


ARTIFICIAL INTELLIGENCE APPLICATIONS IN E-COMMERCE: A BIBLIOMETRIC STUDY FROM 1995 TO 2023 USING MERGED DATA SOURCES

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ARTICLE INFO	ABSTRACT
<p>Article history: Received: January, 02nd 2023 Accepted: March, 20th 2024</p>	<p>Purpose: The aim of this study is to conduct a comprehensive review of scientific articles concerning artificial intelligence (AI) applications in electronic commerce through bibliometric analysis.</p>
<p>Keywords: E-commerce; Artificial Intelligence; Bibliometric Analysis; R Software; Biblioshiny; Scopus and Web of Science.</p>	<p>Theoretical Framework: The current study utilized both the SCOPUS and Web of Science (WoS) databases to enrich the analysis with a wider selection of papers in the field, incorporating an examination of the most cited documents.</p>
	<p>Design/Methodology/Approach: The dataset for analysis was selected according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, integrating data from Scopus and WoS through R software, specifically using the biblioshiny library. It includes 8372 papers published from 1995 to 2023. This study's data analysis used two approaches: descriptive analysis to examine the data quantitatively and scientific mapping to explore the intellectual and social structures within the dataset.</p>
	<p>Findings: The results reveal significant trends in the application of artificial intelligence in e-commerce, highlighting the rapid growth of interest in this area over the last decade. China emerges as the country with the highest number of citations, with ZHANG Y identified as the most relevant author and HU M as the most cited author. Furthermore, the study identifies prevalent keywords used by the authors, including sentiment analysis and recommendation systems.</p>
	<p>Research, Practical & Social Implications: This study underscores the transformative potential of AI in enhancing e-commerce practices, offering insights for both academic researchers and industry professionals by providing valuable perspectives on current trends and contributions.</p>
	<p>Originality/Value: The value of the study lies in its comprehensive bibliometric approach, which integrates two major databases to explore AI's applications in e-commerce. This deviation from previous reviews, which often rely on a single database, provides a deeper understanding of the current landscape and future directions in this field.</p>
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APLICAÇÕES DE INTELIGÊNCIA ARTIFICIAL NO COMÉRCIO ELETRÔNICO: UM ESTUDO BIBLIOMÉTRICO DE 1995 A 2023 UTILIZANDO FONTES DE DADOS INTEGRADAS

RESUMO

Objetivo: O objetivo deste estudo é realizar uma revisão abrangente de artigos científicos sobre as aplicações de inteligência artificial (IA) no comércio eletrônico por meio de análise bibliométrica.

Referencial Teórico: O estudo atual utilizou tanto as bases de dados SCOPUS quanto Web of Science (WoS) para enriquecer a análise com uma seleção mais ampla de artigos no campo, incorporando um exame dos documentos mais citados.

Desenho/Metodologia/Abordagem: O conjunto de dados para análise foi selecionado de acordo com o framework PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), integrando dados do Scopus e WoS por meio do software R, especificamente utilizando a biblioteca biblioshiny, e inclui 8372 artigos publicados de 1995 a 2023. A análise de dados deste estudo utilizou duas abordagens: análise descritiva para examinar os dados quantitativamente e mapeamento científico para explorar as estruturas intelectuais e sociais dentro do conjunto de dados.

Resultados: Os resultados revelam tendências significativas na aplicação da inteligência artificial no comércio eletrônico, destacando o rápido crescimento do interesse nesta área ao longo da última década. A China emerge como o país com o maior número de citações, com ZHANG Y identificado como o autor mais relevante e HU M como o autor mais citado. Além disso, o estudo identifica palavras-chave prevalentes usadas pelos autores, incluindo análise de sentimento e sistemas de recomendação.

Pesquisa, Implicações Práticas e Sociais: Este estudo destaca o potencial transformador da IA em aprimorar práticas de comércio eletrônico, oferecendo insights tanto para pesquisadores acadêmicos quanto profissionais da indústria, fornecendo perspectivas valiosas sobre tendências atuais e contribuições.

Originalidade/Valor: O valor do estudo reside em sua abordagem bibliométrica abrangente, que integra duas bases de dados principais para explorar as aplicações da IA no comércio eletrônico. Esta divergência das revisões anteriores, que frequentemente se baseiam em uma única base de dados, proporciona uma compreensão mais profunda do cenário atual e das direções futuras neste campo.

Palavras-chave: Comércio Eletrônico, Inteligência Artificial, Análise Bibliométrica, Software R, Biblioshiny, Scopus e Web of Science.

APLICACIONES DE INTELIGENCIA ARTIFICIAL EN EL COMERCIO ELECTRÓNICO: UN ESTUDIO BIBLIOMÉTRICO DE 1995 A 2023 UTILIZANDO FUENTES DE DATOS FUSIONADAS

RESUMEN

Propósito: El objetivo de este estudio es realizar una revisión exhaustiva de artículos científicos sobre las aplicaciones de la inteligencia artificial (IA) en el comercio electrónico a través de análisis bibliométrico.

Marco Teórico: El estudio actual utilizó tanto las bases de datos SCOPUS como Web of Science (WoS) para enriquecer el análisis con una selección más amplia de artículos en el campo, incorporando un examen de los documentos más citados.

Metodología: El conjunto de datos para el análisis fue seleccionado de acuerdo con el marco PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), integrando datos de Scopus y WoS a través del software R, específicamente utilizando la biblioteca biblioshiny, e incluye 8372 artículos publicados desde 1995 hasta 2023. El análisis de datos de este estudio utilizó dos enfoques: análisis descriptivo para examinar los datos cuantitativamente y mapeo científico para explorar las estructuras intelectuales y sociales dentro del conjunto de datos.

Conclusiones: Los resultados revelan tendencias significativas en la aplicación de la inteligencia artificial en el comercio electrónico, destacando el rápido crecimiento del interés en esta área durante la última década. China emerge como el país con el mayor número de citas, con ZHANG Y identificado como el autor más relevante y HU M como el autor más citado. Además, el estudio identifica palabras clave prevalentes utilizadas por los autores, incluyendo análisis de sentimientos y sistemas de recomendación.

Implicaciones de la Investigación: Este estudio subraya el potencial transformador de la IA en mejorar las prácticas de comercio electrónico, ofreciendo ideas tanto para investigadores académicos como profesionales de la industria, proporcionando perspectivas valiosas sobre tendencias actuales y contribuciones.

Originalidad/Valor: El valor del estudio radica en su enfoque bibliométrico exhaustivo, que integra dos bases de datos principales para explorar las aplicaciones de la IA en el comercio electrónico. Esta desviación de revisiones anteriores, que a menudo se basan en una sola base de datos, proporciona una comprensión más profunda del panorama actual y las direcciones futuras en este campo.

Palabras clave: Comercio Electrónico, Inteligencia Artificial, Análisis Bibliométrico, Software R, Biblioshiny, Scopus y Web of Science.

1 INTRODUCTION

The internet revolution has increased the significance and the prevalence of electronic commerce (e-commerce), enabling businesses to effectively connect with consumers worldwide through e-commerce platforms (Sudirjo, 2023), thereby facilitating the online offering of products and services.

E-commerce, defined as the electronic buying and selling of goods and services (Holsapple & Singh, 2000; Bawack et al., 2022), has transformed the dynamics of global business operations. It includes various models (Purnomo, 2023), such as: Business to Consumer (B2C), where individuals purchase from businesses online; Business to Business (B2B), involving transactions between companies for supply chain or business needs; Consumer to Consumer (C2C), where individuals sell goods or services directly to each other without company mediation; Consumer to Business (C2B), allowing consumers to offer products or services to companies; and Business to Government (B2G), describing company transactions with government agencies for their requirements.

In this rapidly evolving e-commerce landscape, the role of artificial intelligence (AI) has become paramount. This field, originally introduced by John McCarthy, often referred to as the father of AI, is dedicated to creating and applying technologies that replicate human skills such as learning, comprehension, processing natural language, visual perception, speech recognition, decision-making, and translating languages (Pallathadka et al., 2023). These AI capabilities are currently leading the charge in innovating the e-commerce sector, focusing on the development of smart computer programs that not only automate complicated tasks but also provide personalized experiences (Pallathadka et al., 2023).

Through the implementation of AI technologies, businesses are capable of providing customized shopping experiences and recommendations (Tran & Huh, 2023), enhancing consumer engagement and loyalty, and offering continuous assistance through chatbots and virtual assistants (Marjerison et al., 2022). On the operational side, AI refines and optimizes inventory management (Tang et al., 2023), supply chain processes, and predictions of market trends, thereby reducing expenses and increasing efficiency.

Considering the transformative influence of AI in enhancing consumer experiences and optimizing operational efficiencies, the current bibliometrics study aims to explore various aspects related to AI applications in the field of e-commerce. Specifically, it examines the evolution of the concept, identifies influential journals within the field, analyzes the

productivity of authors, investigates the intellectual structure of the research community, identifies highly influential documents, examines significant contributions from different countries, and investigates the international relations in scientific production.

Following this introduction, this study advances to the literature review section, which examines previous researches in the field. The subsequent section on data and methodology explains the data collection process and the analytical framework used for the bibliometric analysis. Then, the results section is presented, which includes a descriptive analysis, an exploration of the intellectual and social structures. The study concludes with the conclusion section, where findings are summarized and the study's limitations are discussed.

2 LITERATURE REVIEW

Bibliometrics analysis studies utilize quantitative methods, including mathematical and statistical approaches, to examine patterns within the previously published literature (Saibaba, 2023). This field has a rich history that dates back several decades. In 1923, Hulme introduced statistical bibliography as a means to understand the history of science and technology by quantitatively analyzing document counts (Osareh, 1996). Building upon this foundation, Pritchard coined a new term in 1969 called “bibliometrics” to replace the earlier concept of statistical bibliography (Osareh, 1996). Concurrently, Nalimov & Mulchenko proposed the term “scientometrics” as an alternative (Osareh, 1996). Pritchard's terminology was widely supported and recognized as the foundation of the term “bibliometrics,” with him being acknowledged as the founder of this term due to the endorsement of numerous researchers (Osareh, 1996). Bibliometric methods enable researchers to base their conclusions from aggregated bibliographic data generated by other scientists in the field (Zupic & Čater, 2015). They aim to examine the links between disciplines, fields of expertise, keywords, documents and authors (Ribeiro et al., 2022). This approach provides valuable information for a better understanding of trends and dynamics in scientific research.

Bibliometrics analysis in the field of e-commerce has been studied in various ways, reflecting the diverse and evolving nature of the field. Kumar et al. (2021) offers a 20-year overview of the field with 516 documents, establishing a foundation for understanding e-commerce's growth. Gecit (2021) focuses on e-commerce during the Covid-19 pandemic, using 345 documents to illustrate the rapid transformation in consumer behavior and business practices. Rita and Ramos (2022) examine consumer behavior and sustainability, and

Arfiansyah et al. (2023) delve into customers' purchase intentions, within the e-commerce sector. Wulfert and Karger, (2022) analyze platform research, with their extensive study comprising 7463 documents reflecting the diversity of e-commerce platforms. AI's impact on e-commerce is detailed by Bawack et al. (2022) and Frioui and Graa (2024), through an analysis of 4335 and 669 documents, respectively. Altarturi et al. (2023) explore the impact of technological advancements in agricultural e-commerce, citing 1298 documents. Saibaba (2023) examines customer loyalty in e-commerce with 505 publications. Finally, Poláček et al. (2024) analyze dynamic pricing strategies within the e-commerce industry.

This study contributes to the existing literature by merging data from Scopus and Web of Science and utilizing various terms related to key aspects of AI and e-commerce to select a large corpus of 8372 documents, providing a comprehensive insight into the application of AI in e-commerce between 1995 and 2023. Table 1 detailed information on selected studies concerning bibliometric analysis within the e-commerce domain.

Table 1

Bibliometric studies in e-commerce: Overview

Article	Field	Databases	Period	N° documents
Kumar et al., 2021	20 years of Electronic Commerce Research	Scopus	2001:2020	516
Gecit, 2021	Electronic Commerce During the Covid-19 Pandemics	Scopus	2020	345
Rita and Ramos, 2022	Consumer behavior and sustainability in E-Commerce	Scopus	2001:2022	104
Wulfert and Karger, 2022	Platforme research in e-commerce	Scopus	1993:2022	7463
Bawack et al., 2022	AI in e-commerce	WoS	1991:2020	4335
Altarturi et al., 2023	Technological advancement applications in agricultural e-commerce	Scopus & WoS	2003:2022	1298
Saibaba, 2023	Customer loyalty in e-commerce	Scopus	1999:2022	505
Arfiansyah et al., 2023	Customers'Purchase Intention in e-commerce	Scopus	2001:2021	1298
Poláček et al., 2024	Dynamic pricing in the e-commerce industry	WoS	2001:2021	135
Frioui and Graa, 2024	Artificial Intelligence in the Scope of E-Commerce: Trends and Progress over the Last Decade	Scopus	2014:2023	669
This study	AI applications in e-commerce	Scopus & Wos	1995:2023	8372

Source: Author's elaboration (2024)

3 DATA AND METHODOLOGY

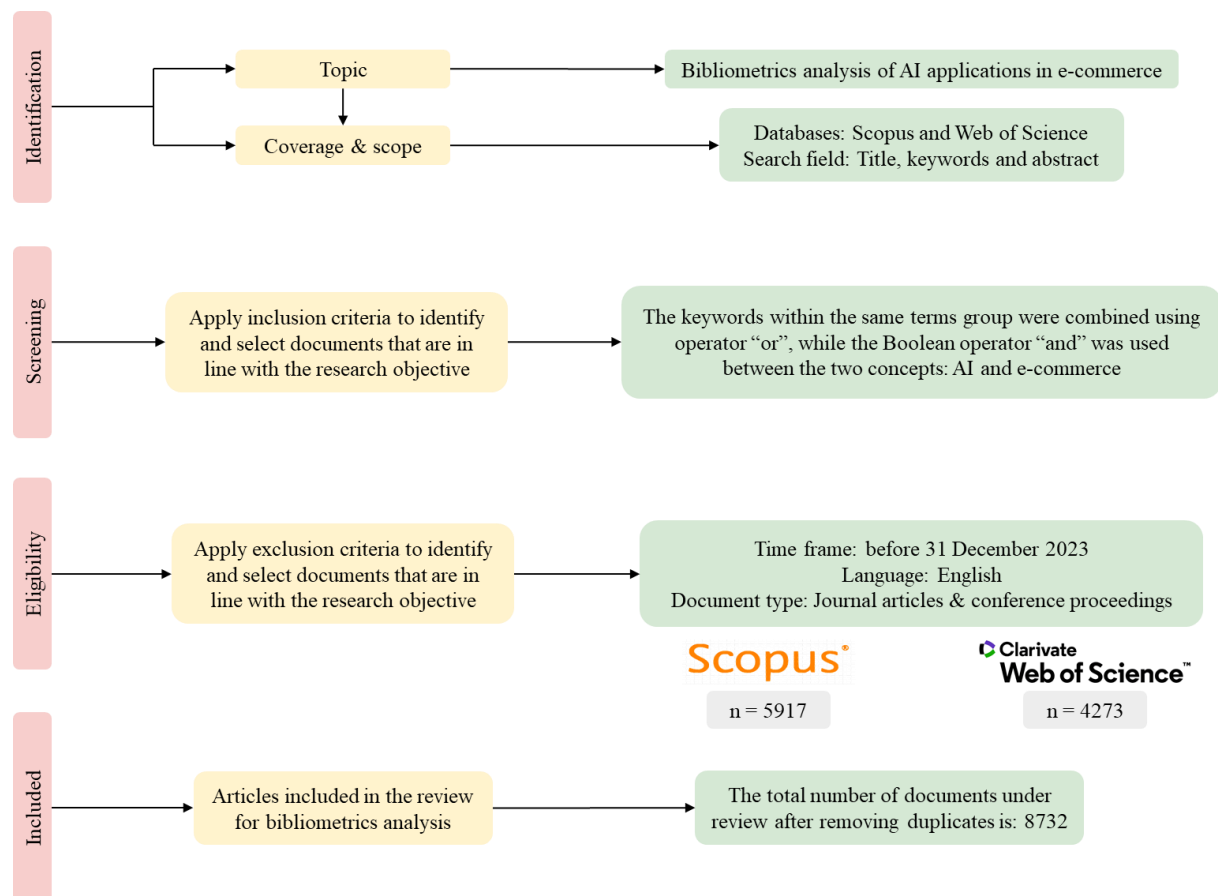
This research paper used bibliometric analysis to examine the existing literature on the applications of AI in e-commerce. This methodological approach enables the identification, organization, and analysis of key elements within the research field. Through this data analysis, the study aims to anticipate emerging trends that will capture the attention of the scientific community in the future.

3.1 DATABASES SEARCH

Multiple databases, including Scopus, WoS, Lens, Dimensions, PubMed, Google Scholar, and the Cochrane Library, can be used for importing bibliographic data. However, this study has selected two primary databases: Scopus and WoS. Scopus is developed by Elsevier, whereas WoS is created by Clarivate Analytics (Visser et al., 2021). These two databases were selected for their extensive use across multiple disciplines, providing comprehensive coverage of diverse fields and areas of expertise (Chițimiea et al., 2021). The decision to merge the two database is based on Fernández et al. (2010)'s suggestion that they complement each other, and Mongeon and Paul-Hus (2016)'s recommendation to utilize both, particularly when making comparisons across various fields, institutions, countries, or languages.

3.2 DATASETS ANALYSIS FRAMEWORK

To identify relevant studies, The PRISMA method, introduced by Moher (2009), facilitated the identification of relevant studies through a concise four-step process: study identification, screening, eligibility determination, and inclusion in the analysis (Echchakoui, 2020). The process of selecting the final dataset is shown in the PRISMA chart illustrate in Figure 1.

Figure 1*PRISMA Flowchart for Data Selection*

Source: Author's elaboration

The data collection process for the bibliometric datasets was conducted on January 10, 2024. The research study was focused on identifying keywords that exist within the title, keywords, or abstract of the articles. An initial search conducted in both databases with the primary keyword "Artificial Intelligence in e-commerce" led to the identification of 15 documents in Scopus and 5 in WoS.

Due to the relatively low number of documents, terms related to "Artificial Intelligence" and "e-commerce" were used to identify additional articles on the topic. Following the identification of all the keywords, a new search was conducted in Scopus and WoS. The keywords within the same synonym group were combined using the boolean operator "or", while the boolean operator "and" was used between the two concepts of AI and e-commerce. The following specific criteria for the keyword search were applied: (("Electronic Commerce" OR "e-commerce" OR "e-business" OR "Digital marketplace" OR "Online retailing" OR "E-marketplace" OR "E-retail") AND ("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning")).

This study focuses on analyzing articles that examine the applications of AI in the e-commerce field. It includes research on any branch of e-commerce applications of AI, adhering to specific criteria. The methodology is strictly limited to only articles written in English, excluding those in other languages. Additionally, the timeframe for the publications under consideration was set to include only papers published before December 31, 2023. Furthermore, the type of publication was restricted to journal articles and conference proceedings, with other types of publications being not selected for this analysis.

The documents selected from Scopus and WoS through PRISMA method were combined for separate and joint analyses, allowing for a comparison of findings. A primary challenge encountered in merging the two datasets was due to discrepancies in their tagging systems. For instance, the tag field for article titles in Scopus is denoted as “Title”, whereas in WoS, it is referred as “Article title”. To address this issue, Zotero, which is a free and open-source tool designed to help collect, organize, cite, and share research materials available at www.zotero.org, was utilized to facilitate the integration process. The data from Scopus and WoS were imported into Zotero, providing tools to effectively identify and remove duplicates. After the data cleansing process, Zotero was used to export the unified dataset, ensuring that the merged information was coherent and ready for analysis.

This methodology led to the identification of a collection of 5917 scientific documents in Scopus and 4273 in WoS. After the removal of duplicates, a total of 8732 research papers were included in this bibliometric analysis.

4 RESULTS AND DISCUSSION

The data analysis in this study employed two approaches: descriptive analysis and scientific mapping. Using the Biblioshiny R library (Aria & Cuccurullo, 2017), the analysis focused on evaluating and visualizing bibliometric data to examine key characteristics of the dataset for descriptive analysis. Additionally, advanced visualization techniques were applied for scientific mapping to explore the intellectual and social structures.

4.1 DESCRIPTIVE ANALYSIS

This subsection presents comprehensive statistics on annual scientific production, average citations per year, and the most productive authors, affiliations, countries, articles, and author's keywords, along with information about the most cited sources and authors.

4.1.1 Main Information

Table 2 shows an overview of the main statistics for the datasets from Scopus, WoS, and the merged data. The merged data covers the period from 1995 to 2023 and is based on 3382 various sources. A total of 8372 documents were analyzed, with an average annual growth rate of 28.47%. The average age of the documents is 8.4 years, and each document has an average of 9.56 citations. There are 16540 author's keywords and 21142 unique keywords identified as keywords plus, which suggests a total of 21142 keyword occurrences in article titles. The research involved the contributions of 14065 authors, with 827 authors contributing single-authored documents. Collaboration among authors resulted in 1068 single-authored documents, with an average of 3.21 co-authors per document and 10.45% of the collaborations consisted of international co-authorships.

Table 2 – Overview of main data statistics

Description	Results		
	Scopus	WoS	Total
General information			
Timespan	1995:2023	1996:2023	1995:2023
Number of sources	2145	1984	3382
Number of documents	5915	4247	8372
Annual rate growth Rate	27.18%	26.05%	28.47%
Average age of document	7.7	8.14	8.4
Average citations per document	11.19	9.903	9.56
Contents of documents			
Keywords plus	23864	2 58	21142
Author's keywords	12424	9049	16540
Authors			
Number of authors	11756	8370	14065
Authors of single-authored docs	663	375	827
Collaboration among Authors			
Single-authored documents	819	415	1068
Average number of co-authors per document	3.22	3.35	3.21
Percentage of international co-authorships	14.61	20.56	10.45

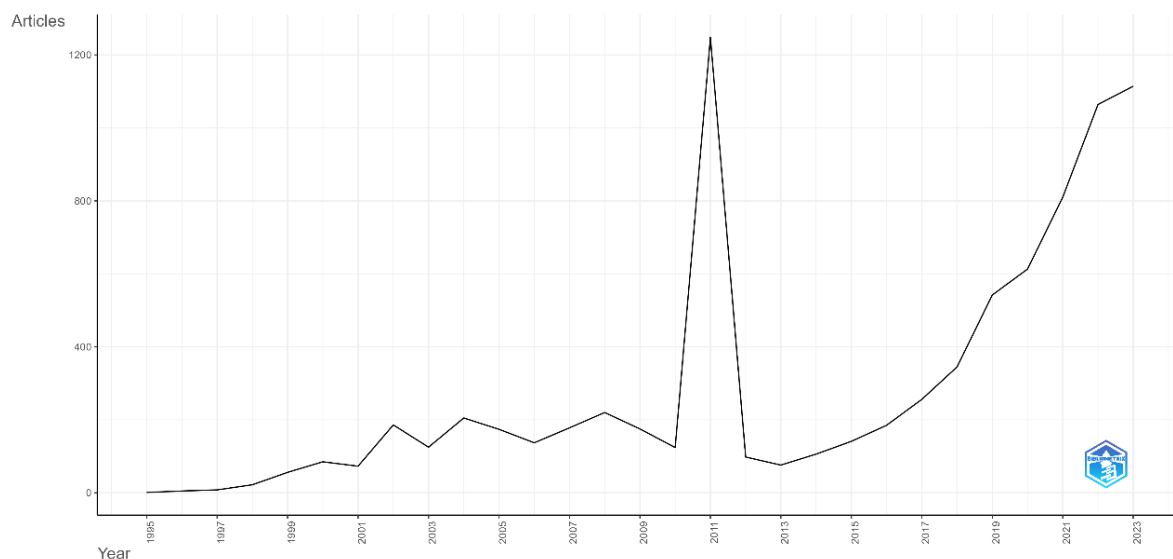
Source: Author's elaboration (2024)

4.1.2 Annual scientific production and average citation per year

Within the examined 28-year period of scientific production, a remarkable increase in the number of publications has been observed over the last ten years, as showed in Figure 2. This increase may indicate a growing awareness of the importance of understanding and resolving the issue of AI in e-commerce. Notably, from 1996 to 2010 there is a gradual increase in publications over the years until a sudden spike in 2011. This is followed by a decrease in 2012, returning to the levels seen before the peak. From 2011 to 2018, there is relative stability with a slight increase, and from 2018 there is a notable and consistent rise, with the number of publications reaching the highest point by 2023.

Figure 2

Annual scientific production



Source: Author's elaboration based on the output from Biblioshiny

4.1.3 Sources

According to preliminary statistics, a total of 8372 articles were published across 3382 different sources. The top 10 sources, as shown in Table 3, have a total of 1731 articles, accounting for about 21% of the total. The AIMSEC International Conference Proceeding and the ACM International Conference on E-business are sources with 1119 and 164 related articles respectively. Table 3 illustrates also the 10 most cited sources in this area. The most cited source is attributed to Expert Syst Appl, which has 1583 articles, followed by Lect Notes Comput Sc

with 1429 articles. Arxiv source was third with 1356 articles, while Decis Support Syst was fourth with 1033 articles.

Comparing the most relevant and cited sources, it is clear that there are different. The absence of citations for a source can be considered a negative point for them in terms of their visibility and influence in the field.

Table 3

Most relevant and cited sources

Most relevant sources	Articles	Most cited sources	Articles
AIMSEC ¹ 2011 international conference proceedings	1119	Expert Syst Appl	1583
ACM international conference proceedings	164	Lect Notes Comput Sc	1429
Electronic commerce research and applications	71	Arxiv	1356
Ceur workshop proceedings	69	Decis Support Syst	1033
Journal of physics: conference series	64	Ieee Access	988
IEEE access	52	J Bus Res	874
Intelligence and security informatics, proceedings	50	Mis Quart	848
ICEB ² international conference proceedings	49	Proc Cvpr Ieee	813
Expert systems with applications	47	Comput Hum Behav	805
Electronic commerce research	46	Lect Notes Artif Int	692

¹ Artificial Intelligence, Management Science And Electronic Commerce

² International Conference On Electronic Business

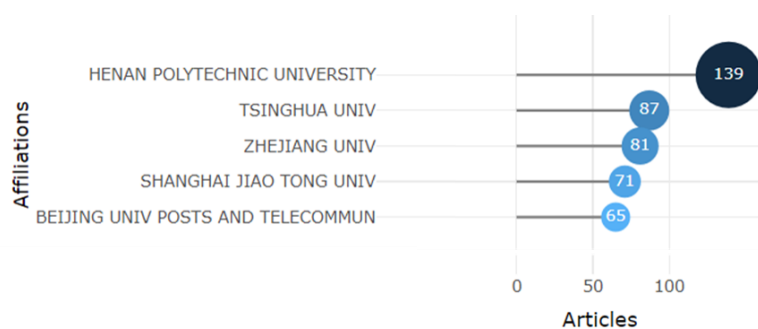
Source: Author's elaboration based on the output from Biblioshiny (2024)

4.1.4 Affiliations

As shown in Figure 3, this study also examines the affiliations or institutions of authors contributing to AI applications in e-commerce research. Henan Polytechnic University has the highest number of articles at 139, followed by Tsinghua University and Zhejiang University.

Figure 3

Most relevant affiliations



Source: Author's elaboration based on the output from Biblioshiny

4.1.5 Countries

Table 4 presents information regarding the scientific production of various country concerning this field. The top three countries in terms of publication frequency are China with 6276 publications, followed by USA with 1937 publications, and India with 1714 publications. Brazil and Morocco hold the 23rd and 29th positions, respectively, with Brazil contributing 149 articles and Morocco 86.

Comparing the production by regions, Europe, Asia, Africa, and the Americas, it can be observed that Asia, including China, India, South Korea, leads the scientific production with a cumulative frequency of 8471 publications. Europe is represented by countries such as Germany, the UK, Spain, Italy and France, with a cumulative frequency of 1678 publications. Africa, represented by Morocco, accounts for a frequency of 86 publications. Lastly, the Americas are represented by the USA and Canada, contributing a total of 2206 publications. These trends can be attributed to factors such as market size, technological advancements, research capabilities, and regional focus on e-commerce development.

Figure 4 shows the productivity over time for four countries: China, USA, Brazil, and Morocco. For China, the graph indicates a continuing upward trend in research, with the number of articles growing gradually from 1995 to 2010, and then experiencing rapid growth between 2010 to 2011, where articles surged from 754 to 1961, signifying a significant rise in research activity. The USA's growth is steady, reaching close to 2000 publications by 2023. In contrast, Brazil and Morocco show only a slight increase in article numbers over time.

Table 4

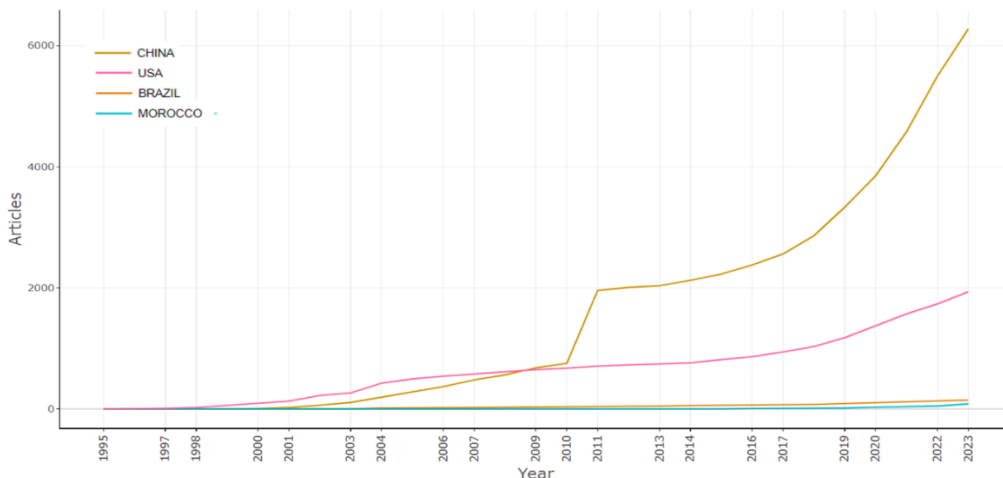
Scientific production by country

Contries	Articles	Contries	Articles	Countires	Articles
China	6276	Italy	268	Portugal	156
Usa	1937	France	203	Greece	150
India	1714	Saudi Arabia	195	Brazil	149
South Korea	481	Turkey	182	Indonesia	136
Germany	464	Netherlands	177	Bangladesh	114
Uk	445	Malaysia	176	Iran	110
Australia	325	Pakistan	176	Romania	108
Japan	298	Vietnam	170	Ukraine	91
Spain	298	Poland	168	Morocco	86
Canada	269	Singapore	167		

Source: Author's elaboration based on the output from Biblioshiny (2024)

Figure 4

Evolution of scientific production in China, USA, Brazil and Morocco from 1995 to 2023



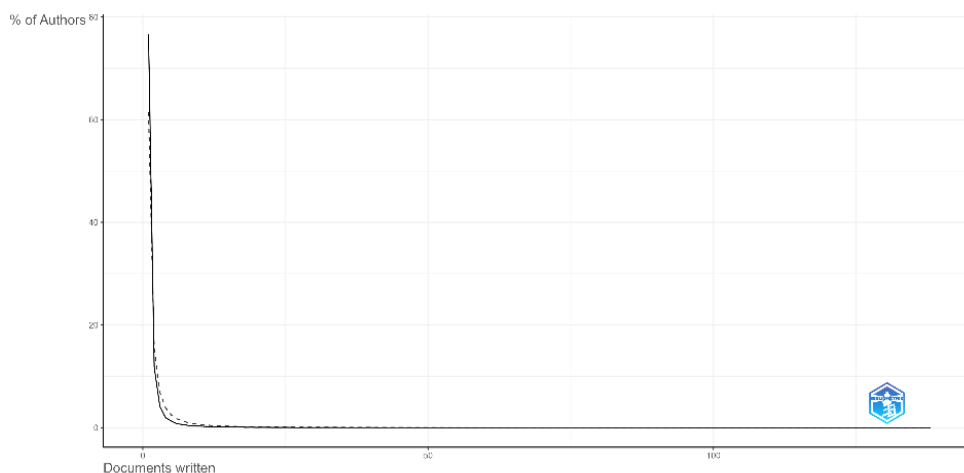
Source: Author's elaboration based on the output from Biblioshiny

4.1.6 Authors

The author productivity is illustrated in Figure 5, which is a visual representation of the Lotka's Law distribution. The x-axis represents the number of articles, while the y-axis represents the percentage of authors. Lotka's Law is represented by a dashed line. The graph shows that a small number of authors have a large number of publications, while the majority of authors have few publications. The majority of authors, approximately 76.7%, have contributed only one document, and the proportion of authors decreases as the number of documents authored increases.

Figure 5

Author productivity with Lotka's Law



Source: Author's elaboration based on the output from Biblioshiny

Table 5 provides information on 10 most relevant and most cited authors. In the first column, authors are represented along with the number of articles they have written. Among notable authors, Zhang and Li have contributed 138 and 131 articles respectively. The third column, shows authors along with the number of local citations they have received. Hu and Liu have obtained 30 local citations each, and MAES P with 26.

Comparing the most relevant and cited authors, it can be seen that there is no direct correlation or similarity between the mentioned authors. The authors with the highest relevance do not necessarily correspond to the most cited authors.

Table 5

Most relevant and cited authors

Most relevant authors	Frequency	Most cited authors	Frequency
ZHANG Y	138	HU M	30
LI Y	131	LIU B	30
WANG Y	122	MAES P	26
LIU Y	101	ADAM M	23
ZHANG J	95	BENLIAN A	23
WANG X	86	WESSEL M	23
ZHANG X	86	LIU Y	22
LI J	85	GUTTMAN R	20
WANG J	80	MOUKAS A	20
LI X	78	YANG H	18

Source: Author's elaboration based on the output from Biblioshiny (2024)

4.1.7 Articles

Table 6 illustrates the most cited articles and shows the authors of the papers and their total citation counts. The selected articles consist of those that have garnered more than 300 citations. The leading article, by (Leskovec, Adamic, Huberman, 2007), focuses on the recommendation network for different products and has accumulated 1352 citations, indicating its significant impact and regard in the research community. Following this, other notable works include (Zhou et al., 2018) on predicting click-through rates in industrial applications with 815 citations, and (Wei et al., 2017)'s exploration of recommendation systems using deep learning, cited 521 times. Additional contributions, such as (Qiu and Benbasat, 2009) on product recommendation agents, (Yu and Singh, 2002) on distributed reputation management, (Zeng and Sycara, 1998) on decision-making models in negotiation, (Zhang et al., 2015) on consumer sentiment classification, and (Xu et al., 2019) on predicting the next user action, further

demonstrate the breadth and depth of research that has substantially influenced the development of digital technologies and their applications.

Table 6

Most cited documents

Articles	Citation	Main objective
(Leskovec, Adamic, Huberman, 2007)	1352	Recommendation network for different type of products
(Zhou et al., 2018)	815	Predicting the click-through rate in industrial applications
(Wei et al., 2017)	521	Recommendation system using deep learning
(Qiu and Benbasat, 2009)	458	Product recommendation agents
(Yu and Singh, 2002)	413	Distributed reputation management
(Zeng and Sycara, 1998)	359	Decision-making model of negotiation
(Zhang et al., 2015)	348	Consumer sentiment classification
(Xu et al., 2019)	325	Preiction of the next action for the user

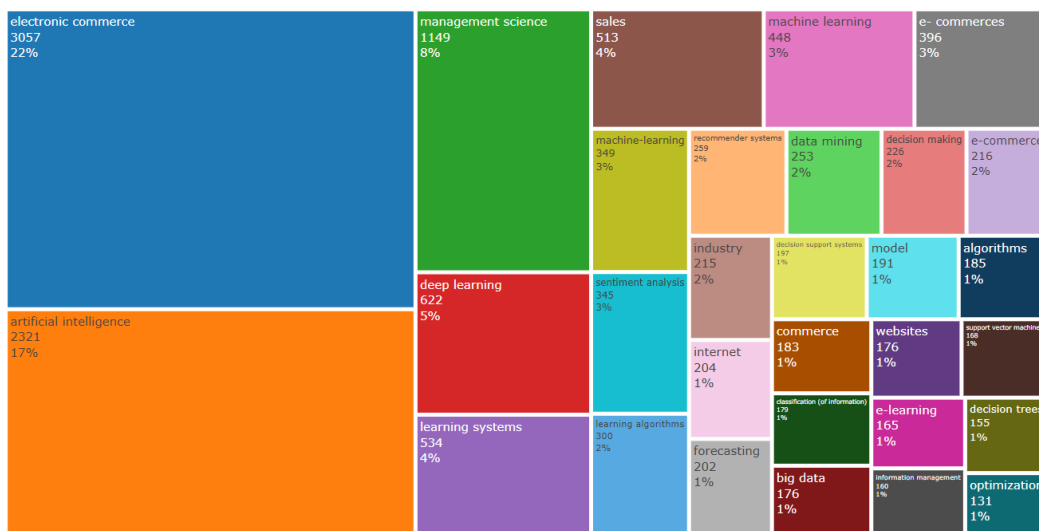
Source: Author’s elaboration based on the output from Biblioshiny (2024)

4.1.8 Author’s keywords

Figure 6 shows the frequency distribution of key terms within the field of application for AI in e-commerce. The term "e-commerce" appears as the frequently mentioned with occurring 3057 times, and "Artificial Intelligence" is referenced 2321 times.

Figure 6

Most relevant author’s keywords used in AI and e-commerce



Source: Author's elaboration based on the output from Biblioshiny

Two areas are prominently highlighted, which are "Sentiment analysis" with 345 citations, suggesting significant research activity in understanding and processing user opinions

and emotions, and "recommendation systems", cited 259 times, indicating the dedication to creating personalized user experiences. These terms, along with others like "machine learning," "deep learning," "data mining," and "learning systems," signify the diverse technological approaches being explored and applied within the sector. The inclusion of terms like "optimization," "algorithms," and "decision trees" reflects the foundational techniques employed to enhance various aspects of e-commerce through AI.

4.2 INTELLECTUAL STRUCTURE

Co-citation analysis aims to explore the relationship between the cited articles and those that cite them (Saibaba, 2023). This happens when multiple articles independently cite the same sources. When multiple articles co-cite the same sources, it suggests a significant relationship between them (Ribeiro et al., 2022). It can evaluate the degree of similarity between documents, authors, and sources. To achieve this, the number of nodes is set to fifty, and the Louvain clustering method is applied. As a result, diagrams reveal distinct clusters of articles, authors and sources with each cluster represented by a unique color. In the context of co-citation analysis, centrality measures are calculated for the co-authorship network, including articles, authors, sources. The centrality degree signifies the level of collaboration an individual has with others in the creation of an article (Ribeiro et al., 2022). It can be subdivided into two categories: betweenness centrality and closeness centrality. Closeness centrality refers to entities that have extensive connections within the network. On the other hand, betweenness centrality indicates an entity's role as a connecting link between distinct research streams.

4.2.1 Articles

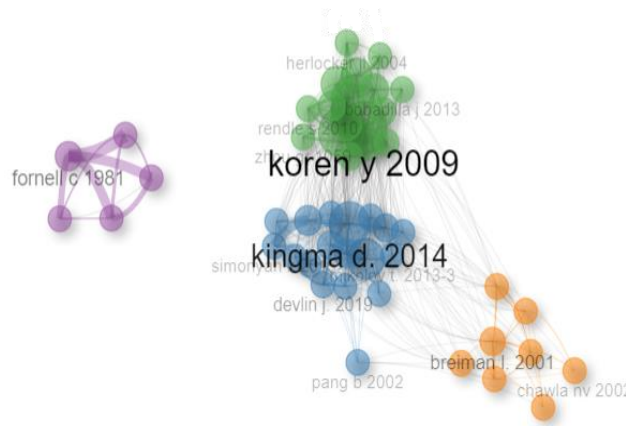
Figure 7 shows four distinct clusters of articles, where the size of each circle corresponds to the frequency of citation. articles with similar co-citation profiles are grouped within the same cluster. The green cluster includes 17 articles focused on recommendation system techniques, while the blue cluster contains 18 articles pertaining to optimization and machine learning models. The purple cluster comprises 5 articles associated with the marketing field. Additionally, Table 7 lists the top 10 articles ranked according to their similarity measures, specifically betweenness centrality and closeness centrality.

4.2.2 Authors

Figure 8 shows four distinct clusters of authors, where the size of each circle corresponds to the frequency of citation. Authors with similar co-citation profiles are grouped within the same cluster. Table 8 presents the top 10 authors based on the similarity measures of betweenness centrality and closeness centrality. Notably, author ZHANG Y received the highest measures on both scales, which means that he plays a central role in the author network.

Figure 7

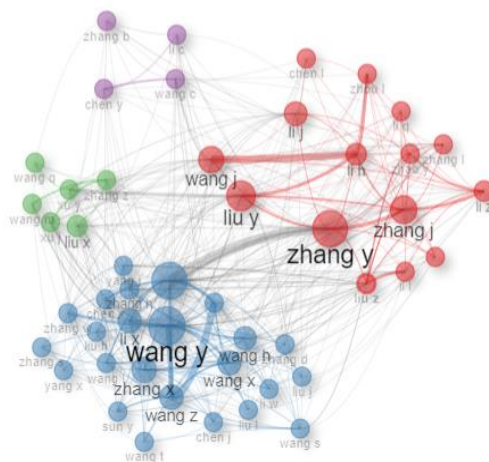
Co-citation network: Articles



Source: Author's elaboration based on the output from Biblioshiny

Figure 8

Co-citation network: Authors



Source: Author's elaboration based on the output from Biblioshiny

Table 7*Top 10 articles with high betweenness centrality and closeness centrality*

Articles	Betweenness	Articles	Closeness
(Kingma and Ba, 2014)	161.409788847	(Fornell and Larcker, 1981)	0.05
(Koren, Bell, and Volinsky, 2009)	89.8424860662	(Davis, 1989)	0.05
(Graves, 2012)	66.0258570373	(Podsakoff et al., 2003)	0.05
(He et al., 2017)	46.1038725396	(Hair, 2009)	0.05
(Sarwar et al., 2001)	44.3722414058	(Henseler, Ringle, and Sarstedt, 2015)	0.05
(Blei, Ng, and Jordan, 2003)	44.3440741880	(Kingma and Ba, 2014)	0.013333333333
(Pang, Lee, and Vaithyanathan, 2002)	43.6626635417	(Koren, Bell, and Volinsky, 2009)	0.013157894736
(Mikolov et al., 2013)	41.3500883815	(Graves, 2012)	0.012987012987
(Pedregosa et al., 2011)	39.7459062707	(Blei, Ng, and Jordan, 2003)	0.012820512820
(Chen and Guestrin, 2016)	33.6573077768	(Mikolov et al., 2013)	0.012658227848

Source: Author's elaboration based on the output from Biblioshiny (2024)

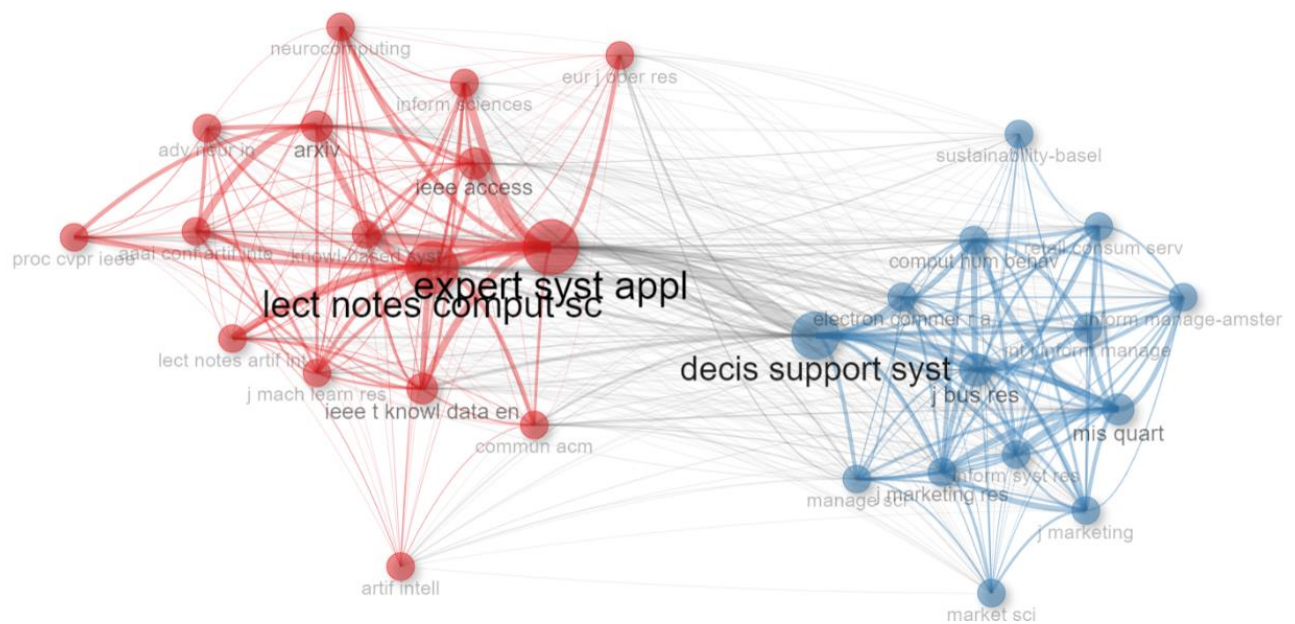
Table 8*Top 10 authors with high betweenness centrality and closeness centrality*

Authors	Betweenness	Authors	Closeness
ZHANG Y	57.48058317006494	ZHANG Y	0.01612903225806452
LIU Y	22.72943054666121	LI Y	0.01612903225806452
ZHANG J	19.63628834578301	WANG Y	0.01538461538461539
WANG J	31.6302524194463	ZHANG X	0.01492537313432836
LI J	16.01676596633764	WANG H	0.01470588235294118
LI Z	16.54745504026909	LI X	0.01449275362318841
LI H	20.87183711117191	WANG X	0.01428571428571429
ZHANG L	13.09627439297008	WANG J	0.01408450704225352
ZHAO Y	11.15029898649387	ZHANG H	0.01388888888888889
LI L	10.62274444955647	LIU X	0.01388888888888889

Source: Author's elaboration based on the output from Biblioshiny (2024)

4.2.3 Sources

Figure 9 shows two distinct clusters of sources, where the size of each circle corresponds to the frequency of citation. Sources with similar co-citation profiles are grouped within the same cluster. The red includes articles that focus on applied research and practical applications. It covers a variety of topics, such as neural networks, data mining, and expert systems. The blue cluster focuses on articles in marketing, retailing, decision support systems, and market science research. The cluster covers a variety of topics such as marketing strategy, consumer behavior, economic analysis and information systems.

Figure 9*Co-citation network: Sources*

Source: Author's elaboration based on the output from Biblioshiny

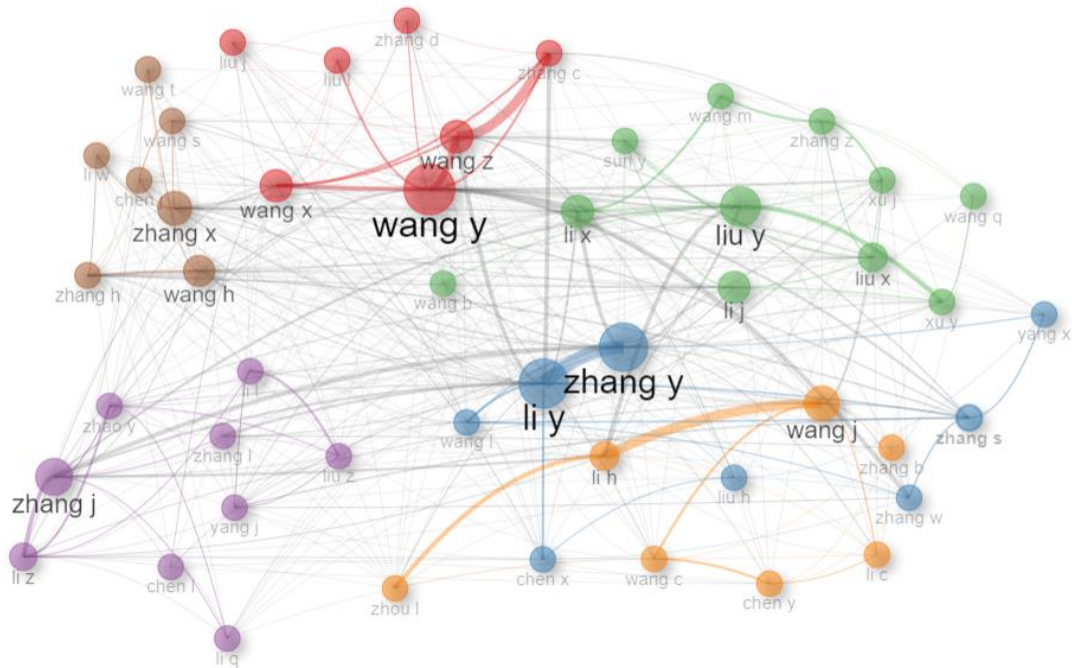
4.3 SOCIAL STRUCTURE

The objective of social network analysis is to uncover the connections within a given research topic (Saibaba, 2023). In a social network, each node represents an actor, which can be authors, affiliations, or countries. To achieve this, the number of nodes is set to fifty, and the Louvain clustering method is applied.

Figure 10 shows a network of co-authors with six clusters. Two clusters led by WANG Y and LI Y stand out with a higher number of co-authors. These authors also have the highest number of articles in the descriptive analyze. In Figure 11, a co-affiliation network with six clusters shows that the Henan Polytechnic University has strong affiliations. Figure 12 shows the co-country network with three clusters where China stand out due to its numerous country connections. This country also have the highest number of articles in the descriptive analyze.

Figure 10

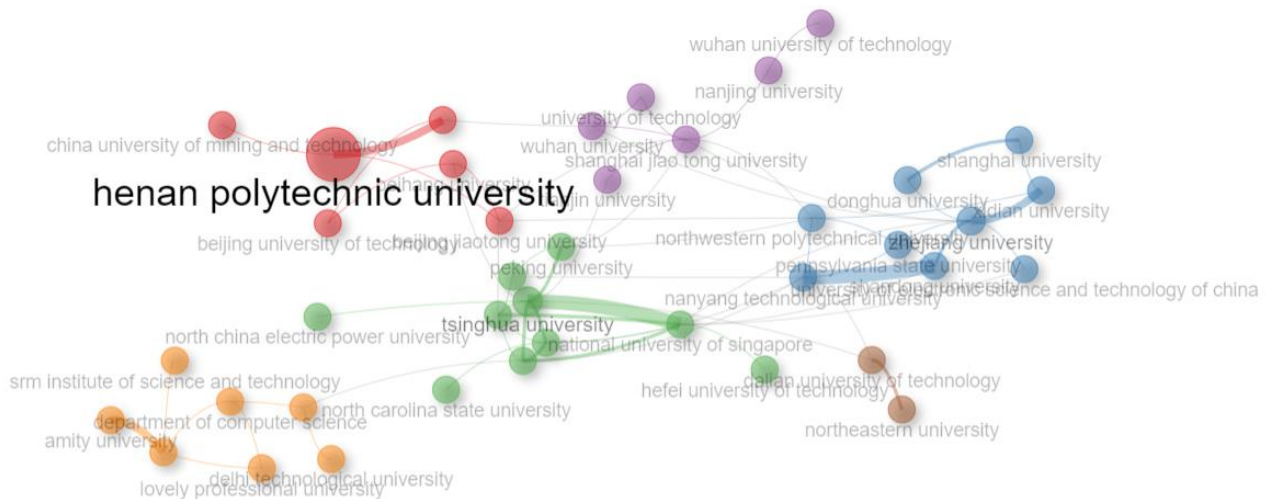
Authors collaboration network



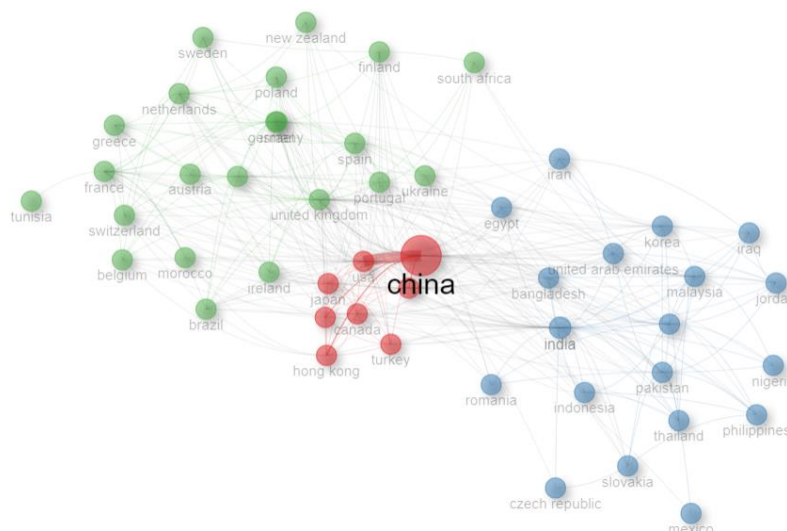
Source: Author's elaboration based on the output from Biblioshiny

Figure 11

Affiliations collaboration network



Source: Author's elaboration based on the output from Biblioshiny

Figure 12*Countries collaboration network*

Source: Author's elaboration based on the output from Biblioshiny

5 CONCLUSION

The aim of this research is to examine the evolution of AI applications in e-commerce from 1995 to 2023, through a bibliometric study of 8,372 research articles sourced from the Scopus and WoS databases. To our knowledge, this study is the first in the field to utilize merged databases for a bibliometric analysis. The study conducts a thorough quantitative evaluation and scientific mapping to explore various factors such as the number of articles published, authors and co-authors, number of citations, average number of citations per article, countries, institutions, and journals of publication. Despite its comprehensive scope, the selection of keywords could have influenced the results obtained, suggesting that future studies could benefit from the inclusion of alternative keywords to enhance the depth of analysis. Furthermore, this study facilitates more focused inquiries into specific AI techniques within the e-commerce domain, while also considering the potential limitations of its methodological approach.

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