of multiple emerging technologies can shape the adoption of e-commerce. Also, studies could focus on the value added by adding new emerging technologies into various aspects of e-commerce at the firm level in order to offer a better experience to the customers, increase their retention, offer a secure environment, and increase supply chain resilience.

Having all this mentioned, the present study can represent a precious contribution to the scientific community. The main desire was to offer a comprehensive overview of the domain, discuss the most relevant aspects, understand the current trends, and lay the basis for future research directives. The results are of high importance for the existing knowledge's advancement, as they offer a systematic overview of the field, highlight the evolution of the domain within the scientific community over time, identify important contributions, key areas of interest, gaps, unexplored topics, research boundaries, challenges, and even insights related to the domain's evolution and growth. This study will assist future researchers interested in this sector in having a stronger perspective of the domain, further expanding the field, and enhancing the overall understanding of the connection between emerging technologies and electronic commerce. Apart from these, scientists can identify the most influential journals, institutions, possible collaboration with other involved countries in the sector, and choose the optimal methodologies after exploring the top papers in the domain.

The studies' findings are not beneficial only for the academic community, as they can provide actionable insights for stakeholders as well.

For instance, once the practitioners trust the advanced techniques and become aware of the high impact that cutting-edge technologies have on companies' evolution, relevant improvements in cross-border e-commerce logistics, new opportunities, increased security, data accuracy, future market directions, along with new opportunities, will become visible.

For policymakers, this type of research is truly important in understanding the gaps in public investment, identifying the current barriers, achieving insights about the needed resources, guiding international partnerships, improving strategies, policies, and adapting them based on priorities and research trends uncovered in bibliometric studies.

To conclude, the findings presented in this paper should be considered by academics, authorities, and companies involved in this domain of high importance. As technology advances rapidly, the domain requires continuous investigation. There is a crucial need to continuously adopt new strategies in order to ensure a safe and efficient shopping experience, gain customers' trust and loyalty, and constantly adapt to their needs and expectations.

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L.-A.C., C.I., I.-D.C., and C.D.; Writing—original draft, A.S. and C.D.; Writing—review and editing, L.-A.C., C.I., and I.-D.C. All authors have read and agreed to the published version of the manuscript.

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