



Article

Is Artificial Intelligence a Game-Changer in Steering E-Business into the Future? Uncovering Latent Topics with Probabilistic Generative Models

Simona-Vasilica Oprea * and Adela Bâra

Department of Economic Informatics and Cybernetics, Bucharest University of Economic Studies, Piața Romană, 010374 Bucharest, Romania; bara.adela@ie.ase.ro

* Correspondence: simona.oprea@csie.ase.ro

Abstract: Academic publications from the Web of Science Core Collection on “e-business” and “artificial intelligence” (AI) are investigated to reveal the role of AI, extract latent themes and identify potential research topics. The proposed methodology includes relevant graphical representations (trends, co-occurrence networks, Sankey diagrams), sentiment analyses and latent topics identification. A renewed interest in these publications is evident post-2018, with a sharp increase in publications around 2020 that can be attributed to the COVID-19 pandemic. Chinese institutions dominate the collaboration network in e-business and AI. Keywords such as “business transformation”, “business value” and “e-business strategy” are prominent, contributing significantly to areas like “Operations Research & Management Science”. Additionally, the keyword “e-agribusiness” recently appears connected to “Environmental Sciences & Ecology”, indicating the application of e-business principles in sustainable practices. Although three sentiment analysis methods broadly agree on key trends, such as the rise in positive sentiment over time and the dominance of neutral sentiment, they differ in detail and focus. Custom analysis reveals more pronounced fluctuations, whereas VADER and TextBlob present steadier and more subdued patterns. Four well-balanced topics are identified with a coherence score of 0.66 using Latent Dirichlet Allocation, which is a probabilistic generative model designed to uncover hidden topics in large text corpora: Topic 1 (29.8%) highlights data-driven decision-making in e-business, focusing on AI, information sharing and technology-enabled business processes. Topic 2 (28.1%) explores AI and Machine Learning (ML) in web-based business, emphasizing customer service, innovation and workflow optimization. Topic 3 (23.6%) focuses on analytical methods for decision-making, using data modeling to enhance strategies, processes and sustainability. Topic 4 (18.5%) examines the semantic web, leveraging ontologies and knowledge systems to improve intelligent systems and web platforms. New pathways such as voice assistance, augmented reality and dynamic marketplaces could further enhance e-business strategies.

Keywords: e-business; AI; latent themes; sentiment analysis; future pathways; relevant trends



Academic Editors: Dongxiao Gu,
Jiantong Zhang and Jia Li

Received: 25 November 2024

Revised: 10 January 2025

Accepted: 17 January 2025

Published: 22 January 2025

Citation: Oprea, S.-V.; Bâra, A. Is Artificial Intelligence a Game-Changer in Steering E-Business into the Future? Uncovering Latent Topics with Probabilistic Generative Models. *J. Theor. Appl. Electron. Commer. Res.* **2025**, *20*, 16. <https://doi.org/10.3390/jtaer20010016>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

1.1. General Context of AI Implementation in E-Business

E-business refers to the use of internet-based technologies and digital platforms to conduct business operations. It encompasses a broad range of activities, including online sales (e-commerce), supply chain management, digital marketing, Customer Relationship

Management (CRM) [1,2], etc. AI has emerged as a game-changer in the e-business landscape by enabling automation, personalization, data-driven decision-making and enhanced customer experiences [3,4]. One of the most significant contributions of AI to e-business lies in the customer experience. AI enables businesses to analyze customer behavior, preferences and purchasing history to deliver highly personalized recommendations. Chatbots and virtual assistants, powered by AI, are increasingly used to provide real-time support, guiding users through purchasing decisions and addressing their queries [5–7]. Additionally, dynamic pricing models leverage AI to adjust prices based on demand, customer segmentation and competitor strategies [8]. AI also revolutionizes supply chain and inventory management in e-business. By utilizing predictive analytics, businesses optimize logistics, ensuring timely deliveries and cost efficiency. ML models help predict inventory needs based on historical data, market trends and seasonal fluctuations, reducing over- or understocking risks [9,10]. Furthermore, in terms of security, AI is an important tool for fraud detection and cybersecurity. Advanced algorithms continuously monitor transactions to detect anomalies, safeguarding both businesses and customers from financial losses [11].

AI-powered tools also facilitate smarter data analytics and decision-making. These systems process vast amounts of data in real-time, providing actionable insights that enable businesses to make informed strategic decisions. Predictive analytics helps forecast trends, customer behavior and market dynamics [12,13]. Marketing and customer engagement have also benefited greatly from AI integration. It enhances digital marketing strategies through targeted advertisements, personalized email campaigns and optimized content delivery. With Natural Language Processing (NLP), businesses analyze social media sentiment and customer reviews, allowing them to adapt their strategies based on customer feedback [14].

Routine tasks within e-business are increasingly automated using robotic process automation powered by AI. These systems handle repetitive activities such as data entry, order processing and report generation, improving operational efficiency while reducing human error [15,16]. However, the integration of AI also brings challenges, including concerns about data privacy, potential biases in algorithms, high implementation costs and the risk of job displacement [17]. Innovations such as voice commerce, where purchases are facilitated through voice-activated assistants and Augmented Reality (AR), which provides immersive shopping experiences, are set to transform the industry even further. Predictive commerce, powered by AI systems that anticipate customer needs and blockchain integration for enhanced transaction transparency and trust are also on the horizon.

1.2. Controversies

AI in e-business raises several controversies. These issues are rooted in ethical, social, economic and technical challenges that must be addressed to ensure the responsible use of AI. One of the most prominent concerns is data privacy and security. AI systems in e-business rely heavily on collecting and analyzing customer data to provide personalized experiences and optimize operations. However, this extensive data collection often occurs without explicit consent or sufficient transparency, raising privacy concerns. Moreover, the centralized nature of AI systems makes them vulnerable to data breaches, exposing sensitive customer information. The use of AI to track user behavior and preferences may also be perceived as surveillance, eroding trust between businesses and consumers [18].

Another contentious issue is algorithmic bias and fairness. AI systems may inadvertently perpetuate biases present in their training data, leading to discriminatory practices. For instance, certain customer demographics might be unfairly targeted with specific advertisements or pricing strategies. Compounding this issue is the opaque nature of many AI models, which makes it difficult to identify and rectify biases [19,20]. Additionally, AI-

driven automation in e-business has sparked debates about its impact on employment. By automating routine tasks, AI reduces the need for human intervention. While this increases efficiency, it also raises concerns about job displacement and economic inequality. Furthermore, the ability of AI to predict and influence consumer behavior has led to concerns about manipulative practices. AI-driven personalization may exploit customer vulnerabilities, encouraging impulsive purchases or targeting specific groups with products they may not need [20]. Furthermore, addictive designs, such as gamification and psychological triggers, are increasingly used to foster dependency on e-commerce platforms, raising ethical questions about consumer autonomy.

Accountability is another significant issue. When AI systems make mistakes, such as denying legitimate transactions or producing biased outcomes, it is often unclear who should be held responsible. This ambiguity complicates efforts to address issues of accountability and fairness in e-business. The growing reliance on AI in e-business also introduces systemic risks and reduces human oversight. Overdependence on AI may lead to complacency, where human decision-makers fail to question automated decisions. Furthermore, a malfunction or failure in widely used AI systems may disrupt operations across multiple e-business platforms, causing widespread consequences [21].

In marketing and advertising, AI has sparked debates about ethical boundaries. While personalization enhances customer experiences, hyper-targeted advertising may feel invasive and manipulative [22,23]. Additionally, AI is increasingly used to create deceptive content, such as fake reviews or deepfake advertisements, undermining consumer trust. Moreover, the concentration of AI resources and expertise in a few large corporations creates issues of monopoly and market dominance [24]. Smaller businesses often struggle to compete with the efficiency and personalization capabilities of these larger entities, which may stifle innovation and limit consumer choice.

1.3. Side-Effects Mitigation

Alleviating the side effects of AI in e-business requires a combination of ethical practices, regulatory frameworks, technical innovation and education: (1) Developers should focus on creating diverse and unbiased training datasets to minimize the risk of discriminatory outcomes. Additionally, explainable AI (XAI) tools may improve transparency by providing insights into how AI systems make decisions, allowing for greater accountability and trust [25]. (2) Governments and businesses should collaborate to provide training programs that help workers transition into roles that complement AI-driven automation. Incentives for businesses to retain and retrain their workforce may also encourage a more inclusive transition. (3) Laws should be established to prevent exploitative behaviors, such as using AI to manipulate consumers into making impulsive purchases or to promote addictive designs [26]. (4) Governments need to establish clear rules for accountability when AI systems fail or produce harmful outcomes. Frameworks should outline responsibilities for developers, businesses and operators of AI systems. (5) AI systems should be designed to augment human decision-making rather than replace it entirely. Human-in-the-loop systems ensure that critical decisions remain under human control, reducing the risks associated with overdependence on AI.

1.4. Objective, Research Questions and Contributions

The objective of our research is to investigate the intersection of e-business and AI through a comprehensive analysis of academic publications extracted from the Web of Science Core Collection. It aims to uncover the role of AI in e-business, identify latent themes and highlight emerging research topics.

The main research questions to which the authors intend to answer are as follows:

RQ1: *What are the main topics embedded in the e-business and AI-related publications?*

RQ2: *What are the key topics that could be further studied in the research landscape?*

By employing advanced methodologies such as graphical trend analysis, co-occurrence networks, Sankey diagrams, sentiment analysis and LDA for topic modeling, providing a multidimensional exploration of the field, our research makes significant contributions to both academic and practical domains. It advances knowledge on the role of AI in e-business by providing insights into how AI facilitates business transformation, strategic value creation and operational efficiency. Additionally, the methodological approach, including the use of LDA for topic modeling, enhances bibliometric and text analysis techniques, offering a valuable methodological framework for future research.

The identification of emerging trends and gaps is another key contribution. Practically, this paper underscores the potential of AI in enabling data-driven decision-making, improving information sharing and streamlining business processes. Furthermore, the emphasis on sustainability, particularly through the recent concept of e-agribusiness, demonstrates how businesses can align technological advancements with environmental objectives, promoting sustainable development.

From an academic perspective, this paper enriches the understanding of AI in e-business by identifying four coherent thematic areas using topic modeling. These include (1) data-driven decision-making, (2) ML applications in business innovation, (3) analytical methods for enhancing sustainability, and (4) the role of the semantic web in intelligent systems. This paper also adds to the field of sentiment analysis by comparing methodologies such as custom analysis, VADER and TextBlob, offering insights into their robustness and limitations.

Our research findings may have implications for policymakers and strategists, particularly in guiding digital transformation efforts and fostering sustainable innovations. The dominance of Chinese institutions in the collaborative networks also highlights the geographical and institutional dynamics of this research area, providing a basis for strengthening international collaboration.

Finally, this paper opens pathways for future research by identifying underexplored areas such as the application of AI in e-agribusiness and the semantic web. The future of e-business powered by AI offers transformative potential across several dimensions, promising to revolutionize operations, customer interactions and innovation. It advocates for cross-disciplinary studies that integrate AI, e-business and sustainability. It also identifies new pathways, such as voice and conversational commerce, immersive experiences with AR, emotion-aware AI, blockchain integration, dynamic marketplaces and advanced sentiment analysis.

This research contributes to understanding the role of AI in e-business by conducting a comprehensive bibliometric and textual analysis of academic publications from the Web of Science Core Collection. Our research offers fresh insights into AI's role in e-business. It highlights how AI facilitates business transformation, strategic value creation and operational efficiency in e-business. Key applications include customer personalization, supply chain optimization, fraud detection and marketing automation. Our findings emphasize the integration of e-business principles with environmental objectives, such as the concept of e-agribusiness, demonstrating AI's potential to promote sustainable practices. This research highlights the growing prevalence of positive sentiment in the field and provides a comparative evaluation of sentiment analysis techniques. The dominance of Chinese institutions in the collaboration network provides a basis for strengthening international partnerships in e-business and AI research. The findings offer valuable insights for policymakers and strategists in guiding digital transformation.

Apart from other bibliometric analyses on AI and e-business intersection, our research offers two main contributions:

1. Identification of emerging themes and trends. Using advanced methods like Latent LDA, this research uncovers four coherent thematic areas:
 - o Data-driven decision-making in e-business.
 - o AI and machine learning applications for innovation and workflow optimization.
 - o Analytical methods enhancing sustainability and strategy.
 - o The role of the semantic web in intelligent systems and web platforms.
2. Methodological advancements. The integration of LDA topic modeling and sentiment analysis (using custom analysis, VADER and TextBlob) offers a framework for exploring large text corpora, providing actionable insights for future bibliometric studies.

The remainder of this paper is organized as follows: Section 2 describes the most recent and relevant literature review and Section 3 presents the methodology, including the data sources, analytical tools and techniques used. Section 4 presents the results, detailing the key findings. Section 5 provides a discussion on future pathways, exploring their significance and potential applications. Section 6 concludes this paper by summarizing the main contributions, highlighting limitations and suggesting directions for future research.

2. Literature Review

AI has become a widely adopted technology in the e-commerce sector, enabling businesses to enhance various aspects of their operations. Despite the growing use of AI in this industry, there has been limited bibliometric analysis conducted to systematically map the research in this field. While AI applications in e-commerce continue to expand, a comprehensive overview of scholarly work that tracks the progress, key research areas and emerging trends has not been extensively explored, leaving a gap in understanding the full scope of academic contributions to AI in e-commerce.

A bibliometric analysis and a literature review were combined to explore AI research in e-commerce, analyzing 4335 documents and 229 key articles [27]. It highlighted recommender systems, sentiment analysis, trust, personalization and optimization as central themes, with China leading in research contributions. Another piece of research examined the impact of AI on fashion e-commerce through a systematic review of 219 publications from Web of Science and Scopus [28]. The articles were categorized using AI techniques into two groups, enabling the identification of research gaps in AI applications. These gaps highlighted opportunities for future exploration. Furthermore, 711 articles on AI and Big Data Analytics (BDA) published between 2012 and 2022 were reviewed [29], identifying key trends and contributions across multiple disciplines. Data from 59 countries showed the USA as the most influential nation (101 documents; 5405 citations) and China as the most productive (204 documents; 2371 citations). Symbiosis International University in India emerged as the leading institution. This research highlighted five main clusters: Business and Management, Engineering, Healthcare, Sustainable Operations and Industry 4.0 and Tourism and Hospitality, with applications in real-world challenges. Prominent research areas were highlighted. A total of 658 publications from Scopus on digitalization between 2018 and 2022 were further analyzed using RStudio and VOSviewer [30]. It identified ten key application areas, including Industry 4.0, AI in supply chain management, augmented reality, healthcare and digital collections.

Another piece of research reviewed research on how technologies such as NLP, sentiment analysis, business intelligence and IoT data influenced customer behavior in online and virtual marketplaces [31]. A quantitative review of 84 studies from 2022 narrowed down to 17 empirical sources using tools like PRISMA, AXIS and VOSviewer. The find-

ings showed that predictive algorithms, data visualization and artificial neural networks enhanced performance in livestreaming e-commerce by shaping purchasing habits, loyalty and customer engagement. It highlighted the significant role of AI and data-driven tools in transforming the retail metaverse. Moreover, [32] conducted a bibliometric analysis of AI in e-commerce from 2014 to mid-2023 using data from 669 manuscripts in the Scopus database. It evaluated author status, nations, affiliations and keywords using VOSviewer and R Studio. The UK emerged as the leading publisher with the strongest co-authorship links, while the most productive journal was Proceedings of the International Conference on Electronic Business. Key research areas included business, management and accounting, with popular keywords such as ML, e-commerce, recommender systems, fraud detection and data mining. AI has driven rapid changes, enhancing efficiency, productivity and cost-effectiveness for companies. Additionally, [33] analyzed research trends in AI applications within e-commerce through systematic review, network analysis and bibliometric methods, focusing on co-authorship, co-citation and keyword analysis. The findings revealed a growing academic interest in AI's role in e-commerce, highlighting its importance for theoretical and applied research. Another piece of research analyzed trends and developments in e-retailing, focusing on Indonesia and the global context, using bibliometric analysis and systematic literature review with VOSviewer software [34]. The findings identified eight key clusters in e-retailing: chatbots, customer satisfaction, purchase intention, customer experience, artificial intelligence, social media and mobile commerce.

The impact of AI in marketing through a bibliometric and intellectual network analysis of 1580 papers published between 1982 and 2020 was further reviewed [35]. Using methods such as co-citation, co-occurrence analysis and the Louvain algorithm, the researchers identified key authors, sources, sub-themes and future directions for AI in marketing. Practical examples highlighted AI's transformative role in e-commerce, particularly through Amazon's use of AI to enhance customer experiences and streamline online shopping. Another piece of research examined the influence of AI on product recommendations in e-commerce, focusing on its impact on consumer behavior and purchasing decisions [36]. Using bibliometric analysis of 103 articles from 2017 to 2023 in the Scopus database, 29 relevant studies were analyzed. The findings revealed that AI significantly affects recommendation systems, decision support systems, customer behavior and customer trust, highlighting the role of product recommendations in shaping e-commerce outcomes. However, the review identified a limited number of studies addressing the implementation of AI in areas such as consumer behavior, trust and purchasing decisions, underscoring the need for further research in this field. The challenges of integrating AI into businesses were investigated [37], noting that 85% of AI initiatives fail to meet expectations. Using Alibaba's e-commerce fulfillment center as a case study, it analyzed how AI technology, human resources and processes can be managed to create value. Key AI resources, including data, algorithms and robots, were found to generate capabilities like forecasting, planning and learning when effectively orchestrated with facilities and information systems.

Another piece of research examined the applications of ML and AI in e-commerce, corporate management and finance [38]. AI has been employed to enhance customer experience, optimize supply chain management, improve operational efficiency and maintain low costs while ensuring product quality. Key applications included sales growth, profit maximization, sales forecasting, inventory management, security, fraud detection and portfolio management. ML and deep learning were highlighted as significant tools for analyzing complex and diverse data, with ongoing developments targeting industries such as food, finance and e-commerce to drive innovation and efficiency. How AI can optimize digital marketing strategies through a systematic literature review using the PRISMA framework was also analyzed [39]. Investigating 211 articles, this research identified key clusters:

AI/ML algorithms, social media, consumer behavior, e-commerce, digital advertising, budget optimization and competitive strategies. The findings highlighted AI's transformative potential in enhancing marketing efforts and provided insights into trends, challenges and opportunities at the intersection of AI and digital marketing. Reference [40] examined the impact of different types of online customer service: AI, manual and human-machine collaboration, on customer purchase intentions, using service encounter and superposition theories. Two shopping experiments revealed that perceived service quality significantly influences purchase intention, serving as a mediating factor, while product type moderates this relationship. Notably, human-machine collaboration demonstrated a superposition effect, enhancing customer purchase intention.

Technologies like ML and deep learning have enhanced e-commerce operations through personalized product recommendations, automated customer service, optimized search interfaces and improved security [41]. These AI-driven solutions have enabled companies to enhance customer experiences, lower operational costs and increase efficiency, supporting the continued evolution of e-commerce. Another piece of research explored the implementation of AI fairness in e-commerce, focusing on coupon allocation based on clickstream sessions [42]. While AI fairness successfully reduced disparate outcomes and met fairness requirements with minimal impact on prediction performance, it also increased financial costs. The findings highlighted the trade-offs between ethical AI practices and operational expenses, offering insights into designing information systems that prioritize fairness while balancing performance and cost considerations.

The role of AI in e-commerce was examined [43], emphasizing its transformative potential for personalization and product customization. However, it highlighted the ethical challenges surrounding the explainability of AI systems. This research explored the concept of XAI, a field focused on making ML models transparent and interpretable. The findings underscored the need to improve AI models to enhance their comprehensibility, laying a foundation for developing XAI frameworks that address ethical concerns while maintaining effectiveness in e-commerce applications. Nonetheless, the future of AI in e-commerce is marked by greater personalization, automation and convenience for customers, alongside enhanced efficiency and profitability for businesses. The researchers found that AI has already transformed business operations and customer experiences, enabling companies to reduce costs and improve performance [44]. Table 1 provides a comparative view of the previous studies.

Table 1. Comparison of the previous research on e-business and AI.

Ref	Objective	Methods	Keywords	Main Findings
[27]	Synthesizes research on AI in e-commerce and proposes IS research guidelines.	Bibliometric analysis and extensive literature review (4335 documents analyzed, 229 articles reviewed).	AI, E-commerce, Recommender Systems, Personalization, Sentiment Analysis, Trust, Optimization.	Recommender systems dominate research. Identified core themes: sentiment analysis, trust, personalization, optimization. China is leading in research output.
[28]	Examines AI's significance and impact on fashion e-commerce.	Systematic review using Web of Science and Scopus databases (219 publications).	Fashion E-commerce, AI, Research Gaps.	Identified two categories in AI's application in fashion e-commerce and research gaps for future exploration.

Table 1. Cont.

Ref	Objective	Methods	Keywords	Main Findings
[29]	Summarizes bibliometric articles on AI and BDA across multiple fields.	Bibliometric review (711 documents from Scopus Q1 and Q2 journals, 2012–2022).	AI, BDA, Bibliometric Analysis, NLP, Deep Learning.	USA is most influential, China is most productive. Five main disciplines for AI/BDA: Business, Engineering, Healthcare, Sustainable Operations, Tourism.
[30]	Analyzes publications on digitalization from 2018 to 2022.	Bibliometric review using RStudio and VOSviewer (658 documents).	Digitalization, Big Data, AI, Industry 4.0.	Identified ten fields of digitalization applications, with AI and supply chain management being prominent areas.
[31]	Examines AI tools' role in retail metaverse.	Quantitative literature review with PRISMA framework (17 articles analyzed).	Retail Metaverse, AI, Sentiment Analysis, Predictive Algorithms.	AI enhances business performance in live-streaming e-commerce via predictive algorithms, sentiment analysis, and data visualization tools.
[32]	Assesses AI research landscape and trends in e-commerce (2014–2023).	Bibliometric analysis using Scopus database, VOSviewer, and R Studio (669 manuscripts).	E-commerce, AI, ML, Fraud Detection.	Popular areas: business, management, and accounting. UK leads in publications and co-authorship. Key terms: recommender systems, fraud detection, decision-making systems.
[33]	Analyzes research trends on AI in e-commerce.	Systematic review, network, and bibliometric analysis.	AI, E-commerce, Productivity, Efficiency.	AI use in e-commerce is increasing, focusing on efficiency, cost reduction, and productivity improvement.
[34]	Analyzes trends and developments in e-retailing, focusing on Indonesia and globally.	Bibliometric analysis and literature review using VOSviewer.	E-retailing, Chatbots, Customer Satisfaction, Mobile Commerce.	Chatbots, customer satisfaction, and purchase intention are key to e-retailing success.
[35]	Comprehensive review of AI in marketing (1982–2020).	Bibliometric, abstract, and intellectual network analysis (1580 papers).	AI, Marketing, E-commerce, Amazon.	Identified research sub-themes and practical examples of AI in e-commerce, with Amazon as a key example.
[36]	Explores AI's impact on product recommendations in e-commerce.	Bibliometric analysis of 103 articles from Scopus (2017–2023).	AI, Product Recommendations, Customer Trust, Decision-making.	AI influences consumer behavior, customer trust, and purchasing decisions in e-commerce.
[37]	Analyzes AI's success factors in e-commerce using Alibaba as a case study.	Resource orchestration perspective.	AI, Resource Management, E-commerce, Alibaba.	AI resources (data, algorithms, robots) co-evolve with human capabilities to drive efficiency and effectiveness.
[38]	Discusses AI applications in e-commerce, corporate management, and finance.	Literature review.	AI, ML, Deep Learning, Fraud Detection.	AI improves customer experience, operational efficiency, and business profitability.
[39]	Optimizes digital marketing strategies using AI.	Systematic literature review with PRISMA framework (211 articles).	AI, Digital Marketing, Consumer Behavior, Social Media.	AI/ML algorithms are crucial for digital marketing, focusing on personalization, social media, and competitive strategies.
[40]	Examines AI's role in online customer service and purchase intention.	Shopping experiments based on service encounter and superposition theories.	AI, Customer Service, Purchase Intention.	Human–machine collaboration enhances perceived service quality and purchase intention.
[41]	Examines AI's transformative role in e-commerce.	Descriptive analysis.	AI, Personalization, Automation, E-commerce.	AI enables personalization, reduces costs, and enhances efficiency in e-commerce.

Table 1. *Cont.*

Ref	Objective	Methods	Keywords	Main Findings
[42]	Explores AI fairness in e-commerce.	Developed AI fairness model using clickstream sessions.	AI Fairness, E-commerce, Clickstream Sessions.	AI fairness increases financial costs but ensures compliance with fairness requirements.
[43]	Investigates XAI models' role in e-commerce.	Word cloud, voyance, and concordance analysis.	Explainable AI, XAI, E-commerce, Personalization.	Proposed XAI models for transparent and interpretable AI systems in e-commerce.
[44]	Analyzes AI's evolving role in e-commerce.	Qualitative analysis.	AI, E-commerce, Personalization, Automation.	AI enhances personalization, automation, and profitability in e-commerce.

The key gaps identified in the literature are the lack of analysis on latent topics within academic publications and the fresher exploration of emerging trends and opportunities that AI could bring to e-business. While existing studies have focused on specific applications or case studies, there remains a need for a comprehensive approach to uncover hidden themes, research trajectories and potential future directions in the integration of AI within e-business ecosystems.

3. Methodology

This section outlines the input dataset and the proposed methodology, detailing the steps taken to derive insights from the data. The selected methods, Latent Dirichlet Allocation, sentiment analysis, visual representations, graphical networks, trends, distributions and frequency analysis, are employed to achieve the research objectives and address the research questions.

3.1. Input Dataset

The dataset (<https://github.com/simonavoprea/ebai>) is downloaded from Web of Science (WoS) Core Collection previously filtered by “e-business” and “artificial intelligence”, aiming to analyze the publications in which these two topics are studied together. 448 of full records were found by mid-November 2024 (17th of November). The search focused on the two concepts, “e-business” and “artificial intelligence”, aiming to explore their intersection and derive insights from academic publications. All publication types, such as C (Conference papers or proceedings), J (Journal articles) and S (Short papers, symposium contributions, or other specific formats), were extracted. No additional filters were applied to the search criteria. No full text was obtained, only the abstract was available for each publication. Out of the entire set of columns (over 70), we keep the most relevant ones (as in Table 2):

Table 2. Relevant columns in the input dataset, their meanings, along with examples of possible values.

Column Name	Meaning	Example Value
Publication Type	Type of publication (e.g., journal, conference)	“C” (Conference), “J” (Journal)
Article Title	Title of the research article	“The Impact of Artificial Intelligence and Internet of Things on E-business”
Source Title	Name of the journal or conference where the article was published	“ANNALS OF OPERATIONS RESEARCH”
Document Type	Specific type of the document	“Proceedings Paper”, “Article”

Table 2. *Cont.*

Column Name	Meaning	Example Value
Conference Date	Date of the conference	"26 April 2019", "NaN"
Conference Location	Location of the conference	"Charlottesville, VA", "NaN"
Author Keywords	Keywords provided by the authors	"Artificial Intelligence; E-business; IoT"
Keywords Plus	Additional keywords generated by indexing	"E-COMMERCE; AI", "PREDICTION"
Abstract	Summary of the article	"This study explores the impact of Artificial Intelligence..."
Affiliations	Affiliations of the authors	"Tshwane University of Technology", "NaN"
Times Cited, All Databases	Total citations from all databases	-
180 Day Usage Count	Number of accesses in the last 180 days	-
Since 2013 Usage Count	Number of accesses since 2013	-
Publisher	Publisher of the journal or conference proceedings	"IEEE", "SPRINGER"
Publisher City	City where the publisher is based	"NEW YORK", "BERLIN"
Publisher Address	Address of the publisher	"345 E 47TH ST, NEW YORK, NY 10017 USA"
Publication Date	Specific date of publication	"JUL", "NaN"
Publication Year	Year of publication	2019, 2023
WoS Categories	Web of Science categories for the article	"Computer Science, Interdisciplinary Applications"
Research Areas	Research areas associated with the article	"Computer Science; Engineering"

Summary statistics for the non-numerical columns and numerical columns are provided in Tables 3 and 4.

Table 3. Summary statistics for the non-numerical columns.

Column	Count	Unique	Top Value	Frequency
Publication Type	448	3	C	282
Article Title	448	448	The Impact of Artificial Intelligence and Internet of Things in the Transformation of E-Business Sector	1
Source Title	448	293	UNCERTAINTY REASONING FOR THE SEMANTIC WEB I	22
Document Type	448	7	Proceedings Paper	282
Conference Date	331	190	11–15 November 2007	27
Conference Location	331	149	Busan, SOUTH KOREA	27
Author Keywords	335	334	mash up; drag and drop; faceted browsing; simultaneous editing; ontology alignment; end-user programming	2
Keywords Plus	188	178	ALGORITHM	4
Abstract	445	445	[Full abstract text]	1
Affiliations	408	341	University of Salento	5
Publisher	448	73	SPRINGER-VERLAG BERLIN	120

Table 3. *Cont.*

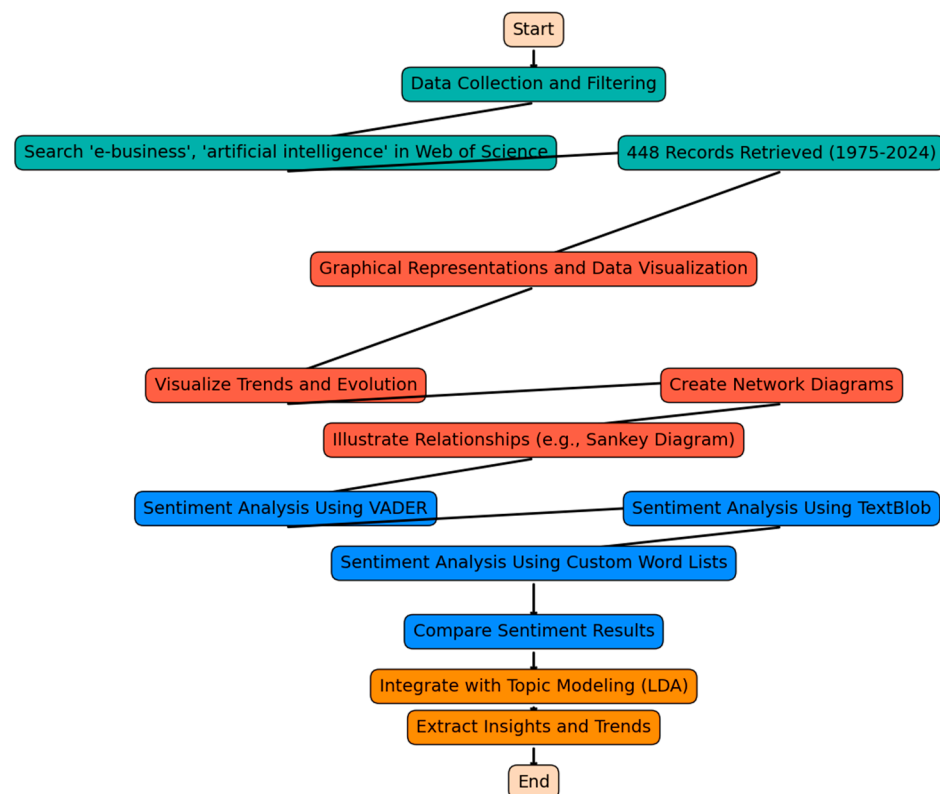
Column	Count	Unique	Top Value	Frequency
Publisher City	448	59	BERLIN	120
Publisher Address	448	81	HEIDELBERGER PLATZ 3, D-14197 BERLIN, GERMANY	120
Publication Date	105	50	AUG	9
WoS Categories	447	138	Computer Science, Artificial Intelligence	82
Research Areas	447	65	Computer Science	234

Table 4. Summary statistics for the numerical columns.

Column	Count	Mean	Std Dev	Min	25%	50%	75%	Max
Cited Reference Count	448	30.801	31.733	0	12	20	36	244
Times Cited, WoS Core	448	7.772	19.220	0	0	1	6	197
Times Cited, All DBs	448	8.391	21.211	0	0	1.5	7	231
180 Day Usage Count	448	3.002	10.404	0	0	0	1	135
Since 2013 Usage Count	448	17.781	42.799	0	1	3	12.25	442
Publication Year	448	2012	7.466	1999	2006	2010	2020	2025

3.2. Methodology Steps

The proposed methodology, depicted in the flowchart in Figure 1, outlines a systematic approach for analyzing research trends and sentiment related to “e-business” and “artificial intelligence” by leveraging bibliometric and text analysis techniques. A detailed breakdown of each step in the methodology is offered in the following paragraphs.

**Figure 1.** Flowchart of the proposed methodology.

Step 1. Data collection and filtering.

This research begins with the identification and retrieval of relevant literature from the Web of Science database. Keywords such as “e-business” and “artificial intelligence” are used to filter records, spanning from 1999 to 2024, yielding a dataset of 448 records.

Step 2. Graphical representations and data visualization.

The collected data undergo processing for visualization to make trends and patterns more understandable. Two main visualization objectives are pursued:

- Visualizing trends and evolution. This involves identifying temporal changes in research activity, such as the frequency of publications over time, key contributing institutions or thematic shifts.
- Creating network diagrams. Network diagrams depict relationships between keywords or research topics, highlighting interconnected areas of study.

Step 3. Illustrate relationships (e.g., Sankey diagram).

Relationships among key terms, concepts or research trends are illustrated using Sankey diagrams. These diagrams show the flow or connections between key elements, such as those focused on “business”, publication years and research areas, offering a clear picture of how different ideas or areas interact or temporarily evolve.

Step 4. Sentiment analysis.

Sentiment analysis is performed to assess the emotional tone and context of the literature:

- Using VADER. A rule-based sentiment analysis tool tailored for text, focusing on the positive, negative or neutral tone of the text (opinions).
- Using TextBlob. A tool for NLP that provides a polarity score (positive/negative) and subjectivity score.
- Using custom word lists. A tailored approach where domain-specific terms are manually curated, assigning sentiment scores based on the context of e-business and artificial intelligence.

Step 5. Compare sentiment results.

Results from all sentiment analysis methods are compared to identify patterns or discrepancies. This triangulation ensures consistent findings by capturing both general and context-specific sentiments.

Step 6. Integrate with topic modeling.

Sentiment analysis results are integrated with LDA topic modeling to identify dominant research themes and their sentiment context. This step links the emotional tone of discussions to specific themes or areas within the dataset, offering deeper insights. The final step synthesizes the findings, highlighting key trends, themes and patterns in the research landscape of e-business and artificial intelligence.

The combination of sentiment analysis, topic modeling and visualizations creates a holistic understanding of the field. Using multiple sentiment tools (VADER, TextBlob, custom word lists) ensures both breadth and depth, accommodating general sentiment and domain-specific nuances. Visualizing relationships through Sankey diagrams and network diagrams enhances the interpretability of complex connections between concepts.

For the application of the LDA to abstracts of publications in the WoS dataset, each abstract consisting of 200–350 words, we define the probabilistic generative process and associated mathematical equations.

Step 6.1. Key notations are defined in Table 5.

Table 5. LDA model variables.

Variable	Depiction
D	Number of abstracts (documents) in the dataset
V	Vocabulary size (total unique words across all abstracts)
K	Number of topics k .
N_d	Number of words in document d (approximately 200–350 words in this context)
$w_{d,n}$	The n -th word in document d , where $w_{d,n} \in \{1, 2, \dots, V\}$
θ_d	Topic distribution for document d , a K -dimensional vector
ϕ_k	Word distribution for topic k , a V -dimensional vector
$z_{d,n}$	Latent topic assignment for word $w_{d,n}$, where $z_{d,n} \in \{1, 2, \dots, K\}$

Step 6.2. Generative process

LDA models the generative process for each word in the abstracts as follows:

1. For each document d in the corpus—sample a topic distribution θ_d from a Dirichlet distribution:

$$\theta_d \sim \text{Dirichlet}(\alpha) \quad (1)$$

where α is a K -dimensional hyperparameter controlling the sparsity of θ_d .

2. For each topic k —sample a word distribution ϕ_k from another Dirichlet distribution:

$$\phi_k \sim \text{Dirichlet}(\beta) \quad (2)$$

where β is a V -dimensional hyperparameter controlling the sparsity of ϕ_k .

3. For each word $w_{d,n}$ in document d , perform the following:

- Sample a topic assignment $z_{d,n}$ from the document's topic distribution:

$$z_{d,n} \sim \text{Categorical}(\theta_d) \quad (3)$$

- Sample the word $w_{d,n}$ from the topic's word distribution:

$$w_{d,n} \sim \text{Categorical}(\phi_{z_{d,n}}) \quad (4)$$

Step 6.3. Joint distribution. The joint probability of the observed words w , topic assignments z and latent variables θ and ϕ is given by the following:

$$P(w, z, \theta, \phi | \alpha, \beta) = \prod_{k=1}^K P(\phi_k | \beta) \prod_{d=1}^D P(\theta_d | \alpha) \prod_{n=1}^{N_d} P(z_{d,n} | \theta_d) P(w_{d,n} | \phi_{z_{d,n}}) \quad (5)$$

Step 6.4. Marginal likelihood. The likelihood of the observed data (words w) is obtained by marginalizing over z , θ and ϕ :

$$P(w | \alpha, \beta) = \iint \sum_z P(w, z, \theta, \phi | \alpha, \beta) d\phi d\theta \quad (6)$$

Step 6.5. Approximation methods

- Variational inference. Approximate $P(w, z, \theta, \phi)$ with a variational distribution $q(\theta, \phi, z)$ to minimize the Kullback–Leibler (KL) divergence:

$$KL(q || P) = \mathbb{E}_q[\log q(\theta, \phi, z) - \log P(\theta, \phi, z | w, \alpha, \beta)] \quad (7)$$

- Gibbs sampling—use collapsed Gibbs sampling to iteratively sample the topic assignments $z_{d,n}$ based on the conditional distribution:

$$P(z_{d,n} = k | w, z_{-d,-n}, \alpha, \beta) \propto \frac{n_{d,k}^{-n} + \alpha}{n_{d,\cdot}^{-n} + K\alpha} \frac{n_{k,w}^{-d,-n} + \beta}{n_{k,\cdot}^{-d,-n} + V\beta} \quad (8)$$

where $n_{d,k}$ —count of words in document d assigned to topic k .

$n_{k,w}$ —count of word w assigned to topic k .

The superscript $-n$ or $-d, -n$ indicates the exclusion of the current word or document.

Step 6.6. Evaluation metrics

- Perplexity (measures the generalization ability of the model):

$$Perplexity = \exp \left(- \frac{\sum_{d=1}^D \log P(w_d | \alpha, \beta)}{\sum_{d=1}^D N_d} \right) \quad (9)$$

- Topic coherence (measures interpretability of topics):

$$Coherence = \sum_{i < j} \log \frac{P(w_i, w_j)}{P(w_i)P(w_j)} \quad (10)$$

where $P(w_i, w_j)$ is the probability of words w_i and w_j co-occurring in the same document.

For abstracts in the WoS dataset, the LDA reveals thematic structures by (1) treating each abstract as a document and processing the text into a bag-of-words representation; using variational inference or Gibbs sampling to estimate topic distributions (θ_d) for each abstract; (2) extracting insights such as the dominant research topics, their evolution over time and key trends by analyzing the topic-word distributions (ϕ_k) and document-topic distributions (θ_d).

4. Results

4.1. Graphical Representations

Figure 2 illustrates the number of publications related to e-business and AI over time, showing distinct trends across different periods. Between 2000 and 2010, there was a steady rise in publications, peaking around 2005–2010, reflecting the initial integration of AI technologies into e-business and the growing research interest in their applications. Following this peak, the number of publications declined slightly and entered a relatively stable phase during the period from 2011 to 2018. This phase indicates a period with fewer groundbreaking developments. A renewed interest is evident post-2018, with a sharp increase in publications around 2020 and beyond, reaching a new peak. This resurgence can be attributed to advancements in AI technologies, including ML, deep learning, blockchain and big data analytics, as well as the rapid expansion of e-commerce during the COVID-19 pandemic.

The violin plot in Figure 2 represents the distribution of citation counts for publications across different years. Publications from earlier years, particularly pre-2005, show a wider spread in citation counts, with some papers receiving significantly high citations (above 200). During the mid-years, between 2005 and 2015, the citation distribution narrows, suggesting fewer outliers with extremely high citations. Most publications during this period received moderate and consistent citation counts. In the post-2015 period, recent publications exhibit lower citation counts with tighter distributions.

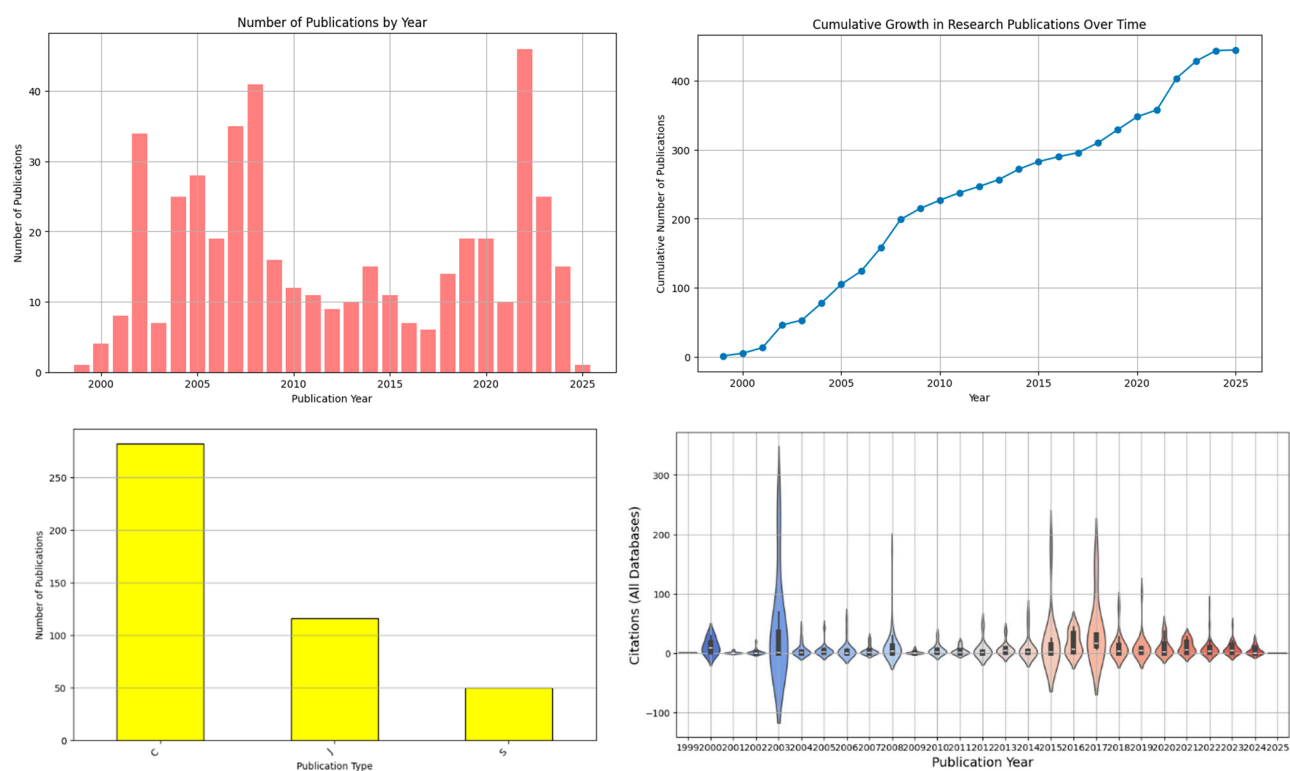


Figure 2. Number and cumulative growth in research publications, type and distribution of citations.

The two plots in Figure 3 provide a detailed overview of the research focus on “e-business” and “artificial intelligence” by examining keyword frequency and the distribution of publications across research areas. The first plot highlights the most commonly used keywords. Significant terms, such as “e-commerce”, “machine learning” and “semantic web” suggest a strong emphasis on integrating AI technologies into digital business processes and structuring data for meaningful applications. Additionally, terms like “trust” and “digitalization” indicate emerging themes, reflecting growing attention to the ethical, relational and transformational aspects of AI in business contexts. Keywords like “data mining” and “classification” reveal the technical approaches frequently employed in this research.

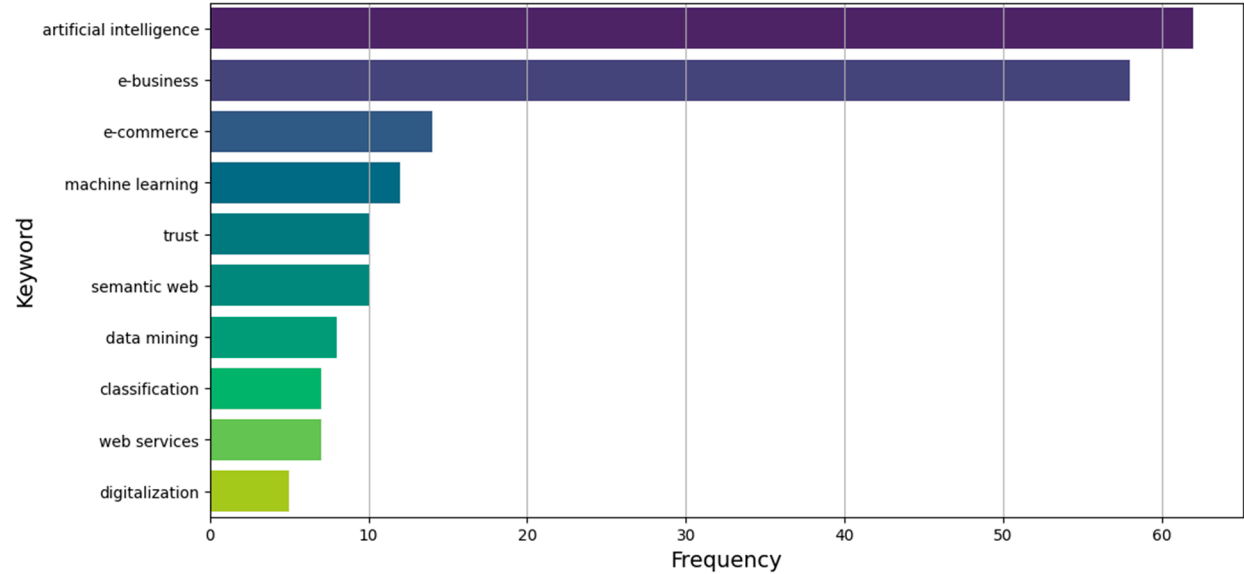


Figure 3. Cont.

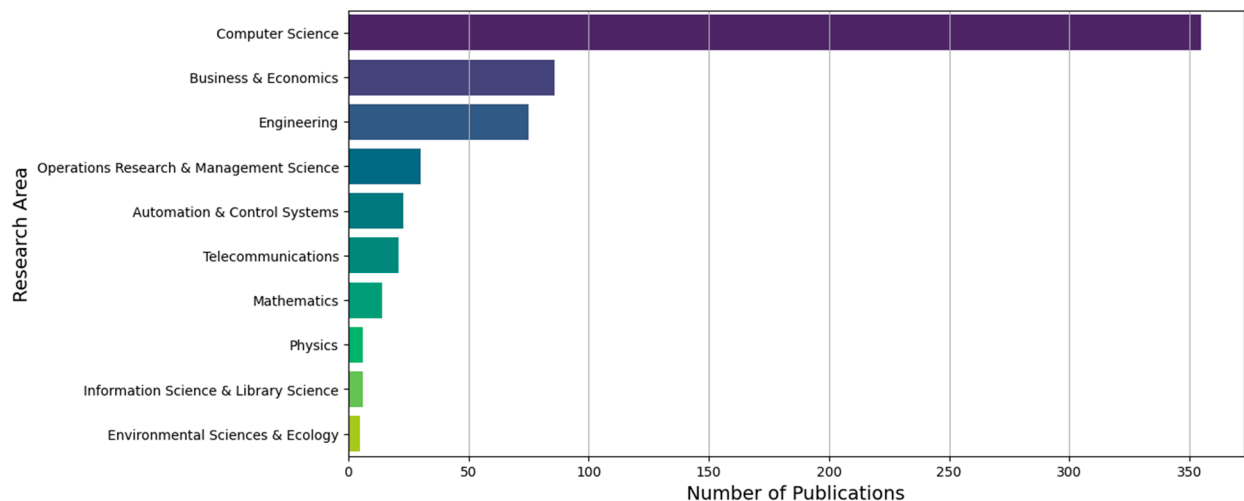


Figure 3. Top ten most common keywords and the number of publications by research area (top ten).

The second plot focuses on the distribution of publications across research areas, showing that the majority of work is concentrated in “Computer Science”. “Business & Economics” is another major focus, highlighting the application of AI in business strategies, decision-making and economic modeling. Significant contributions also come from “Engineering” and “Operations Research & Management Science”. In Figure 4, the word cloud reflects the expected output.



Figure 4. Word cloud on the Author Keywords column.

Figure 5 illustrates the collaboration network among the top institutions engaged in e-business and AI. The Nanjing University of Finance & Economics is at the center of the network, acting as a hub with connections to multiple other institutions, including the Chinese Academy of Sciences, Nanjing University and the University of Technology Sydney.

Figure 6 shows the relationships between key terms in prosumer research based on their co-occurrence in the literature. “E-business” is the central node, connected to numerous keywords like “artificial intelligence”, “e-commerce”, “trust” and “machine learning”. Strong connections exist between “artificial intelligence” and “e-commerce”, as well as between “machine learning” and “artificial intelligence”. Keywords like “ontology”, “web services” and “classification” have relatively fewer connections.

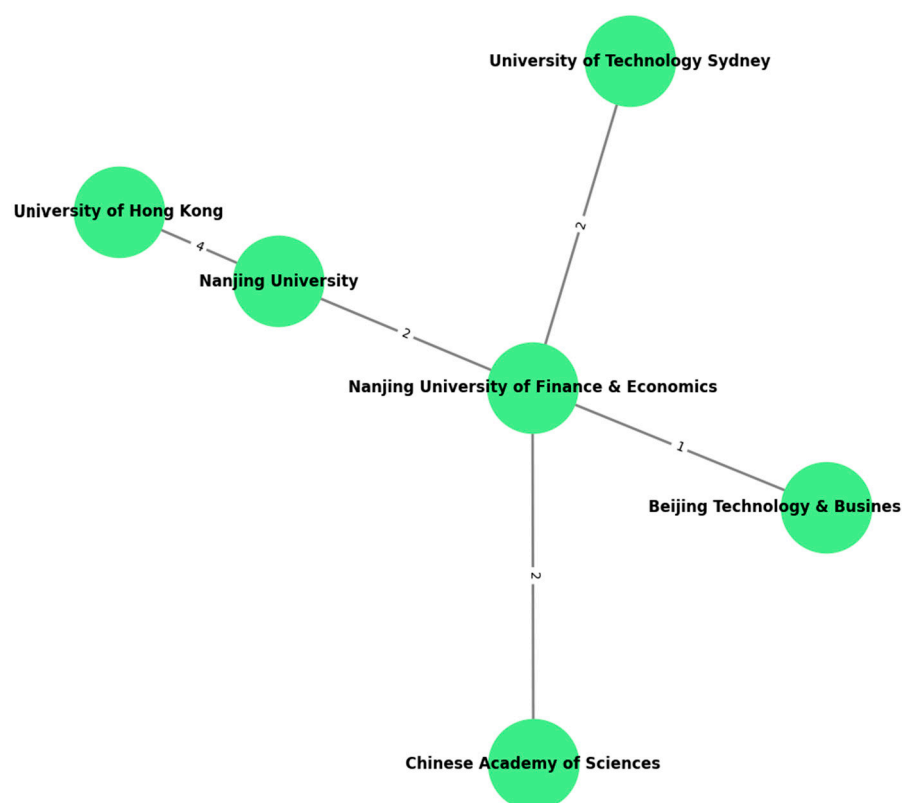


Figure 5. Collaboration network of top seven institutions in e-business and AI. The numbers represent collaborations between universities and institutes.

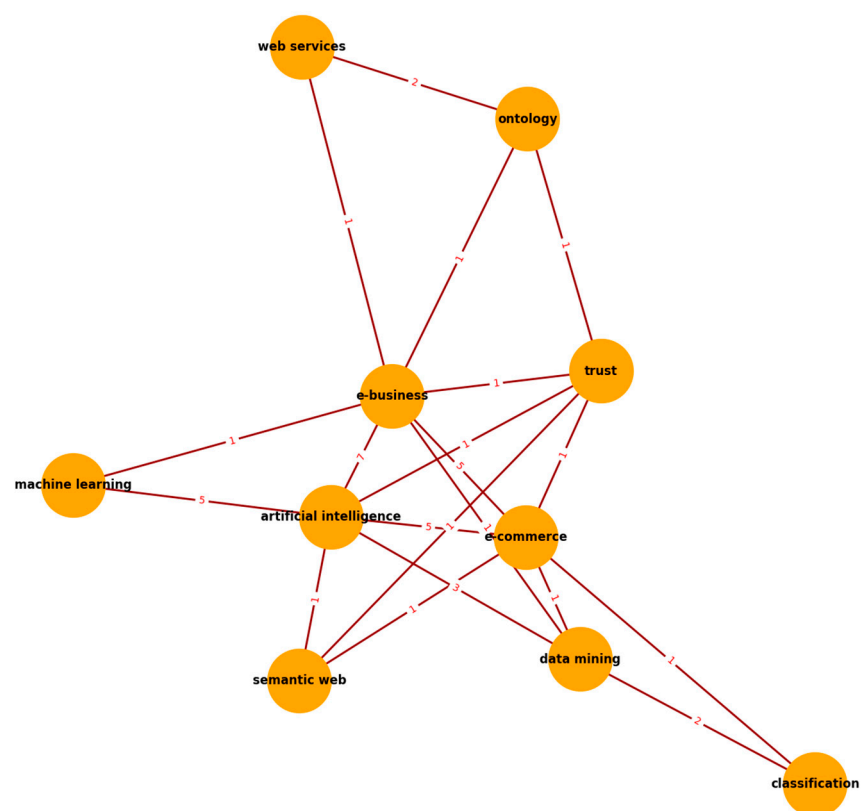


Figure 6. Co-occurrence of keywords in e-business and AI publications. The numbers are the co-occurrences where two keywords were found.

At the center of the network in Figure 7, “artificial intelligence”, “e-business” and “business & economics” act as critical connecting points, linking various research areas like “computer science”, “engineering” and “operations research & management science”. Keywords such as “semantic web”, “trust” and “machine learning” are closely connected to both technical disciplines and business-focused research areas, reflecting their importance in technical innovation and business applications. Emerging fields like “environmental sciences & ecology” and “information science & library science” are less connected, suggesting that their integration with e-business and AI is still developing.

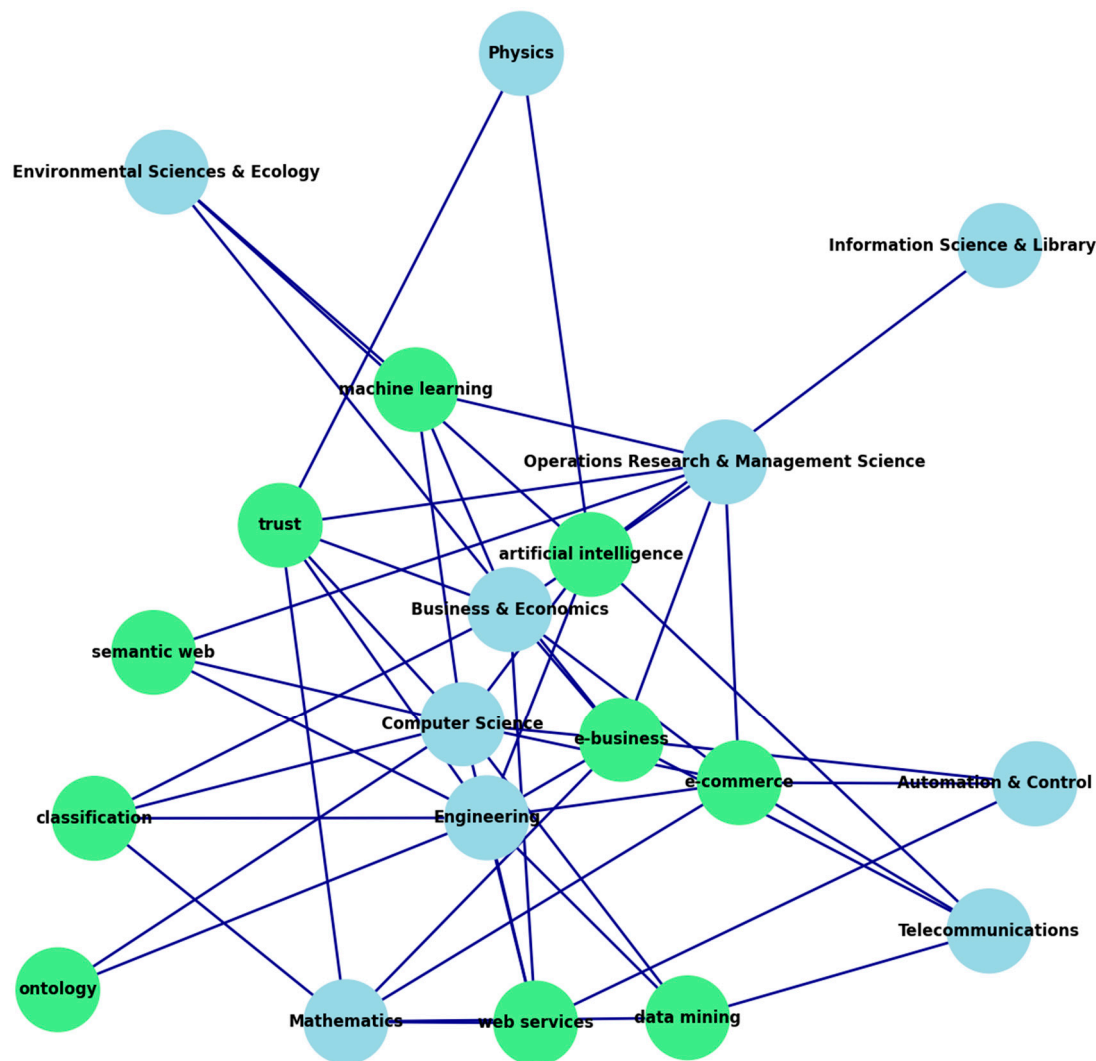


Figure 7. Network of research areas and keywords in e-business and AI.

The Sankey diagram in Figure 8 illustrates the connections between keywords, research areas and publication years for business-related research. Keywords such as “business transformation”, “business value” and “e-business strategy” are prominent, contributing significantly to areas like “Operations Research & Management Science”. Additionally, the keyword “e-agribusiness” appears connected to “Environmental Sciences & Ecology”, indicating the application of e-business principles in sustainable agricultural practices. The temporal distribution, spanning from 2018 to 2024, shows a notable diversification in research over time. Earlier studies, particularly from 2018 to 2020, were predominantly tied to established fields like “Business & Economics” and “Computer Science.” In contrast, research from 2021 onward reveals increasing interdisciplinary engagement, with growing connections to fields such as “Environmental Sciences & Ecology” and “Mate-

rials Science.” This shift highlights a broadening focus on sustainability and innovative applications. The emergence of topics like “business transformation” and “business analytics” in recent years reflects a greater emphasis on digital transformation and data-driven decision-making processes.

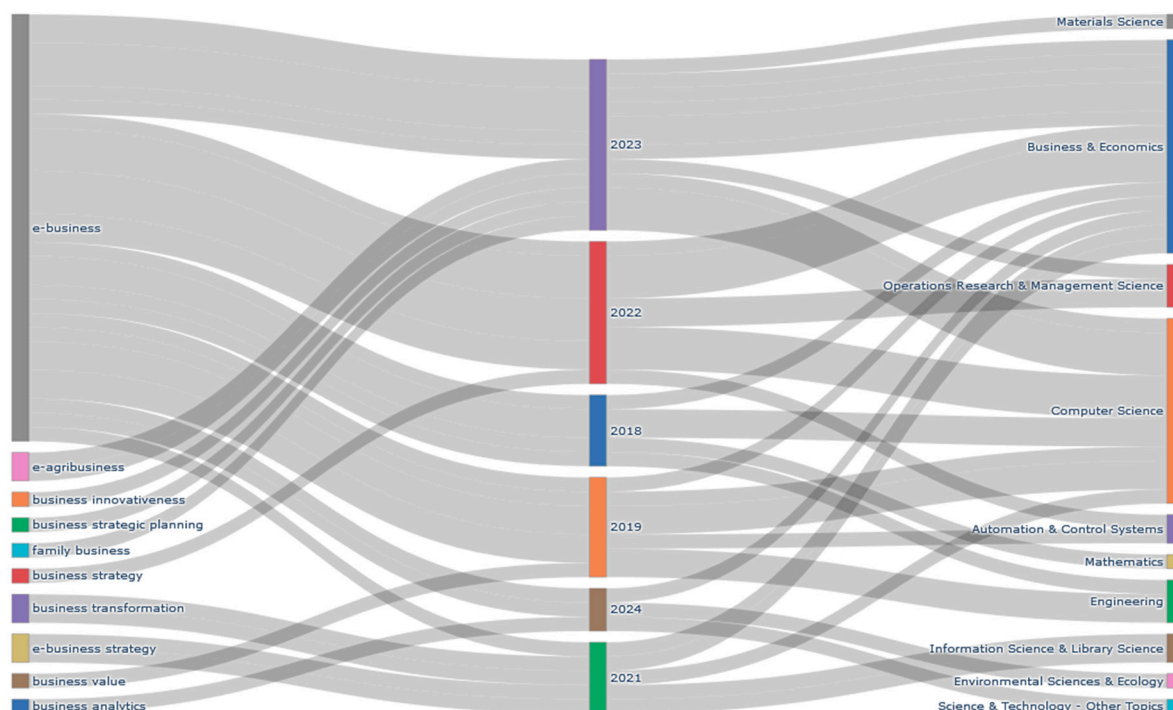


Figure 8. Sankey diagram linking “business” term to research areas and publications years.

4.2. Sentiment Analysis

The results of the sentiment analysis are briefly presented in Table 6.

Table 6. Sentiment analysis custom word lists, VADER, TextBlob libraries.

Year	Custom Pos	Custom Neg	Custom Neu	VADER Neg	VADER Neu	VADER Pos	VADER Compound	TextBlob Pol.	TextBlob Sub.
1999	0.00	0.00	93.00	0.00	0.87	0.13	0.89	0.09	0.39
2000	0.25	0.25	127.00	0.02	0.89	0.09	0.73	0.12	0.43
2001	0.13	0.38	122.50	0.03	0.84	0.13	0.85	0.12	0.52
2002	0.48	0.21	139.73	0.02	0.86	0.12	0.76	0.14	0.45
2003	1.00	0.57	168.29	0.03	0.86	0.11	0.65	0.10	0.54
2004	0.32	0.32	133.84	0.02	0.89	0.09	0.69	0.10	0.45
2005	0.48	0.33	128.00	0.03	0.88	0.08	0.44	0.07	0.53
2006	0.47	0.42	121.63	0.03	0.87	0.10	0.55	0.09	0.48
2007	0.35	0.12	114.76	0.02	0.86	0.13	0.78	0.12	0.47
2008	0.41	0.39	131.88	0.04	0.87	0.09	0.49	0.10	0.44
2009	0.50	0.25	136.75	0.02	0.85	0.12	0.86	0.06	0.53
2010	0.33	0.33	133.08	0.02	0.87	0.10	0.59	0.01	0.50
2011	0.09	0.27	134.91	0.03	0.85	0.12	0.83	0.11	0.47
2012	0.78	0.22	138.89	0.03	0.84	0.13	0.82	0.09	0.50

Table 6. Cont.

Year	Custom Pos	Custom Neg	Custom Neu	VADER Neg	VADER Neu	VADER Pos	VADER Compound	TextBlob Pol.	TextBlob Sub.
2013	0.50	0.10	149.80	0.02	0.88	0.11	0.69	0.07	0.50
2014	0.53	0.20	178.07	0.03	0.86	0.11	0.70	0.11	0.44
2015	0.36	0.36	128.73	0.03	0.87	0.09	0.64	0.05	0.38
2016	0.43	0.57	153.00	0.04	0.87	0.09	0.50	0.05	0.36
2017	0.57	0.36	155.71	0.03	0.88	0.09	0.57	0.12	0.46
2018	0.71	0.14	158.43	0.03	0.86	0.11	0.69	0.07	0.44
2019	0.68	0.21	159.74	0.03	0.84	0.13	0.76	0.08	0.44
2020	0.79	0.42	178.26	0.03	0.83	0.14	0.83	0.07	0.49
2021	0.80	0.10	246.40	0.02	0.87	0.11	0.82	0.05	0.48
2022	0.78	0.30	186.13	0.03	0.85	0.12	0.72	0.08	0.44
2023	0.56	0.24	210.08	0.03	0.84	0.12	0.77	0.05	0.45
2024	1.07	0.53	265.13	0.03	0.86	0.11	0.66	0.05	0.48

The sentiment analysis results using *custom word lists* reveal the progression of positive, negative and neutral sentiments over the years using a custom list of words. Positive sentiment shows fluctuations but demonstrates a general upward trend, with significant peaks observed in 2003, 2012, 2018 and 2021, and a notable high in 2024, reaching 1.07. Negative sentiment also fluctuates, maintaining relatively stable values in earlier years but peaking during specific periods, such as 2003 and 2016, indicating moments of heightened negativity. Neutral sentiment, on the other hand, exhibits a steady upward trend, particularly from 2013 onwards, culminating in its highest value of 265.13 in 2024, which reflects increasing neutrality in sentiment over time. Certain years stand out for their unique sentiment patterns. In 2003, there was a simultaneous spike in both positive and negative sentiments, suggesting a highly polarized year. In contrast, 2011 shows very low positive sentiment and relatively subdued negative sentiment, indicating a year of more balanced or less emotionally charged discourse. In recent years, especially from 2021 to 2024, there has been a strong increase in both positive and neutral sentiments, suggesting a shift towards more optimistic and balanced sentiment patterns. Throughout the dataset, neutral sentiment consistently dominates over positive and negative sentiments, which, as expected, indicates a preference for balanced or non-polarized language.

Moreover, as expected, neutral sentiment is the dominant category with VADER across all years, consistently above 83%, indicating a majority of neutral language. Positive sentiment remains relatively stable over time, typically ranging between 8% and 14%, with minor peaks such as 14% in 2020. Negative sentiment is the smallest category, generally below 4%, suggesting limited negative language. The compound score varies significantly, reflecting the overall sentiment polarity. Higher scores (e.g., 0.89 in 1999 and 0.86 in 2009) indicate strongly positive sentiment, while lower scores (e.g., 0.43 in 2005) suggest weaker positive sentiment or more mixed sentiment. Years such as 2020 and 2021 show high compound scores, indicating increasingly positive trends in sentiment during this period.

Sentiment analysis results using TextBlob, focusing on polarity (sentiment strength and direction) and subjectivity (degree of opinion versus fact) over time, are also presented in Table 5. Polarity values range between 0 and 1, where higher values indicate more positive sentiment. The data show fluctuations in polarity, with peaks in years like 2002 (0.14), 2001 (0.12) and 2007 (0.12). In contrast, years like 2016 (0.0457) and 2024 (0.0465) exhibit lower polarity, suggesting less positivity during these times. Subjectivity values, also ranging from 0 to 1, reflect how subjective or opinionated the content is. Higher subjectivity values

appear in years like 2003 (0.54) and 2005 (0.53), suggesting more opinion-based content. Conversely, lower subjectivity values, such as 2016 (0.35) and 1999 (0.38), indicate more objective content. While there is no consistent trend, subjectivity appears to peak and dip periodically.

While the three methods align in broad trends, with positive sentiment rising over time and neutral sentiment dominating, they differ in granularity and emphasis. Custom analysis provides more pronounced peaks and valleys, while VADER and TextBlob exhibit more stable, subdued trends.

4.3. Latent Dirichlet Allocation

It is a probabilistic generative model designed to uncover hidden topics in large text corpora. It operates on the assumption that documents in a dataset are composed of multiple latent topics, with each topic represented as a probability distribution over words. The primary objective of LDA is to identify these topic distributions, thereby unveiling the underlying thematic structure within the dataset. LDA's core principles revolve around a generative process and its grounding in Bayesian frameworks. The generative process assumes that each document is generated through a mixture of topics, where each topic is a probability distribution over a fixed vocabulary. For every word in a document, a topic is chosen based on the document's topic distribution, and a word is selected from the chosen topic's word distribution. The Bayesian framework introduces two critical parameters: alpha (α), which controls the sparsity of topic distributions across documents, and beta (β), which governs the sparsity of word distributions across topics. A high α results in documents covering many topics, while a high β implies that topics include a broad range of words. LDA employs optimization algorithms, such as Gibbs sampling or variational inference, to estimate the latent variables, including the topic distributions for each document and the word distributions for each topic.

The implementation of LDA begins with data preprocessing, where raw text is cleaned by removing stop words, punctuation and irrelevant terms. Techniques like tokenization, lowercasing and stemming/lemmatization standardize the text, converting the corpus into a document-term matrix representing the frequency of words in each document.

The model is initialized by defining the number of topics (k) and setting the hyperparameters α and β , based on prior assumptions about sparsity. During training, LDA iteratively estimates the latent topic and word distributions. Each word in a document is probabilistically assigned to one of the k topics based on the current estimates of the document's topic distribution and the topic's word distribution. These assignments are refined over multiple iterations.

Evaluation of the LDA model is conducted using coherence scores, which assess the interpretability of the topics. A well-fitted model is indicated by low perplexity, while high coherence scores suggest meaningful and interpretable topics. Visualizations, often produced using tools like pyLDAvis, provide intertopic distance maps and term relevance plots, aiding in understanding topic relationships and key defining terms. When applied to research on e-business and artificial intelligence, LDA proves to be a powerful tool for identifying dominant research themes, emerging trends and essential focus areas. However, challenges persist, such as the need to predetermine the number of topics, which is often subjective and may require extensive tuning.

The LDA diagrams in Figure 9 provide a comprehensive overview of the dominant topics and their associated terms within the dataset related to e-business and artificial intelligence. The intertopic distance map, located on the left of each visualization, illustrates the spatial distribution of the identified topics in a two-dimensional space using multidimensional scaling. Larger circles represent topics with broader ranges of associated

terms, while the degree of separation or overlap indicates the level of uniqueness or shared relevance between the topics. The right side of each visualization highlights the top 30 most relevant terms for each topic. These terms are ranked by their estimated frequency within the topic and their overall saliency in the corpus. Terms shown in red specifically contribute to the selected topic, while terms in blue represent their overall frequency within the dataset.

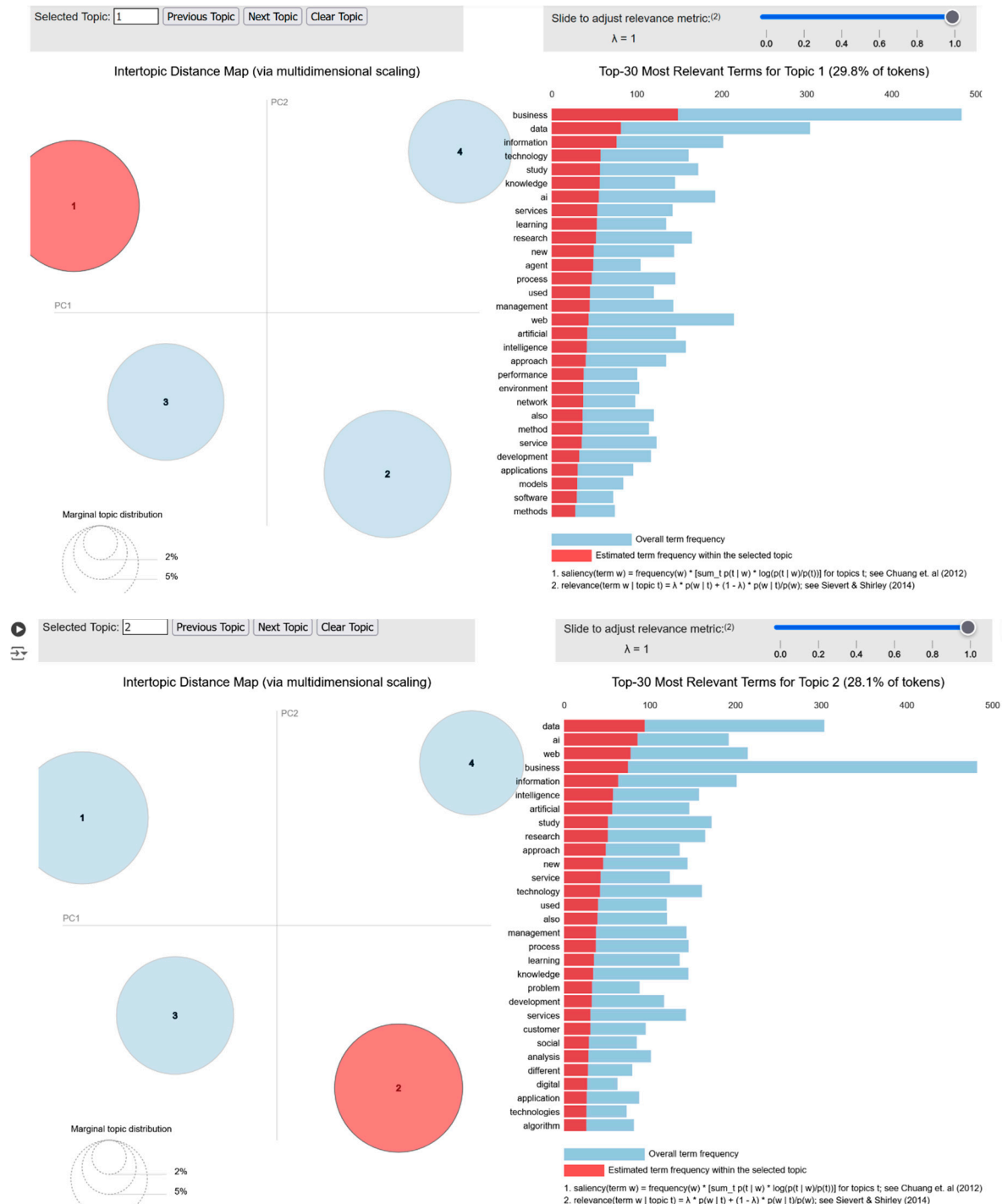


Figure 9. Cont.

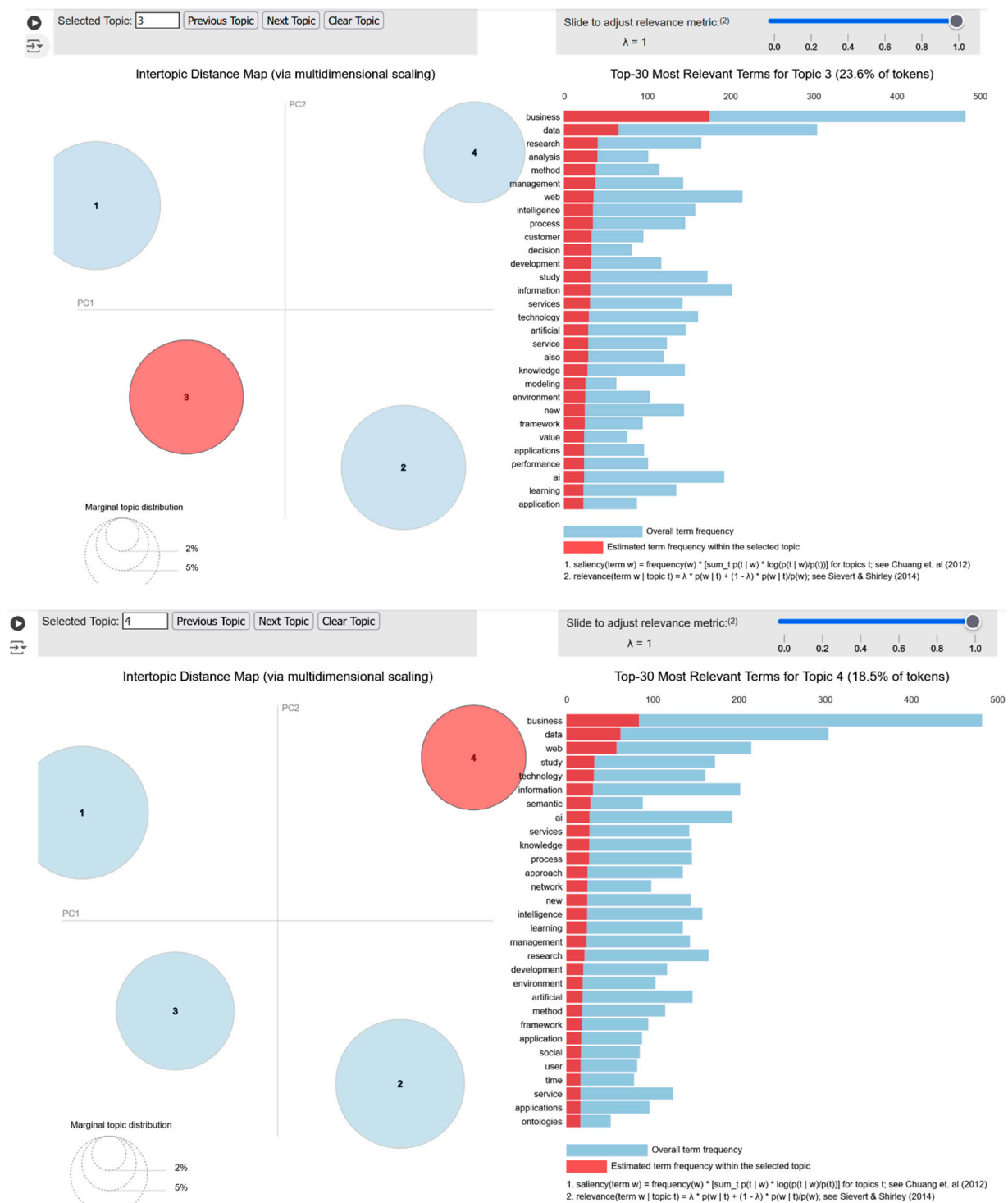


Figure 9. Topics graphical representation. For topics see Chuang et al., 2012 [45] and Sievert & Shirley, 2014 [46].

To answer the first research question (RQ1: What are the main topics embedded in the e-business and AI-related publications?), the topics identified with LDA are described in the following paragraphs.

Topic 1 (Data-Driven E-Business Strategies), which accounts for 29.8% of the tokens, emphasizes the intersection of data-driven decision-making and e-business frameworks. Key terms such as “business”, “data”, “information” and “technology” suggest a strong focus on how data systems, AI integration and information sharing enable business processes and service management.

Topic 2 (AI-Powered Web Solutions), representing 28.1% of the tokens, explores the role of AI and ML in web-based business applications. Terms such as “AI”, “web”, “business” and “intelligence” underscore the focus on leveraging AI to solve business challenges, enhancing customer service and innovating within web technologies. The prominence of terms like “service” and “technology” indicates a clear, practical application of AI in improving business workflows. *Topic 3 (Analytical Frameworks for Decision-Making)*, with 23.6% of the tokens, centers on analytical methods and decision-making frameworks within e-business. This topic is characterized by terms such as “analysis”, “decision-making”, “method” and “process”, which point to the use of data modeling and research to optimize customer behavior analysis, business strategies and operational processes. The inclusion of terms like “environment” reflects an additional focus on adapting business processes to external conditions or sustainability considerations. *Topic 4 (Semantic Web and Intelligent Systems)*, which accounts for 18.5% of the tokens, delves into the semantic web and intelligent systems. Terms such as “semantic”, “ontologies”, “knowledge” and “web” indicate a research emphasis on organizing and interpreting data using semantic technologies to enhance intelligent systems. This topic reflects the role of advanced technologies in creating efficient knowledge systems and improving web-based platforms.

Across all four topics, certain themes are recurrent, such as the foundational role of data and the close connection between AI and business applications. While some topics, such as Topic 1 and Topic 2, share an emphasis on AI and data technologies, others, like Topic 3 and Topic 4, exhibit greater specialization in areas like process optimization and semantic systems. The model with four topics, asymmetric Alpha, and Beta = 0.91 provides the most coherent topics, suggesting this configuration best captures meaningful patterns in the corpus (as in Table 7). The model was tuned considering between 3 and 11 topics.

Table 7. Tuning the parameters of the probabilistic generative model.

Validation Set	Topics	Alpha	Beta	Coherence
75% Corpus	4	asymmetric	0.9099	0.6644
75% Corpus	5	0.9099	0.61	0.6206
75% Corpus	4	0.9099	0.9099	0.6164
75% Corpus	3	asymmetric	0.9099	0.6142
75% Corpus	5	asymmetric	0.9099	0.6037
75% Corpus	3	0.9099	0.9099	0.6005

5. Discussions on the Future of E-Business

The future of e-business powered by AI holds immense potential to redefine how businesses operate, interact with customers and innovate. AI advancements will drive new levels of efficiency, personalization and automation, creating experiences and opportunities that are currently unimaginable. To answer the second research question (RQ2: What are the key topics that could be further studied in the research landscape?), by complementarity with the LDA results, AI may elevate e-business in the future by the following:

(1) Hyper-personalized customer experiences. AI will refine personalization to a higher degree. Future e-businesses could offer real-time, context-aware recommendations based on detailed customer behavior, mood analysis and even biometric data. AI systems could predict customer needs before they are explicitly stated, offering products or services proactively. For example, smart assistants may analyze one’s schedule and suggest purchases or services tailored to the upcoming activities.

(2) Voice and conversational commerce. Voice assistants and conversational AI will play a central role in e-business. Advanced NLP (speech-to-text) will enable seamless,

intuitive shopping experiences through voice commands. Customers may engage in multi-step, dynamic conversations to search for products, compare options and complete transactions. These assistants may also integrate with smart home devices to suggest purchases based on household needs.

(3) Immersive shopping with AR. AI will enhance AR to create immersive e-business environments. Customers could virtually “try on” clothes, visit hotel rooms, test furniture in their living spaces or explore virtual showrooms. AI algorithms may optimize these experiences by tailoring them to individual preferences, ensuring that the visualizations are accurate and engaging.

(4) Predictive and proactive commerce. AI will enable businesses to shift from reactive to proactive commerce. Predictive analytics powered by AI will identify what customers need before they realize it themselves. For instance, a grocery delivery service might automatically generate a shopping list based on previous purchases and predicted consumption patterns, delivering essentials before customers run out.

(5) Autonomous supply chains. Future supply chains will be fully autonomous, driven by AI and robotics. Predictive logistics will anticipate demand surges and optimize inventory and shipping routes dynamically. Autonomous drones and vehicles may handle last-mile delivery, ensuring faster and more efficient service. AI-powered systems will also improve supply chain resilience by predicting (e.g., based on local events in social media) and mitigating risks in real-time.

(6) Emotion-aware AI. AI systems of the future may become emotion-aware. They may assess the ethical implications of business decisions and adjust strategies to align with customer values. Emotion recognition technologies could analyze customer sentiment during interactions, customizing responses to create a more empathetic and satisfying experience.

(7) Blockchain integration for transparent transactions. AI and blockchain technologies will converge to enhance transparency and security in e-business. Smart contracts powered by AI could automate transaction verification and enforcement, reducing fraud and disputes. Blockchain-backed AI systems might also provide customers with full traceability of products, ensuring ethical sourcing and sustainability.

(8) Dynamic marketplaces. AI could revolutionize online marketplaces by creating dynamic, self-regulating platforms (e.g., for local electricity trade). These platforms would analyze real-time data to adjust pricing, match buyers with sellers more effectively and optimize product listings for visibility and sales. AI agents could even negotiate on behalf of buyers and sellers, creating a more efficient marketplace ecosystem.

(9) Advanced sentiment analysis and brand management. AI will become more adept at analyzing customer sentiment across multiple channels, including social media, reviews and direct feedback. Future systems will detect sentiment and also predict trends and public opinion shifts.

(10) Enhanced fraud prevention and security. AI will advance fraud detection by incorporating behavioral biometrics, anomaly detection and multi-layered authentication systems. Future e-business platforms may use AI to identify sophisticated cyber threats in real time, ensuring transactions remain secure. Blockchain and AI integration would also enhance trust and reduce fraud in online marketplaces.

6. Conclusions and Practical Implications

Our research seeks to reveal how AI-driven innovations are transforming e-business strategies, operations and sustainability practices. It identifies significant trends, such as the resurgence of interest in this research area post-2018, driven by factors like the COVID-19 pandemic, and highlights the dominant role of Chinese institutions in global collaborations. Furthermore, this research delves into the thematic prominence of keywords like “business

transformation”, “e-business strategy” and the emerging “e-agribusiness”, linking them to broader fields such as environmental sustainability. For instance, businesses may integrate AI-driven e-agribusiness solutions to achieve economic and environmental benefits by leveraging smart farming platforms. These systems optimize resource usage, enhance crop yields, and reduce costs through real-time data analysis and predictive analytics. Further, AI may enhance the traceability of products in e-agribusiness, benefiting both economic and environmental outcomes. By integrating AI with technologies such as blockchain, businesses create transparent and immutable records of a product’s path from farm to consumer.

Through sentiment analysis, this study analyzes shifts in emotional tones within the literature, revealing a rise in positive sentiment over time. Lastly, the identification of four balanced topics underscores key areas of focus in the e-business and AI landscape: data-driven decision-making, AI in web-based business, analytical methods for decision-making and advancements in semantic web technologies. This research contributes to advancing knowledge in e-business and AI by mapping current trends and proposing future research directions.

The findings of this research have several practical implications across various domains:

- **Enhanced business strategies.** The emphasis on keywords like “business transformation”, “business value” and “e-business strategy” highlights how AI and data-driven approaches can reshape traditional business models. For instance, Amazon uses AI-driven recommendations to transform customer purchasing experiences, generating significant revenue from cross-selling and up-selling. Similarly, AI-powered dynamic pricing models are employed by airlines and e-commerce platforms to adjust prices based on demand, competitor activity and customer behavior, enhancing revenue and customer satisfaction.
- **Targeted investment in AI research.** The surge in publications post-2018, particularly during the COVID-19 pandemic, indicates a growing reliance on AI to solve complex challenges. For example, AI-driven tools like Zoom and Microsoft Teams revolutionized remote work and education, enabling businesses and institutions to maintain operations during lockdowns. In healthcare, AI applications like telemedicine and predictive analytics are interesting achievements.
- **Global collaboration opportunities.** The dominance of Chinese institutions in the collaboration network presents opportunities for international partnerships. For instance, collaborations between Alibaba and European e-commerce businesses have leveraged AI to optimize supply chain logistics and improve market reach.
- **Applications in sustainability.** The connection between “e-agribusiness” and “Environmental Sciences & Ecology” underscores the role of AI and e-business in sustainable agriculture. For example, precision agriculture platforms use AI to analyze soil data and weather conditions, optimizing crop yields while reducing environmental impact. Additionally, AI-powered drones in India are used to monitor crop health and reduce pesticide usage, promoting eco-friendly practices.
- **Improved customer experience.** The findings related to web-based AI applications for customer service and workflow optimization indicate practical opportunities for businesses to enhance customer engagement, streamline operations and innovate in e-commerce platforms. Chatbots provide personalized product recommendations and answer queries in real-time, improving shopping experiences.
- **Advancements in knowledge systems.** The exploration of the semantic web and ontologies can drive the development of intelligent systems that organize and interpret vast amounts of data. These systems can be applied to improve search engines, recommendation systems and knowledge-sharing platforms. Google’s Knowledge

Graph is an example, providing users with structured and meaningful search results. In certain e-learning platforms, AI organizes course content based on user preferences, enhancing learning experiences through personalized recommendations.

- Guidance for research and policy. The identification of latent themes and research gaps provides a roadmap for future studies in e-business and AI. For example, the rise of AI ethics committees in certain tech companies is shaping policies to address algorithmic fairness and data privacy. These efforts ensure responsible AI deployment while fostering public trust.
- AI-driven decision support. The focus on data-driven decision-making and analytical methods indicates practical pathways for implementing AI-powered tools in business environments. For example, AI-based tools like Tableau and Power BI enable real-time data visualization, helping managers make informed decisions. Predictive analytics platforms in retail, forecast inventory needs, optimize supply chains and reduce costs by ensuring products are available when and where they are needed.

The main limitations of the current research are (1) the coherence score of 0.66 indicates moderate interpretability of the identified topics. Higher scores might be achievable with alternative topic modeling techniques like BERTopic; (2) while this study mentions applications like “e-agribusiness”, it does not explore sector-specific implications in depth; (3) this paper attributes a surge in publications around 2020 to the COVID-19 pandemic, but does not fully explore how pandemic-driven changes in research priorities and practices might have long-term implications for e-business and AI.

Two directions for future research are identified: (1) exploring alternative or hybrid topic modeling approaches could enhance the coherence and interpretability of the latent topics, potentially yielding more actionable insights; (2) investigating the role of emerging technologies, such as blockchain, quantum computing or generative AI, in transforming e-business could open new avenues for exploration.

Author Contributions: S.-V.O.: conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing—original draft, writing—review and editing, visualization, supervision. A.B.: formal analysis, investigation, validation, writing—original draft, writing—review and editing, visualization, project administration. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by a grant from the Ministry of Research, Innovation and Digitization, CNCS/CCCDI—UEFISCDI, project number COFUND-CETP-SMART-LEM-1, within PNCDI IV.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data will be available on request.

Conflicts of Interest: The authors declare that there are no conflicts of interest.

References

1. Huo, D.; Chen, Y.; Hung, K.; Ouyang, R.; Sun, B.; Cai, Y. Quality management of e-business: A key node analysis of ecological network in digital economy by using artificial intelligence. *Rom. J. Econ. Forecast.* **2019**, *22*, 166–179.
2. Purnomo, A.; Aziz, A.; Afia, N.; Sari, A.K.; Primadani, T.I.W. E-CRM: Three Decades of A Bibliometric Networks Visualizing of Academic Publication. In Proceedings of the 3rd International Conference on Cybernetics and Intelligent Systems, ICORIS 2021, Makasar, Indonesia, 25–26 October 2021. [\[CrossRef\]](#)
3. Tulcanaza-Prieto, A.B.; Cortez-Ordoñez, A.; Lee, C.W. Influence of Customer Perception Factors on AI-Enabled Customer Experience in the Ecuadorian Banking Environment. *Sustainability* **2023**, *15*, 12441. [\[CrossRef\]](#)
4. Arora, A.; Gupta, S.; Devi, C.; Walia, N. Customer experiences in the era of artificial intelligence (AI) in context to FinTech: A fuzzy AHP approach. *Benchmarking Int. J.* **2023**, *30*, 4342–4369. [\[CrossRef\]](#)

5. Nicolescu, L.; Tudorache, M.T. Human-Computer Interaction in Customer Service: The Experience with AI Chatbots—A Systematic Literature Review. *Electronics* **2022**, *11*, 1579. [\[CrossRef\]](#)
6. Huong, T.T.T.; Hanh, N.T.; Trang, H.T.D.; Chi, N.T.K. The impact of AI chatbots on customer experience in online retailing in an emerging economy. *Int. J. Process Manag. Benchmarking* **2023**, *15*, 182–197. [\[CrossRef\]](#)
7. Kanbach, D.K.; Heiduk, L.; Blueher, G.; Schreiter, M.; Lahmann, A. The GenAI is out of the bottle: Generative artificial intelligence from a business model innovation perspective. *Rev. Manag. Sci.* **2024**, *18*, 1189–1220. [\[CrossRef\]](#)
8. Sharma, A. Analyzing the Role of Artificial Intelligence in Predicting Customer Behavior and Personalizing the Shopping Experience in Ecommerce. *Int. J. Sci. Res. Eng. Manag.* **2023**, *7*, 1–8. [\[CrossRef\]](#)
9. Modgil, S.; Singh, R.K.; Hannibal, C. Artificial intelligence for supply chain resilience: Learning from COVID-19. *Int. J. Logist. Manag.* **2022**, *33*, 1246–1268. [\[CrossRef\]](#)
10. Sharma, R.; Shishodia, A.; Gunasekaran, A.; Min, H.; Munim, Z.H. The role of artificial intelligence in supply chain management: Mapping the territory. *Int. J. Prod. Res.* **2022**, *60*, 7527–7550. [\[CrossRef\]](#)
11. Oprea, S.-V.; Bâra, A. Detecting Malicious Uniform Resource Locators Using an Applied Intelligence Framework. *Comput. Mater. Contin.* **2024**, *79*, 3827–3853. [\[CrossRef\]](#)
12. Al Adwan, A.; Aladwan, R. Use of artificial intelligence system to predict consumers' behaviors. *Int. J. Data Netw. Sci.* **2022**, *6*, 1223–1232. [\[CrossRef\]](#)
13. Biswas, B.; Sanyal, M.K.; Mukherjee, T. AI-Based Sales Forecasting Model for Digital Marketing. *Int. J. E-bus. Res.* **2023**, *19*, 1–14. [\[CrossRef\]](#)
14. Vaduva, A.-G.; Oprea, S.-V.; Barbu, D.-C. Understanding Customers' Opinion using Web Scraping and Natural Language Processing. *Ovidius Univ. Ann. Econ. Sci. Ser.* **2023**, *1*, 537–544. [\[CrossRef\]](#)
15. Ratuszniak, M. Business response to market tendencies: Consumerism, AI, e-commerce, and their influence on modern societies. *Bus. Econ. Sustain. Leadersh. Innov.* **2020**, *5*, 4–7. [\[CrossRef\]](#)
16. ThiDang, N.; MinhNguyen, T. Impact of Artificial Intelligence on E-Commerce Businesses in Ho Chi Minh City. *Glob. Acad. J. Econ. Bus.* **2022**, *4*, 146–151. [\[CrossRef\]](#)
17. Arman, M.; Lamiyar, U.R. Exploring the Implication of ChatGPT AI for Business: Efficiency and Challenges. *Int. J. Mark. Digit. Creat.* **2023**, *1*, 64–84. [\[CrossRef\]](#)
18. Yigitcanlar, T.; Degirmenci, K.; Inkinen, T. Drivers behind the public perception of artificial intelligence: Insights from major Australian cities. *AI Soc.* **2024**, *39*, 833–853. [\[CrossRef\]](#) [\[PubMed\]](#)
19. Lari, H.A.; Vaishnav, K.; Manu, K.S. Artificial Intelligence in E-commerce: Applications, Implications and Challenges. *Asian J. Manag.* **2022**, *13*, 235–244. [\[CrossRef\]](#)
20. Bansal, C.; Pandey, K.K.; Goel, R.; Sharma, A.; Jangirala, S. Artificial intelligence (AI) bias impacts: Classification framework for effective mitigation. *Issues Inf. Syst.* **2023**, *24*, 367–389. [\[CrossRef\]](#)
21. Janssen, M.; Hartog, M.; Matheus, R.; Ding, A.Y.; Kuk, G. Will Algorithms Blind People? The Effect of Explainable AI and Decision-Makers' Experience on AI-supported Decision-Making in Government. *Soc. Sci. Comput. Rev.* **2022**, *40*, 478–493. [\[CrossRef\]](#)
22. Areiqat, A.Y.; Alheet, A.F.; Qawasmeh, R.A.A.; Zamil, A.M. Artificial intelligence and its drastic impact on e-commerce progress. *Acad. Strateg. Manag. J.* **2021**, *20*, 1–11.
23. Wang, C.; Ahmad, S.F.; Ayassrah, A.Y.B.A.; Awwad, E.M.; Irshad, M.; Ali, Y.A.; Al-Razgan, M.; Khan, Y.; Han, H. An empirical evaluation of technology acceptance model for Artificial Intelligence in E-commerce. *Heliyon* **2023**, *9*, e18349. [\[CrossRef\]](#) [\[PubMed\]](#)
24. Thamik, H.; Wu, J. The Impact of Artificial Intelligence on Sustainable Development in Electronic Markets. *Sustainability* **2022**, *14*, 3568. [\[CrossRef\]](#)
25. Arulprakash, E.; Martin, A. An object-oriented neural representation and its implication towards explainable AI. *Int. J. Inf. Technol.* **2024**, *16*, 1303–1318. [\[CrossRef\]](#)
26. Al Wahshat, H.; Abu-Ulbeh, W.; Yusoff, M.H.; Zakaria, M.D.; Hamzah, W.M.A.F.W.; Stenin, N.P. The Detection of E-Commerce Manipulated Reviews Using GPT-4. In Proceedings of the 2023 International Conference on Computer Science and Emerging Technologies, CSET 2023, Bangalore, India, 10–12 October 2023. [\[CrossRef\]](#)
27. Bawack, R.E.; Wamba, S.F.; Carillo, K.D.A.; Akter, S. Artificial intelligence in E-Commerce: A bibliometric study and literature review. *Electron. Mark.* **2022**, *32*, 297–338. [\[CrossRef\]](#) [\[PubMed\]](#)
28. Goti, A.; Querejeta-Lomas, L.; Almeida, A.; de la Puerta, J.G.; López-de-Ipiña, D. Artificial Intelligence in Business-to-Customer Fashion Retail: A Literature Review. *Mathematics* **2023**, *11*, 2943. [\[CrossRef\]](#)
29. Thayyib, P.V.; Mamilla, R.; Khan, M.; Fatima, H.; Asim, M.; Anwar, I.; Shamsudheen, M.K.; Khan, M.A. State-of-the-Art of Artificial Intelligence and Big Data Analytics Reviews in Five Different Domains: A Bibliometric Summary. *Sustainability* **2023**, *15*, 4026. [\[CrossRef\]](#)
30. Espina-Romero, L.; Guerrero-Alcedo, J. Fields Touched by Digitalization: Analysis of Scientific Activity in Scopus. *Sustainability* **2022**, *14*, 14425. [\[CrossRef\]](#)

31. Rydell, L. Predictive Algorithms, Data Visualization Tools, and Artificial Neural Networks in the Retail Metaverse. *Linguist. Philos. Investig.* **2022**, *21*, 25–40. [[CrossRef](#)]
32. Frioui, S.; Graa, A. Bibliometric Analysis of Artificial Intelligence in the Scope of E-Commerce: Trends and Progress over the Last Decade. *Manag. Econ. Rev.* **2024**, *9*, 5–24. [[CrossRef](#)]
33. Erdoğan, U. A systematic review on the use of artificial intelligence in e-commerce. *Toplum Ekon. ve Yönetim Derg.* **2023**, *4*, 184–197. [[CrossRef](#)]
34. Widjaja, W.; Rustam, Y.W.A. E-Retailing study: A bibliometric analysis and systematic literature review. *TEKNOSAINS J. Sains Teknol. Dan Inform.* **2024**, *11*, 112–119. [[CrossRef](#)]
35. Desai, P.; Ganatra, K. Artificial Intelligence In Strengthening The Operations of Ecommerce Based Business. In Proceedings of the 2022 International Conference on Interdisciplinary Research in Technology and Management, IRTM 2022—Proceedings, Kolkata, India, 24–26 February 2022. [[CrossRef](#)]
36. Louis, J.V.; Noerlina; Syahchari, D.H. Digital business transformation: Analysis of the effect artificial intelligence in e-commerce's product recommendation. *Adv. Inf. Syst.* **2024**, *8*, 64–69. [[CrossRef](#)]
37. Zhang, D.; Pee, L.G.; Cui, L. Artificial intelligence in E-commerce fulfillment: A case study of resource orchestration at Alibaba's Smart Warehouse. *Int. J. Inf. Manag.* **2021**, *57*, 102304. [[CrossRef](#)]
38. Pallathadka, H.; Ramirez-Asis, E.H.; Loli-Poma, T.P.; Kaliyaperumal, K.; Ventayen, R.J.M.; Naved, M. Applications of artificial intelligence in business management, e-commerce and finance. *Mater. Today Proc.* **2023**, *80*, 2610–2613. [[CrossRef](#)]
39. Ziakis, C.; Vlachopoulou, M. Artificial Intelligence in Digital Marketing: Insights from a Comprehensive Review. *Information* **2023**, *14*, 664. [[CrossRef](#)]
40. Qin, M.; Zhu, W.; Zhao, S.; Zhao, Y. Is Artificial Intelligence Better than Manpower? The Effects of Different Types of Online Customer Services on Customer Purchase Intentions. *Sustainability* **2022**, *14*, 3974. [[CrossRef](#)]
41. Rajeshwari, S.; Praveenadevi, D.; Revathy, S.; Sreekala, S.P. Utilizing AI technologies to enhance e-commerce business operations. In *Toward Artificial General Intelligence: Deep Learning, Neural Networks, Generative AI*; De Gruyter: Berlin, Germany, 2023. [[CrossRef](#)]
42. Von Zahn, M.; Feuerriegel, S.; Kuehl, N. The Cost of Fairness in AI: Evidence from E-Commerce. *Bus. Inf. Syst. Eng.* **2022**, *64*, 335–348. [[CrossRef](#)]
43. Khrais, L.T. Role of artificial intelligence in shaping consumer demand in e-commerce. *Future Internet* **2020**, *12*, 226. [[CrossRef](#)]
44. Fatima, S. AI Implementation in an E-commerce. *Int. J. Multidiscip. Res.* **2023**, *5*, 1–11. [[CrossRef](#)]
45. Chuang, J.; Manning, C.D.; Heer, J. Termite: Visualization techniques for assessing textual topic models. In Proceedings of the International Working Conference on Advanced Visual Interfaces, Capri Island, Italy, 21–25 May 2012; pp. 74–77.
46. Sievert, C.; Shirley, K. LDAvis: A method for Visualizing and Interpreting Topics. In Proceedings of the Workshop on Interactive Language Learning, Visualization, and Interfaces, Baltimore, MD, USA, 27 June 2014; pp. 63–70.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.