Bibliometric Examination of Artificial Intelligence within the Framework of E-Commerce Technology from 1996 to 2024

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Abstract. This paper reviews AI research in e-commerce using bibliometrics. Scopus data, containing 4976 papers published from 1996 to 2024, and the R programming package Biblioshiny are used to do bibliometric analysis and investigate linked articles to assess this field's popularity, influence, and development trends. "Machine learning", e-commerce, and AI technologies (deep learning, big data analytics, sentiment analysis) optimize supply chain and personalize user experiences. The research classifies trends as foundational, emergent, and developed. Machine learning, deep learning, and predictive analytics expand AI. Sustainable, cross-border e-commerce, and supply chain optimization are also popular nowadays. In e-commerce AI, it is related to strategic theories like Resources Based View (RBV) and Transaction Cost Economics (TCE). There are many practical considerations, but few theoretical research on AI ethics, transparency, and privacy. Explainable AI, responsible AI adoption rules for corporate effectiveness, and blockchain/Web3 integration for security and transparency should be researched. Finally, this study can offer e-commerce AI trends and research directions.

Keywords: E-commerce, Artificial intelligence (AI), Machine learning, Bibliometric analysis.

1. Introduction

Electronic commerce (e-commerce) refers to services or activities associated with utilizing the internet for the sale of items or services (Kalakota & Whinston, 1997). The global proliferation of the Internet and information systems, coupled with the increasing utilization of technical devices, has significantly increased e-commerce. Recent advancements in this domain have been significant and swift in their progression (Kumar & Kumar, 2021). Nevertheless, as additional competitors enter this sector, client demands are increasing. Artificial Intelligence (AI) has emerged as a pivotal technology for e-commerce, facilitating its expansion and enabling firms to utilize these technologies for enhanced competitive performance (Bawack et al., 2022). AI in e-commerce encompasses techniques, AI-related platforms, utilities, and computational processes utilized in online transactions that enhance the exchange of products and services via the internet. AI has unequivocally revolutionized e-commerce in various aspects. Another application of AI is the deployment of artificial intelligence chatbots to deliver round-the-clock customer support through rapid responses, inquiry resolutions, and personalized product suggestions (Følstad et al., 2018). Recommendation engines utilize machine learning to analyze extensive datasets of client activities, predict preferences, and subsequently suggest appropriate goods, hence enhancing customer satisfaction and sales (Jannach & Jugovac, 2019).

AI algorithms similarly enhance pricing strategies by adjusting prices in real-time, contingent upon prevailing market conditions and competitive pricing pressures (Elmachtoub & Grigas, 2022). Furthermore, both AI and fraud detection are essential in identifying and preventing fraudulent transactions, ensuring secure online payments, and reinforcing consumer trust (Alam et al., 2024). Artificial intelligence enhances delivery routes, forecasts demand, and effectively oversees inventory in logistics and supply chain management, all while reducing costs and optimizing operational efficiency (Rane et al., 2024). Fedorko et al. (2022) conducted a comprehensive evaluation of AI applications in e-commerce, examining the benefits for both firms and consumers. The study verifies that AI enhances consumer relationship management by facilitating personalized shopping experiences and optimizing business processes. This review lacks a quantitative and systematic evaluation of AI's impact on e-commerce, focusing instead on qualitative attributes. The article provides a significant overview of AI's roles in digital commerce; yet, it neglects to examine quantitative research patterns about intellectual advancement and trends in this rapidly evolving domain.

AI research in e-commerce is synthesized through the concurrent application of bibliometrics and systematic literature reviews, along with quantitative data analysis methodologies, as noted by Bawack et al. (2022). An examination of Web of Science data reveals that recommender systems are the primary focus of Artificial Intelligence (AI) research in the context of e-commerce as applied to Information Systems (IS). Additional investigations are necessary to enhance theoretical underpinnings by empirical study across broader domains.

The research employs bibliometric analysis, integrating co-word network analysis and Reference Publication Year Spectroscopy (RPYS) to develop a comprehensive data-driven knowledge of AI applications in e-commerce. This study methodology enables researchers to systematically evaluate publication histories, citation references, and keyword variations, thereby elucidating intellectual activities within the domain of AI studies in e-commerce. This strategy enables researchers to identify emerging research topics, emphasize key figures in their field through seminal papers, and monitor the evolution of the domain. This strategy assists researchers in pinpointing unexplored research domains and neglected concepts that facilitate inventive progress in AI-eCommerce via novel scholarly inquiries.

The research study utilizes bibliometric analysis to assess ethical considerations in the literature on digital commerce and identifies critical research requirements to delineate ethical parameters for AI deployment in this domain (Zheng et al., 2023). This study addresses the identified deficiencies by employing quantitative methodologies and conducting inquiries via the "bibliometrix" software developed in R by Aria and Cuccurullo (2017), which retrieves records from the SCOPUS database.

The study analyzes fundamental components of research, elucidating the interconnections among AI inquiry parts and identifying the authors, institutions, and nations that exert the most significant influence on AI research. These research findings provide a basis for scientists to establish new avenues of inquiry while enhancing scholarly understanding. The study aims to

1. Chart the progression of AI research in e-commerce chronologically, pinpointing significant milestones and pivotal publications.

2. Examine the thematic framework of the research, identifying prevailing themes and nascent areas.

3. Identify significant authors and nations contributing to artificial intelligence research in e-commerce.

4. Analyze the collaborative relationships among terms within this domain

5. Identify research deficiencies and unexamined domains to direct forthcoming research initiatives.

This paper's methodology section delineates the bibliometric analysis. This part presents the analytical results via graphic representations that illustrate research advancements. The results and their research implications are outlined in Section 4. The report concludes in Section 5 with recommendations for future research.

2. Research method

2.1. Data collection

The study dataset was sourced from Scopus, a prominent academic indexing tool. Publications on statistical analysis by year provide scholars with critical insights into the developmental trends and density fluctuations of a certain subject over time (Ahmi & Mohd Nasir, 2019). The database Scopus serves as a reliable platform for bibliometric research, designated as the primary source for data collection. Scopus encompasses diverse forms of intellectual information, including business periodicals, book series, and peer-reviewed journals (Rochman et al., 2024). Scopus provides customers with an intuitive application interface, customizable search functionalities, comprehensive support resources, and direct data extraction capabilities. Scopus's bibliometric assessment capabilities encompass assistance for prominent journals, author network analysis, and research trend analysis systems, rendering them essential for investigations. The research opted for Scopus over Web of Science (WoS) based on two principal considerations. Academic researchers must choose between extensive data coverage and optimal data quality, as Scopus offers twenty percent greater coverage than Web of Science databases (Zhao & Strotmann, 2015). Systematic quantitative literature evaluations and bibliometric research in the social sciences predominantly utilize a single database (Galati & Bigliardi, 2019) due to challenges in data homogeneity associated with different databases. This database comprises 57 million abstracts and disseminates papers over about 22,000 categories from 5,000 distinguished publishers. Publications intended for the Scopus database must adhere to peer review criteria and sustain high impact factors. Scopus offers consumers an intuitive interface that facilitates customized search functionalities alongside comprehensive documentation and data transfer options. Researchers utilizing Scopus can conduct bibliometric analyses via its author network assessment and research pattern evaluation, in conjunction with prominent journal programs. Scopus was chosen as the major database due to its status as the largest vetted resource of academic literature abstracts and citations (V. K. Singh et al., 2021). The data collection for the research took place in December 2024, although the search yielded only content from prior publications.

To facilitate an exhaustive compilation of research articles pertinent to AI in E-commerce, a comprehensive search string integrating the most general keywords related to both AI and CRM was utilized: ("AI" OR "artificial intelligence" OR "machine learning" OR "deep learning" OR "big data" OR "NLP" OR "SVM" OR "robot") AND ("E-commerce" OR "electronic commerce" OR "electric commerce" OR "internet commerce" OR "online commerce" OR "e-business" OR "electronic business"

OR "electric business" OR "online business"). The search was performed in the Scopus database, employing the "title, abstract, and keywords" sections to enhance the breadth of the inquiry. The fundamental filtration of documents entails the selection of journals, conference papers, and conference reviews, as these are most likely to have completed a stringent peer-review procedure prior to publication. (Milian et al., 2019). Choose categories for completed and continuing conferences; language: English. The authors ultimately gathered 4,976 publications on artificial intelligence in E-commerce.

2.2. Data visualization

This study implements the subsequent analytical processes to achieve its research objectives. This study examines various variables, including annual scientific output metrics, publication source data, author contributions, research institution distribution, regional scientific production, and the most cited publications. The prevailing development patterns and status regarding revisit intention in hospitality, leisure, sports, and tourism can be discerned through the analysis of journals, publications, institutions, countries, keywords, and their corresponding outcomes. The principal analytical tool for examining scientific publications comprises software, which enables researchers to formulate research questions, analyze visual data, and disseminate information (Pan et al., 2018). Various applications, such as VOSviewer (Mehmood et al., 2023), CiteSpace (Mou et al., 2019), CitNetExplorer (Van Eck & Waltman, 2017), BibExcel (Persson et al., 2009), and the R software (Aria & Cuccurullo, 2017), enhance bibliometric analysis.

The research employed the "bibliometrix" software from the R programming language to do the bibliometric analysis. This application integrates leading citation analysis technologies, offering comprehensive research content evaluation that enables specialists to get profound field-specific insights (Esfahani et al., 2019; Fosso Wamba, 2020; Pourkhani et al., 2019).

3. Result

3.1. Publication trends

The conceptual evolution of AI research in e-commerce has advanced through three notable phases from 1996 to 2024, as illustrated in Figure 1. The research focus shifted from fundamental decision support systems to AI-driven solutions that currently emphasize massive data analysis and automated tailored offerings.

Between 1996 and 2010, research on AI in e-commerce entered the Foundational Stage, focusing on the development of tools for structured data management and decision-making systems. The salient terms throughout this phase were: "Internet" – denoting the infrastructural basis for e-commerce development; "E-commerce" – signifying the advent of online transactions and the necessity to implement AI for the optimization of digital commerce operations; "Decision support systems" and "Decision support system" refer to AI-driven frameworks that assist enterprises in data analysis and process optimization; "Artificial intelligence" and "Machine learning" constitute the fundamental basis for subsequent AI applications; "Data mining" signifies endeavors to derive valuable insights from the increasing data volume in e-commerce; "Support vector machine (SVM)" is a widely utilized method for data classification and prediction. This development stage primarily concentrated on fundamental AI approaches that provided e-commerce applications for data classification and decision assistance.

Between 2011 and 2020, research has increasingly integrated big data and sentiment analysis. The study focus then shifted from conventional decision-making systems to contemporary big data analytics applications and consumer behavior. The principal keywords during this period encompassed: "E-commerce" – persisting as a central theme, indicative of robust growth in e-commerce and heightened demand for AI applications; "Sentiment analysis" – signifying a transition from structured data analysis to the extraction of emotions and customer opinions from unstructured data, including product reviews and social media feedback; "Big data analytics" signifies the surge of large data and the requirement

for sophisticated AI techniques to derive important insights; "Cross-border e-commerce" denotes the global proliferation of e-commerce, necessitating the utilization of AI to enhance logistics, demand forecasting, and tailored customer experiences; "Simulation" — illustrating the focus on replicating consumer behavior and company methods inside e-commerce contexts
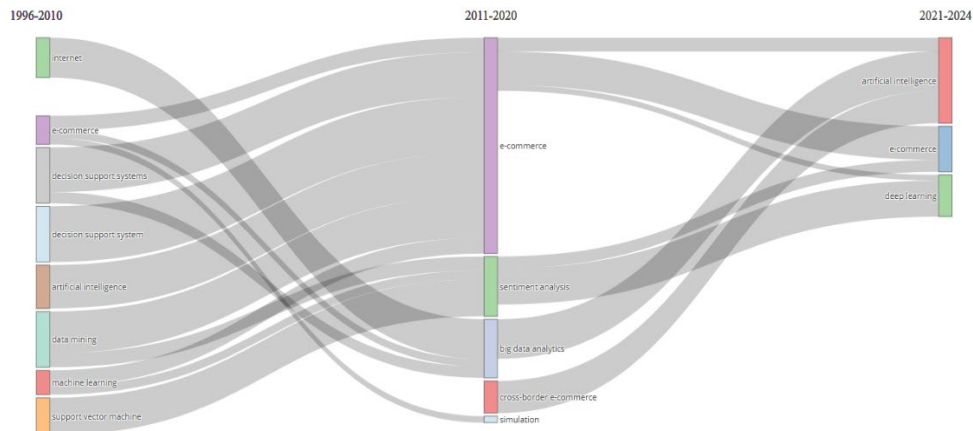

Fig.1: Three phase chart

3.2. Most Cited Publications

Among the top 10 most referenced publications in Table 1, the work by Leskovec et al. (2007) possesses the greatest citation count, totaling 1390. This article examines the evolution and dissemination of viral marketing. The researchers employ a mathematical model to elucidate the dissemination of items, services, or ideas throughout user networks and their impact on purchasing decisions. Ranked second is Akter and Wamba (2016), with 465 citations, which examines the utilization of Big Data in E-commerce. The third study is by Adam et al. (2021), which has garnered 432 citations and examines the influence of AI-driven chatbots on customer service and their effect on user compliance. Of the 10 most cited works, 8 were published subsequent to 2014. The growing utilization and advancement of AI applications signify their profound incorporation into the functioning and strategic evolution of e-commerce enterprises. Artificial intelligence in e-commerce is a multidisciplinary domain that has emerged as a subject of inquiry across several fields, including business, management, computer science, social sciences, economics, finance, and psychology (Frioui & Graa, 2024).

Table 1. Most Cited Publications

Document	Title	Total Citations	TC per Year
Leskovec *et al.* (2007)	The dynamics of viral marketing	1390	77,22
Akter and Wamba (2016)	Big data analytics in E-commerce: a systematic review and agenda for future research	465	51,67
Adam *et al.* (2021)	AI-based chatbots in customer service and their effects on user compliance	432	108,00
Mahler *et al.* (2019)	Learning ambidextrous robot grasping policies	374	62,33
Sima *et al.* (2020)	Influences of the industry 4.0 revolution on human capital development and consumer behavior: A Systematic Review	350	70,00
Arora *et al.* (2019)	Measuring social media influencer index insights from Facebook, Twitter, and Instagram	338	56,33
Yang *et al.* (2020)	Sentiment analysis for E-commerce product reviews in Chinese based on sentiment lexicon and deep learning	326	65,20
J. P. Singh *et al.* (2017)	Predicting the "helpfulness" of online consumer reviews	322	40,25

Document	Title	Total Citations	TC per Year
Luo *et al.* (2003)	A fuzzy constraint-based model for bilateral, multi-issue negotiations in semi-competitive environments	271	12,32
Lehrer *et al.* (2018)	How big data enables service innovation: materiality, affordance, and the individualization of service	270	38,57

3.3. Countries with the Highest Number of Publications

Since 2000, 82 nations globally have disseminated research on artificial intelligence in e-commerce. Table 2 demonstrates that China leads in AI research within the e-commerce sector, with 1,752 articles and 9,836 citations. The preeminent publication output of China's research does not impede its citation index, which is anticipated to remain inferior to that of the United States. The excellent quality and impact of US research is evidenced by 5,611 citations and merely 172 publications. Similar to India, the nation with 4.275 citations is also amplifying research in this domain, as India holds the second position in publication volume (359). Countries with elevated citation indices, determined by their publication counts, including the United Kingdom (55 publications, 2,659 citations) and Germany (49 publications, 2,572 citations), reflecting the significant impact of their research. In contrast, South Korea (52 publications, 629 citations) possesses a comparable amount of publications to the UK, although exhibits significantly lower research impact. Additional nations included Indonesia (36 publications, 100 citations), Australia (32 publications, 943 citations), Italy (31 publications, 1,092 citations), and Spain (31 publications, 1,692 citations). Despite the substantial disparity between citation numbers and publication quantities, the influence of research in these countries remains constrained.

Table 2. Countries with the Highest Number of Publications

Country	N	Citation	N%	SCP	MCP	MCP %
China	1752	9836	35,21%	1636	116	6,62%
India	359	4275	7,21%	314	45	12,53%
USA	172	5611	3,46%	136	36	20,93%
United Kingdom	55	2659	1,11%	29	26	47,27%
Korea	52	629	1,05%	32	20	38,46%
Germany	49	2572	0,98%	30	19	38,78%
Indonesia	36	100	0,72%	31	5	13,89%
Australia	32	943	0,64%	23	9	28,13%
Italy	31	1092	0,62%	19	12	38,71%
Spain	31	1692	35,21%	1636	116	6,62%

3.4. Co-occurrence networks and Thematic evolution

The co-occurrence keyword map in the domain of AI in e-commerce illustrates the structural relationships among diverse study topics, demonstrating the conceptual alignment of research and the predominant theme in academic discourse. Cluster keywords, as outlined by Donthu et al. (2021), have been utilized in the co-occurrence analysis methodology. The primary analytical unit comprises the keywords derived from research papers as outlined in the search strategy. Figure 2 illustrates two primary clusters categorized by keywords: the red cluster, 'machine learning', which signifies the principal areas of investigation in this research domain, and the blue cluster, 'e-commerce'.

The blue cluster, the core and largest cluster on the map, indicates its application domain associated with the keyword "e-commerce," characterized by a prominent node size, so affirming its status as the primary application area of AI approaches. Keywords such as "big data" and "big data analytics" signify the imperative of processing extensive datasets in AI-driven applications, including customer behavior research and market trend prediction. Artificial intelligence plays a pivotal role in shaping marketing efforts and enhancing user experience through personalized product recommendations. The presence of "chatbots" enhances 24/7 customer care and improves service efficiency. Furthermore, this may suggest that in addition to supply chain optimization and international e-commerce operations, including

demand forecasting and inventory management, the prevalence of phrases such as "supply chain" and "cross-border e-commerce" also encompasses the application of AI. Sustainability notably include the utilization of AI to address environmental challenges, such as reducing carbon emissions in e-commerce via logistics optimization.

The second most prevalent research domain in AI applications within e-commerce is the 'red cluster' focused on 'machine learning.' The phrases "deep learning," "neural network," and "convolutional neural network" are interrelated, indicating that deep learning methodologies have been employed in applications such as product image identification and intricate data processing. Furthermore, the incorporation of terms like "natural language processing" (NLP) and "sentiment analysis" signifies the application of machine learning in the study of consumer feedback and reviews, as well as in the construction of chatbots. A similarly significant application is "recommendation systems," a fundamental component of AI in e-commerce, wherein the tailored purchasing experience is facilitated by user behavior. These methods encompass standard machine learning techniques such as "support vector machine" (SVM), "random forest," and "feature selection," demonstrating that conventional machine learning approaches remain applicable for event classification and prediction.

Machine learning is an essential problem-solving instrument for numerous difficulties in e-commerce, encompassing personalization and operational optimization. Significant crossovers exist among the studies on "recommendation systems," "big data," and "personalization." Recommendation systems, developed through collaborative filtering and deep learning algorithms, directly enhance the online purchasing experience. The training of AI models depends on extensive data, enabling personalization that enhances the provision of value-added services to clients. However, the synergy demonstrates that AI is not a supplementary technology; it is a catalyst propelling the transformation of trade in the digital e-commerce era.

Co-occurrence analysis elucidates the comprehensive landscape of AI research in e-commerce, with machine learning as the central component, manifesting in applications such as recommender systems, personalization, and operational efficiency. Emerging supporting technologies, like big data, cloud computing, and blockchain, are increasingly facilitating the integration of AI, hence enabling more comprehensive solutions for the e-commerce sector. This analysis elucidates existing trends and identifies new research avenues to promote sustainable e-commerce growth in the digital age.

Figure 3 presents a thematic map illustrating the graphical representation of research advancements in basic ideas of AI within e-commerce. The methodology employs centrality metrics to assess topic significance within the research domain, while density metrics evaluate theme maturation over time. The quantity of studies pertaining to each issue dictates the visual dimensions of the corresponding circles.
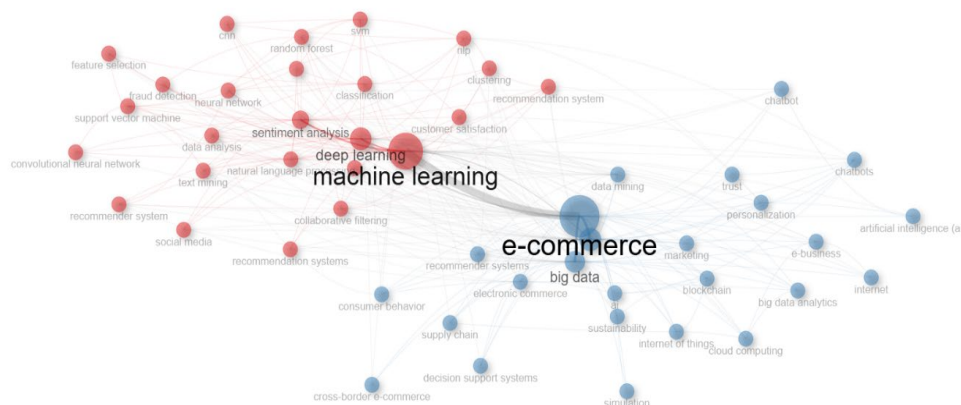

Fig.2: Conceptual Structure of Research Topics Based on Keywords

The fundamental themes from the bottom-right quadrant indicate significant importance and a

foundational comprehension of essential concepts in AI research. The essential components of Artificial Intelligence applications in commerce are prominently highlighted in study through the utilization of the keywords "electronic commerce," "e-commerce," and "sales." The domains of online sales and transaction optimization, together with e-commerce management, continue to be crucial research fields that scholars are diligently advancing.

Motor Themes situated in the upper-right quadrant signify advanced, impactful thoughts that propel the entire study domain towards future advancement. The category encompasses three primary themes: "deep learning," "learning systems," and "sentiment analysis," indicating that academics investigate deep learning while concurrently advancing machine learning systems for sentiment analysis in e-commerce applications. The utilization of artificial intelligence is increasingly significant as it enhances service delivery and customisation while facilitating corporate optimization via customer sentiment monitoring.

The Niche Themes category (top-left quadrant) comprises established study topics with limited interconnections to other core research domains. The top-left quadrant encompasses research on the human dimensions of AI in e-commerce, with studies on commerce and various other subjects.
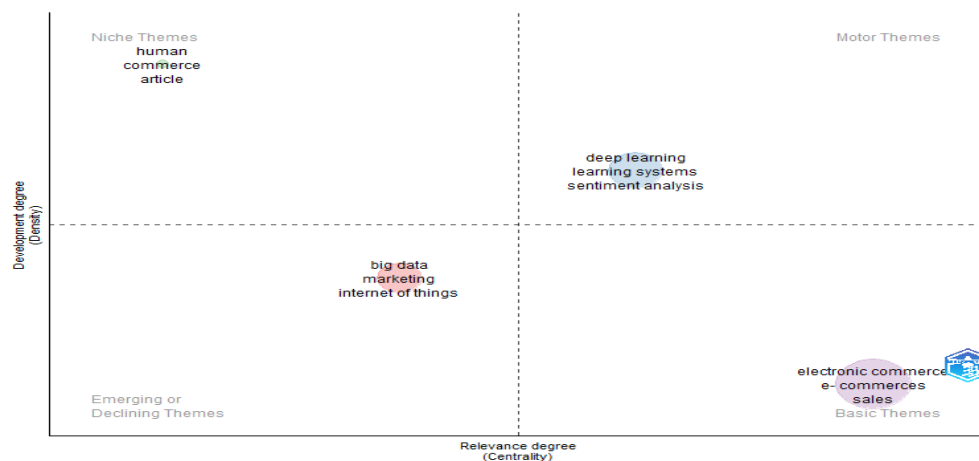

Fig.3: Thematic Map

The bottom-left quadrant features Emerging or Declining Themes, characterized by low topic centrality and low development, signifying possible new topics or ones on the verge of obsolescence. The research domain encompasses three essential keywords: "big data," "marketing," and "Internet of Things (IoT)." Recent investigations that integrate AI with big data and IoT models have become essential to enhance practical applications, since advancements in AI and deep learning technology have markedly progressed since the early prevalence of these trends.

The theme map indicates that current e-commerce AI research emphasizes the integration of deep learning and sentiment analysis platforms to improve user experiences. The fundamental topics of e-commerce and sales remain significant as IoT and big data evolve towards increasingly sophisticated AI solutions. Researchers have commenced the investigation of AI's impact on human behavior; nevertheless, this domain has yet to align effectively with core research issues.

4. Discussion

The examined publications enhance understanding in the domain of AI in E-commerce by categorizing study themes, pinpointing significant technological developments, and delineating intellectual frameworks. Nevertheless, research that expands theoretical frameworks to elucidate the strategic ramifications of AI implementation in E-commerce is still few. We therefore advocate for further study to broaden the theoretical framework to enhance comprehension of AI's impact on digital commerce.Consequently, additional research is required to investigate strategic management theories that inform critical decisions in AI implementation for E-commerce. For example, when determining

whether to create AI solutions internally or to outsource them, both the resource-based view (RBV) theory (Barney, 1991) and transaction cost economics (TCE) theory (Williamson, 1979) offer valuable perspectives. From the RBV perspective, firms ought to invest in internal AI skills if AI is deemed a fundamental capability that bolsters competitive advantage and data-driven decision-making (Grover et al., 2018). The TCE framework recommends that companies assess issues including asset specificity, transaction costs, and environmental uncertainty prior to determining whether to develop or acquire AI solutions. These theoretical frameworks may provide a systematic method for comprehending AI investment strategies within E-commerce enterprises.

The extent of AI automation vs augmentation in E-commerce operations requires more examination beyond investment decisions. AI is essential for personalizing customer experiences, doing predictive analytics, and facilitating automated decision-making; nevertheless, the degree to which AI should supplant or support human decision-making is still a matter of debate. Recent studies indicate that AI-driven automation improves efficiency; nonetheless, human involvement remains essential for ethical monitoring and intricate decision-making (Rust, 2020). This can be analyzed using prospect theory (Kahneman & Tversky, 2013) to comprehend the impact of AI-driven recommendations on consumer decision-making and to determine the presence of biases in AI-generated purchasing suggestions. Some contend that AI automation in E-commerce would supplant human positions, whilst others assert it will enhance personnel' strategic roles, enabling them to concentrate on innovative problem-solving and client interaction (Campbell et al., 2020). Consequently, subsequent study ought to investigate how AI transforms human roles in digital commerce and identify the requisite skill sets for AI-enhanced workforces.

A crucial domain that remains little examined is the ethical ramifications of AI in E-commerce. As AI-driven algorithms increasingly shape pricing strategies, tailored suggestions, and customer behavior forecasting, concerns about fairness, transparency, and consumer data privacy intensify. Our review, however, identified a deficiency of studies that implement ethical ideas in AI-driven E-commerce systems. Future research may include deontological ethics, utilitarian ethics, or virtue ethics (Manna & Nath, 2021) to assess how AI might be engineered to reconcile ethical considerations with commercial efficacy. Moreover, guaranteeing transparency and equity in AI-generated judgments is essential for preserving customer confidence and adhering to regulatory standards. Ultimately, the majority of current research on AI in E-commerce offers cross-sectional insights instead of longitudinal perspectives on the evolution of AI usage. We recommend that subsequent research employ a process theory framework to explore the implementation stages of AI in E-commerce, analyzing how companies address problems, expand AI adoption, and assess its long-term effects. By addressing these study deficiencies, experts can offer a more thorough comprehension of AI's disruptive impact on digital commerce.

5. Conclusion

5.1 Contributions of the Research

The study employing bibliometric methods and thematic mapping analyzes artificial intelligence in e-commerce to pinpoint significant advancements while predicting future research trajectories and obstacles in the ongoing evolution of this domain. The findings of co-occurrence network analysis indicate that "machine learning" and "e-commerce" are the primary subjects highlighting AI's pivotal role in the advancement of digital commerce. Machine learning facilitates deep learning technologies, natural language processing, and recommendation systems that provide critical services to improve supply chain optimization, market strategy creation, and tailored consumer experiences. These research findings are further corroborated by thematic mapping that differentiates AI applications in e-commerce into foundational and emerging, as well as well-established research streams.

The research provides empirical support of the theoretical framework developed by Aria and

Cuccurullo (2017) in their examination of AI and e-commerce. This research employs advanced bibliometric techniques in R programming to examine citations, co-occurrence networks, and thematic methodologies, revealing significant trends and models not previously documented in publications like Fedorko et al. (2022). Research endeavors in digital commerce predominantly emphasize machine learning, with deep learning, big data analytics, and sentiment analysis occupying pivotal roles due to their essential contributions to the evolution of digital commerce operations. The study examines the relationship between AI technologies and researchers, as well as the geographical distribution of research, to reveal global tendencies in this domain.

Thus, from a structural standpoint, machine learning serves as the fundamental catalyst for the AI-driven progression of e-commerce. Big data analytics, customization, and recommendation systems were incorporated into data-driven decision-making, which is crucial for customer engagement and operational efficiency. Sentiment analysis and the associated uses of chatbots signify the transition and progress towards more interactive and intelligent customer support solutions. The application of AI in sustainability, cross-border e-commerce, and supply chain efficiency clearly demonstrates its contribution to environmental digitization.

The theme map analysis indicates that although the core subjects of "e-commerce" and "sales" warrant investigation, cutting-edge AI applications are progressively emerging as predominant research topics. Advanced automation and predictive analytics are now considered essential catalysts for innovation, indicating an increasing interest in deep learning and learning systems. Additionally, the study identifies specialized areas, such as the impact of AI on corporate relationships with individuals, that remain unexamined but are anticipated to be investigated in future research. Furthermore, with the emergence of big data and IoT in AI-driven e-commerce, it is essential to integrate and optimize these elements to maximize their impact.

The report identifies the authors, institutions, and nations that have significantly contributed to AI research in e-commerce. Identifying notable scholars and research centers facilitates collaboration and knowledge exchange, fosters a feeling of academic community, and stimulates additional engagement among researchers. This study additionally demonstrates the interconnectedness of AI in e-commerce research by examining the collaboration patterns of researchers and institutions. The analysis of co-authorship networks and international collaborations reveals the global aspects of the research scene and the possibilities for cross-border partnerships. Understanding the essence of this relationship may accelerate innovation by facilitating information continuity and resource allocation.

Nonetheless, certain research gaps persist. The majority of research in AI and e-commerce has focused on practical applications rather than theoretical advances, emphasizing practical implementations above conceptual improvements. Future study ought to investigate strategic decision-making frameworks, like the Resource Based View (RBV) and Transaction Cost Economics (TCE), in assessing AI adoption methods. Furthermore, for AI to be employed responsibly and sustainably in e-commerce, it is essential to examine the ethical issues for transparency, bias, and data privacy.

Consequently, AI has emerged as a pivotal influence in the e-commerce sector, profoundly transforming operational dynamics and customer-business interactions. Texas Instruments announced that artificial intelligence has integrated with the chemistry of its semiconductor products, among other established technologies, fostering a synergy between AI and digital commerce that presents new prospects for innovation and enhanced efficiency. To fully explore the potential of AI, it is essential to address the absence of theoretical foundations in forthcoming research, raise ethical inquiries, and investigate the emergence of applications that align with the established digital world. Artificial intelligence has the potential to elevate e-commerce by bridging gaps, thereby transforming the digital economy to enhance growth, competitiveness, and sustainability.

5.2 Limitations and Further Research

The research study provides comprehensive analysis of AI in e-commerce, although it reveals

numerous constraints. The research relies predominantly on information from the Scopus database, as it does not authenticate data from other academic databases. A study methodology employing numerous credible databases would enhance comprehension of the entire field. Research should advance by conducting simultaneous database studies to integrate Scopus with Web of Science (WoS) and other appropriate research platforms.

This study necessitates more investigation into the research trajectories revealed by current findings. The development of explainable AI (XAI) algorithms for e-commerce recommender systems necessitates collaboration among user experience designers, marketing researchers, and computer scientists to formulate effective solutions. The examination of ethical issues related to AI in e-commerce necessitates collaborative efforts by ethicists, legal experts, and legislators to formulate reasonable regulations governing AI utilization. Investigating these identified limits while exploring these research avenues will yield more nuanced understanding of the AI-e-commerce interaction.

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