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Emerging Trends and Bibliometric Analysis of AI Applications in Financial Services

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Abstract

The aim of this study is to analyze research themes, leading authors, and global collaboration networks in AI research within the financial services industry from 2019 to 2024 using bibliometric tools such as VOSviewer. Utilizing data from 226 Scopus-indexed publications, we identified five main research clusters: credit evaluation, fraud detection, investment management, personal banking services, and regulatory compliance. The number of publications increased from nine in 2019 to fifty-two in 2024, reflecting growing global collaboration across thirty-two countries in eight distinct groups. IEEE Access and the International Journal of Bank Marketing emerged as the top journals, with h-indices of 7 and 6, respectively. Co-citation analysis highlights evolving patterns in AI-based risk assessment and automated decision-making systems. The findings demonstrate the rapid integration of AI in financial services, driven in part by the COVID-19 pandemic, providing valuable insights for academics, practitioners, and policymakers. This study lays the groundwork for further exploration of AI's regulatory, transdisciplinary, and ethical dimensions in financial services.

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INTRODUCTION

The swift progression of artificial intelligence (AI) has revolutionized various industries, significantly improving the financial services sector. Incorporating AI in financial services has transformed conventional business models, redefined risk management approaches, and improved customer service techniques. Financial organizations are progressively utilizing AI-driven technology, such as automated trading systems, fraud detection algorithms, tailored banking services, and credit scoring (Duan et al., 2019). This transition has been especially significant in developing nations, as financial institutions utilize AI technologies to enhance service delivery and operational efficiency (Gomber et al., 2018).

Technological innovation in digital banking includes using advanced technologies such as artificial intelligence (AI), blockchain, big data analytics, and cloud computing. These technologies enable banks to offer more personalized, secure, and efficient services. For example, AI is used for customer data analysis and fraud detection, while blockchain offers secure and transparent transaction solutions. Big data analytics helps banks better understand customer needs and behavior, while cloud computing allows banks to manage data and applications more flexibly and scalably. However, technology adoption in digital banking also faces various challenges. Data security and privacy are among the main issues that must be addressed. In addition, strict regulations in the financial sector often become an obstacle to technological innovation.

It also needs to invest in team member training and development to ensure they have the necessary skills to effectively manage and utilize new technologies. Apart from that, changes in organizational culture that support innovation are also needed for digital transformation to be successful.

The period from 2019 to 2024 has been marked by significant advancements in financial technology, especially artificial intelligence, accelerated by the global digital shift initiated by the COVID-19 pandemic. Financial institutions have increasingly prioritized advancing AI applications and machine learning models while simultaneously addressing regulatory concerns to ensure their safe and successful implementation. Significant financial investments have recently been allocated to AI technology as banks seek to enhance operational efficiency, customer engagement, and risk management in an increasingly competitive and disruptive market (Gomber et al., 2018). The evolution of AI in finance has transitioned from basic rule-based systems to intricate neural networks capable of comprehending unstructured input and executing astute financial judgments (Wang et al., 2023).

Artificial intelligence technologies have profoundly altered the operational structure of financial services, allowing institutions to examine extensive data and automate intricate decision-making processes. Machine learning algorithms, natural language processing, and deep learning models enable banks to deliver customized services, enhancing the precision and effectiveness of financial operations (Fuster et al., 2022). The integration of AI has enhanced risk evaluation and fraud identification, revolutionizing customer service via advanced virtual assistants and chatbots. Artificial intelligence has enhanced investment management through the automation of trading processes and the monitoring of portfolios. It has facilitated adherence to regulations and the submission of reports (Alt et al., 2018). Recent research indicates that AI-driven solutions have markedly enhanced fraud detection precision and diminished operational expenses in financial organizations (Fuster et al., 2022).

Today, behavioral finance, information theory, and computational economics constitute the theoretical basis underpinning AI applications in finance. Research indicates that deep learning models surpass traditional statistical methods in identifying market inefficiencies and behavioral biases (Johnson et al., 2022). Theoretical progress has led to real-world uses in algorithmic trading, where AI

systems can look at market sentiment, technical indicators, and fundamental data simultaneously to help traders make decisions (Gomber et al., 2018). Progress in previous research has led to practical applications.

Incorporating AI in financial services has substantially enhanced customer relationship management and tailored banking services. Research indicates that AI-driven recommendation systems have markedly enhanced client engagement and elevated cross-selling success rates within banking institutions (Alt et al., 2018). The deployment of AI chatbots and virtual assistants has transformed customer service, markedly decreasing response times and enhancing customer satisfaction ratings in financial organizations (Alt et al., 2018).

Studies demonstrate that artificial intelligence and machine learning have significantly improved the functions of financial services, especially in credit scoring and risk evaluation (Huang & Rust, 2018). The significance of artificial intelligence lies in its ability to restore trust and confidence in financial sectors through enhanced risk management systems (Lui & Lamb, 2018). Nevertheless, these studies primarily concentrated on particular applications instead of thoroughly evaluating the field's advancement. Recent technology breakthroughs have generated novel research opportunities, especially in digital financial applications and automated advisory services (Jung et al., 2018).

Even though there is more and more writing about AI in financial services, few bibliometric analyses look at how research has changed over time, especially from 2019 to 2024. Recent research has primarily focused on customer-facing AI applications or initial stages, overlooking advancements in AI technologies. Moreover, further investigation is necessary to analyze the partnership between researchers and institutions and the spatial distribution of AI research contributions (Hentzen et al., 2022). Regulatory frameworks significantly affect technological progress, but not much research has been done on how they affect AI research, especially on how AI affects the whole financial services system (Pattnaik et al., 2024).

Ethical ethics and regulatory compliance have become significant challenges in the deployment of AI. Financial services necessitate explicit AI decision-making frameworks, especially for credit scoring and risk evaluation (Lui & Lamb, 2018). Due to the increasing complexity of AI models and concerns over their interpretability and potential biases, further study is necessary on explainable AI solutions for the financial sector. Recent advancements in AI governance frameworks emphasize the critical importance of responsible AI utilization, prioritizing data security, algorithmic fairness, and model openness (Haenlein & Kaplan, 2019).

The global landscape of AI research in financial services demonstrates notable regional disparities in focus and implementation rates (Gomber et al., 2018). On the other hand, Asian banks have made significant strides in mobile payment solutions and efforts to make banking more accessible to everyone (Huang & Rust, 2018). The formation of new research clusters in developing nations has introduced several viewpoints, especially in tackling particular issues rising economies encounter (Fuster et al., 2022).

This study seeks to rectify these shortcomings by conducting a thorough bibliometric analysis of artificial intelligence research in financial services from 2019 to 2024. The primary aim is to delineate the progression of research themes and pinpoint significant research clusters and prominent institutions in this domain (Ashta & Herrmann, 2021). This study will examine collaboration patterns among researchers and the impact of legislative reforms on research directions, employing recent improvements in AI applications in finance (Kou et al., 2021). This study seeks to forecast forthcoming research trends and provide valuable insights for researchers, practitioners, and policymakers involved in AI innovation within the financial services sector through a comprehensive analysis of publica-

tion patterns, citation networks, and research themes. The objective is to identify novel research areas and facilitate international collaboration to enhance AI applications in the financial sector.

METHODS

VOSviewer is software that creates maps based on network data and visualizes and explores those maps. The functionality of VOSviewer can be summarized as follows: Create maps based on network data. VOSviewer is a handy tool to help researchers in compiling research background. With its ability to visualize relationships in academic literature, VOSviewer enables researchers to identify trends, gaps, and contributions of previous research more efficiently.

VOSviewer is a software tool for creating maps based on network data and for visualizing and exploring these maps. The functionality of VOSviewer can be summarized as follows:

(1) Creating maps based on network data. A map can be created based on a network that is already available, but it is also possible to first construct a network. VOSviewer can be used to construct networks of scientific publications, scientific journals, researchers, research organizations, countries, keywords, or terms. Items in these networks can be connected by co-authorship, co- occurrence, citation, bibliographic coupling, or co-citation links. To construct a network, bibliographic database files (i.e., Web of Science, Scopus, Dimensions, Lens, and PubMed files) and reference manager files (i.e., RIS, EndNote, and RefWorks files) can be provided as input to VOSviewer. Alternatively, VOSviewer can download data through an API (i.e., Crossref API, OpenAlex API, Europe PMC API, and several others);

(2) Visualizing and exploring maps. VOSviewer provides three visualizations of a map: The network visualization, the overlay visualization, and the density visualization. Zooming and scrolling functionality allows a map to be explored in full detail, which is essential when working with large maps containing thousands of items.

Although VOSviewer is intended primarily for analyzing bibliometric networks, it can in fact be used to create, visualize, and explore maps based on any type of network data. VOSviewer has been developed in the Java programming language. Because Java is platform-independent, VOSviewer runs on most hardware and operating system platforms. VOSviewer can be downloaded from www.vosviewer.com. It can be used freely for any purpose.

Analytical Unit

The study is descriptive and employs an inductive analytical methodology (Dewi et al., 2024). Bibliometric analysis is the quantitative assessment of bibliographic components (Danvila-del-Valle et al., 2019). The thickness of the connecting line and the dimensions of the nodes indicate the strength and significance of the link (Iskandar et al., 2024). This includes co-occurrence, co-citation, co-authorship, and bibliographic association. This study utilized papers from peer-reviewed periodicals as research materials because of their reputation as reliable scholarly sources. The publications have been through a strict peer-review process, which means that the content has been carefully reviewed by experts in the field in line with strict academic standards. This means that the conclusions can be trusted (Ramos-Rodrígue & Ruíz-Navarro, 2004). The examination excluded legal documents, press materials, and other assorted items from the database.

We use citation analysis and co-occurrence analysis (Danvila-del-Valle et al., 2019). The examination of citations depends on the degree of attention scholars devote to an article when referencing it. This analysis suggests that the number of citations for a manuscript is directly correlated with its impact on advancing the scientific field (Ramos & Ruiz, 2008).

Database Sourcing and Management

Data were acquired from articles available in the Scopus database. The initial search was conducted by limiting the criteria to papers that had the phrases "artificial intelligence" and "financial services" in the title, keywords, or abstract. The papers chosen for this bibliometric analysis adhered to a predetermined set of criteria. We included articles focusing on AI applications in financial services, published in peer-reviewed journals, and released between 2019 and 2024. We limited the final dataset to English articles to ensure analytical consistency. We meticulously revised the articles after a rigorous screening procedure, omitting those that fell into irrelevant categories.

A study of the remaining items was done to determine their relevance to the research issue. The research utilized many filters, including year, subject, document type, keyword, and language, to enhance the specificity and usefulness of the findings. (Effendi et al., 2024). This approach allows for the identification of principal characters and foundational research patterns prior to examining the central intellectual node, sub-topic, or specific publication. This research encompasses items published between 2019 and 2024. The selection results are subsequently published in RIS format (Saputra et al., 2024).

Every article is seen as a potential contribution to study on this specific subject. After collecting the dataset, analytical tools were utilized. We utilized Biblioshiny software for bibliometric analysis and deployed VOSviewer to develop and graphically portray associations in a graphical way. Furthermore, network-based analysis was utilized to substantiate the investigation of the issue (Eck et al., 2010).

VOSviewer was employed to depict co-citation analysis, co-occurrence mapping, and network analysis. Co-citation analysis was utilized to ascertain the connections among prominent authors and seminal literature (Small, 1973), whereas co-occurrence mapping facilitated the visualization of keywords that commonly appeared in the research (Callon et al., 1983). Network analysis was utilized to illustrate the contact and collaboration among scholars from various countries. Employing these bibliometric techniques, significant trends in the literature were distinctly illustrated, and groups of active researchers in this domain were recognized.

Indicators and Results Visualization

Descriptive and relational indicators, as well as bibliometric methodologies were employed to perform the research. Language, nationality, and institutions partially shape the sociodemographic situation. The data on publication year frequency enables the display and identification of the historical development phases of research on this topic. Keyword analysis enhances understanding of authors' viewpoints on concepts and studies, along with their categorization and interconnection within the research context. It helps in recognizing subjects that have garnered inadequate focus. The information on principal contributors and prominent journals elucidates the primary researcher in this study and the significant publication venues.

The author's collaborative participation forms the basis of the research community, while the compiled citations clarify the intellectual underpinning of this research. The mapping ultimately offers a more lucid representation of the accomplishments, the community engaged in this endeavor, and perspectives on possible directions for future research.

Data Analysis Process

Figure 1 below illustrates a series of processes involved in the data analysis process. Initially, the criteria for selecting terms, years, target indices, and the database to be utilized are established prior to the collection and purification of the requisite data. The data is subsequently analyzed to implement uniform criteria that facilitate the attainment of the study objectives. The data cleaning process entails the uniformity of lettercases, verification of authors' initials, elimination of duplicate reference citations, and assurance of data correct-

ness, among other procedures. This technique frequently necessitates multiple iterations until precise data are acquired for analysis. Analysis was conducted using the aforementioned indicators and maps to achieve the desired results. The study ultimately synthesized findings and outcomes, together with a compilation of research limitations and recommendations for future investigations, as part of the final analytical process.

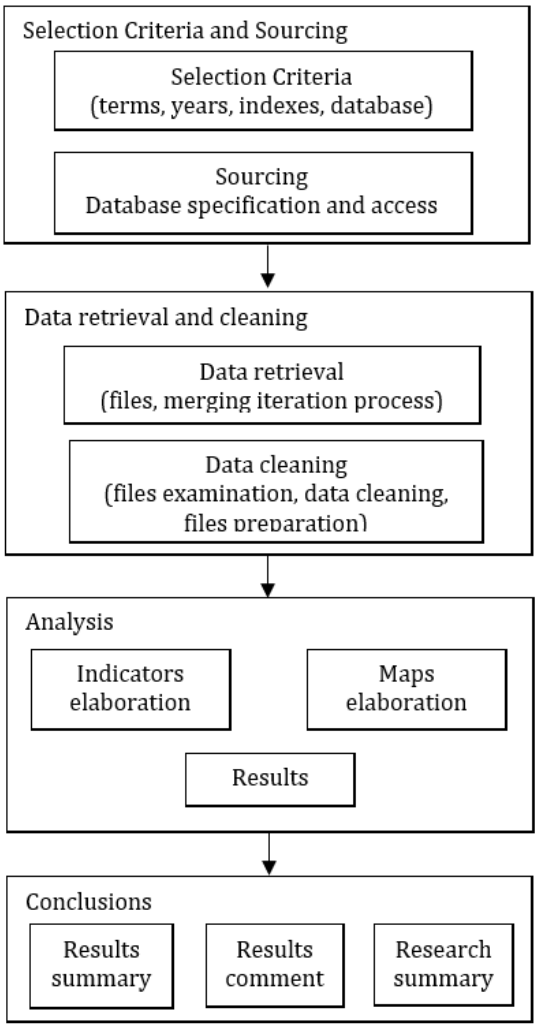

Figure 1. Summary of Analytical Techniques

RESULTS AND DISCUSSION

The selection criteria were employed to identify Scopus' principal database, and data preparation was conducted as previously described, culminating in the acquisition of 226 articles as study samples.

Publications per year

The examined papers were published from 2019 to 2024. Figure 2 delineates the many periods established for subsequent analysis and discourse.Figure 2 illustrates a rise in research articles concerning artificial intelligence in financial services from 2019 to 2024. The year with the highest number of published publications was 2024, totaling around 52 documents. The scientific field has evidently attained a significant stage of advancement. Throughout this period, the production of research in written form has demonstrated a steady rise, reflecting heightened interest in these subjects. Despite yearly fluctuations, the increase in the number of documents from 9 in 2019 to 52 by 2024 indicates a positive trend of interest and progress in this field. The substantial increase from 2019 to 2022 was particularly noteworthy, with the quantity of articles increasing approximately sixfold, likely driven by the swift incorporation of AI technology in the banking sector during the COVID-19 pandemic.

The aforementioned data provides a summary of the trend changes and notable advancements that have transpired in the study field in recent years. Therefore, other study avenues may be explored. It is essential to evaluate the long-term implications of AI integration inside the financial sector, taking into account the vast historical data now available. An alternative strategy involves undertaking more extensive research on regulatory and security concerns, which have been persistent and are well recognized in the field but may not yet be fully resolved. Employing an innovative paradigm, these persistent challenges may be approached from a new angle, perhaps yielding original answers. Furthermore, efforts to establish new international partnerships could expand research in this field, particularly in assessing best practices for AI use in global financial markets.

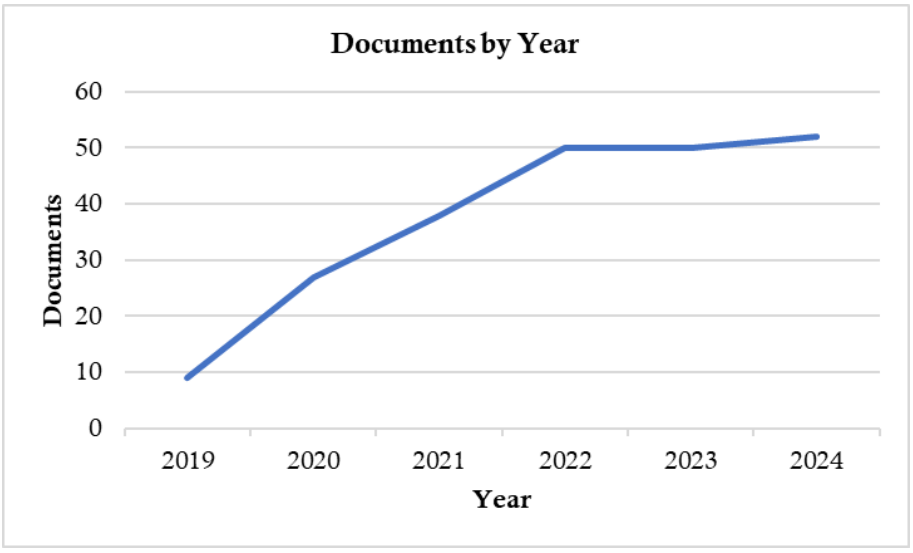

Figure 2. Publication per Year

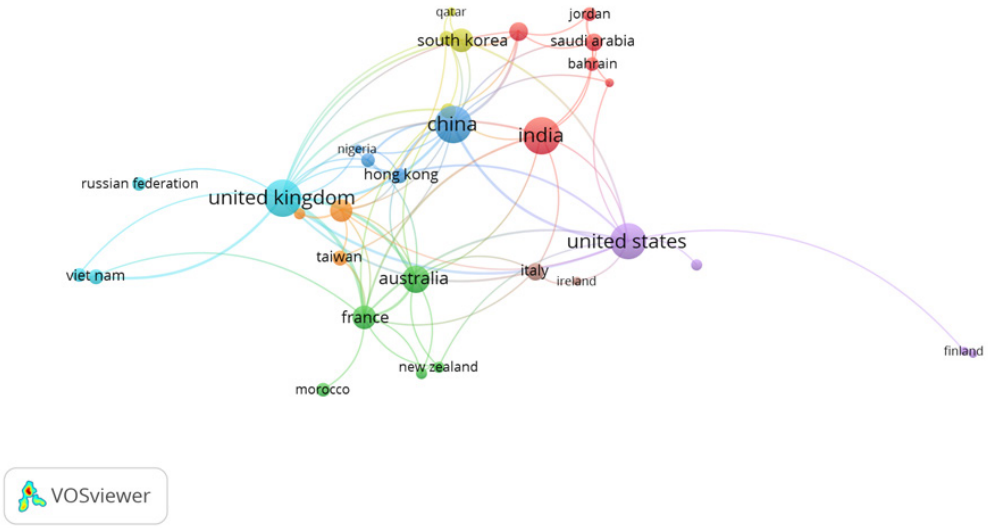

Figure 3. Authors' Nationalities Map

Overall, this table shows that the existing literature has had a very significant impact on research and practice, including in digital contexts. The works listed in this table have provided a strong theoretical and practical basis for understanding and managing in a variety of contexts, including how to leverage new technologies to improve their services and compete in increasingly digital markets. This citation analysis also shows that the topic and technology continue to be an active and relevant area of research, with important contributions from a variety of leading authors and researchers.

Figure 3 a visual network map generated using the device VOSviewer software. This map illustrates the relationship between various keywords that frequently appear in the literature related to technological innovation. Each dot in this map represents a single keyword, while the lines connecting the dots show the relationship between keywords based on the number of times they appear together in the same article. The size and color of these dots provide additional information about the importance and relationships between keywords. The keyword "technological innovation" is the largest and central point in

this map, indicating that this term is central to much research in this field. This indicates that technological innovation is a very common and important theme in the analyzed literature.

Countries and Languages of Publications

All analyzed papers were published in English. Figure 3 illustrates that article submissions originate from 32 distinct countries. This graphic illustrates collaboration among authors from various countries. The closeness of the lines linking the writers signifies an increased frequency of collaboration. It illustrates active collaboration among researchers from many nations, emphasizing the geographical and cultural aspects of scientific cooperation. Five clusters are emerging. Cluster 1 comprises Bahrain, India, Japan, Jordan, Malaysia, and Saudi Arabia. Cluster 2 comprises Australia, France, Morocco, New Zealand, and Singapore. Cluster 3 comprises China, Hong Kong, Nigeria, and Thailand. Cluster 4 comprises Pakistan, Qatar, South Korea, and the United Arab Emirates. Cluster 5 comprises Finland, Indonesia, Sweden, and the United States. Cluster 6 comprises Canada, the Russian Federation, the United Kingdom, and Vietnam. Cluster 7 comprises Germany, the Netherlands, and Taiwan. Cluster 8 comprises Ireland and Italy.

Increased concentrations of articles in particular nations yield two separate outcomes. This specialism may facilitate in-depth and focused research on specific aspects of artificial intelligence in financial services. Moreover, it offers the opportunity to incorporate additional countries into scientific partnerships.

The network map depicts significant contributions from developed nations, such as the United States, the United Kingdom, and China, indicating their strong involvement and investment in AI research within the financial sector. Emerging economies like India, Nigeria, and Vietnam have heightened engagement, highlighting an expanded study scope that includes diverse socio-economic contexts. This inclusion improves the comprehension of AI applications across various financial contexts, providing a more thorough perspective on global AI developments.

This concentration of research facilitates the inclusion of authors and institutions from various nations in collaborative investigations. Such collaborations can produce diverse perspectives and techniques, enhancing international cooperation in AI research within financial services.

Journal Productivity

The preeminent journal sources for works on artificial intelligence in financial services include IEEE Access, the International Journal of Bank Marketing, the Journal of Behavioral and Experimental Finance, the Journal of Business Research, and the Oxford Review of Economic Policy. These journals have significantly progressed research on AI applications in finance, highlighting risk assessment, consumer analytics, and automated decision-making in financial services. The H-index (Hirsch index) in bibliometric analysis assesses the influence of authors or journals by tallying the number of articles (H) that have received a minimum of H citations. It provides a means to evaluate the productivity and influence of a publication or author within a certain field. The m-index is a variant of the H-index, computed as H/n, where H represents the H-index and n indicates the number of years from the author's or journal's first publication in the dataset, so enabling a normalized evaluation of impact. The g-index, proposed by Egghe in 2006, is an improvement upon the H-index. The g-index evaluates global citation performance by assigning greater significance to highly-cited items within a collection, thus offering a more thorough perspective on citation impact. Table 1 enumerates journals possessing a minimum of two entries in the H-index, underscoring significant academic sources that have substantially influenced the research domain of AI in financial services.

Figure 4 shows how the journals that study AI in financial services are linked to each other by showing how they are grouped by how often they are cited and co-cited. This map looks at joint citations to show how close and connected journals are, focusing on how often they are cited together and topics match up in AI research in the financial sector.

The spatial distribution of journals on the map illustrates their degree of interconnectedness. IEEE Access and the International Journal of Bank Marketing exhibit a significant correlation, as demonstrated by shared citations and pertinent research issues. Prominent journals are the Journal of Behavioral and Experimental Finance and Expert Systems with Applications. This shows how important it is to look into AI applications in behavioral finance and system-oriented methodologies.

Overall, this table below shows that the variables have a very significant impact on research and practice, including in the digital context. The works listed in this table have provided a strong theoretical and practical basis for understanding and managing in a variety of contexts, including how to leverage new technologies to improve their services and compete in increasingly digital markets. This citation analysis also shows that technology-related topics continue to be an active and relevant area of research, with important contributions from a wide range of leading authors and researchers.

Table 1. Journals with Publications on Artificial Intelligence in Financial Services

Journal	h_index	g_index	m_index	TC	NP	PY_start
IEEE Access	7	7	1.400	191	7	2020
International Journal of Bank Marketing	6	6	2.000	228	6	2022
Journal of Behavioral and Experimental Finance	3	3	0.600	269	3	2020
Journal of Business Research	3	3	0.750	106	3	2021
Oxford Review of Economic Policy	3	3	0.750	48	3	2021
Strategic Change	3	3	0.750	161	3	2021
Technological Forecasting and Social Change	3	3	0.600	203	3	2020
Australasian Marketing Journal	2	2	0.500	119	2	2021
Computers, Materials and Continua	2	2	0.400	100	2	2020
Expert Systems with Applications	2	2	0.667	41	2	2022

Source: Processed Data, 2024

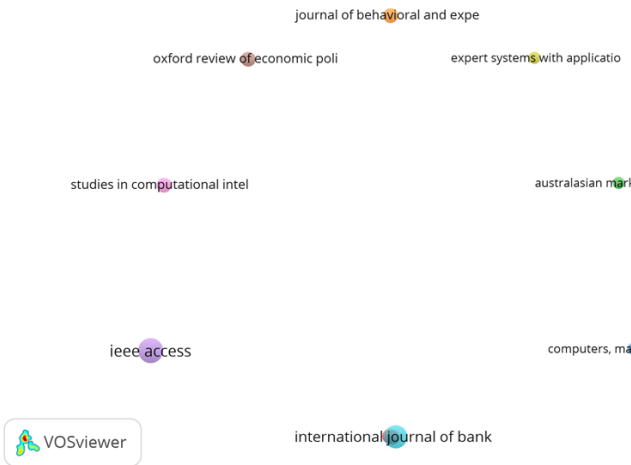

Figure 4. Journals Co-occurrence Map

The map's distribution indicates that certain journals, particularly in marketing and computational intelligence, offer varied insights on AI applications in finance. This graphic facilitates the identification of primary sources that are often cited in conjunction, acting as essential contributors and reference points for research on AI in financial services. The image above is a map of the author collaboration network. Each dot on the map represents an author, and the lines connecting the dots indicate collaborations between authors on scientific publications. Different colors indicate clusters or groups of authors who frequently collaborate with each other.

This map shows several significant clusters of collaboration. The green cluster, for example, shows close relationships between authors who frequently work together to explore how national policies and systems can support . The red cluster, for example, shows intense collaboration in this area.

The yellow cluster emphasizes the importance of cross-organizational collaboration . Authors in the purple cluster appear to focus on energy technology systems, while the blue cluster focuses on the innovation economy. This map provides insight into the structure of collaboration in research , showing that while there are a few key authors who frequently collaborate, there are also authors who contribute significantly as individuals or in small groups.

Authors' Productivity

Table 2 provides details on a single author from a selected group of analyzed articles. The sample has 606 distinct authors. The writers in the table were ranked according to their h-index on the left and their total citations on the right. The utilization of these two rankings provides distinct perspectives on the writers' contributions to this research. The H-index offers a summary of the effect of their study in this domain, while the overall citation count reflects the degree to which their work is referenced by other scholars, illustrating the influence of their research on subsequent studies and collaborative efforts.

In assessing the importance of the h-index, eminent scholars like Zhang X, Ashta A, and Bhatia A hold the top positions. Zhang X, having a strong managerial experience, has achieved a maximum h-index of 3, accumu-

Table 2. Most Prolific Authors

Author	h_index	g_index	m_index	TC	NP	Author	h_index	g_index	m_index	TC	NP
Zhang X	3	3	0.75	101	3	Cho Gh	1	1	0.2	372	1
Ashta A	2	2	0.50	142	2	Ra I-H	1	1	0.2	372	1
Bhatia A	2	2	0.40	116	2	Sharma Pk	1	1	0.2	372	1
Chandani A	2	2	0.40	116	2	Shojafar M	1	1	0.2	372	1
Chen Y	2	2	1.00	6	2	Singh S	1	1	0.2	372	1
Fu S	2	2	0.40	78	2	Yoon B	1	1	0.2	372	1
Giudici P	2	2	1.00	27	2	Mogaji E	2	2	0.5	204	2
Gupta R	2	2	0.50	9	2	Lee I	1	1	0.2	204	1
Hamdan A	2	2	0.50	19	2	Shin Yj	1	1	0.2	204	1
Herrmann H	2	2	0.50	146	2	Caglar U	1	1	0.2	187	1

Note: The Left list is ranked by h-index and the right list is ranked by citations.
Source: Processed Data, 2024

lating 101 citations and publishing 3 papers. Ashta A and Bhatia A concentrated on their respective fields, achieving an h-index of 2, with total citations of 142 and 116, respectively. These authors' research has significantly improved their position in the h-index rankings.

Research by Cho Gh, Ra I-H, Sharma Pk, Shojafar M., Singh S., and Yoon B has garnered a significant citation total of 372, although it comprises only one publication, underscoring the substantial impact of their work. Thus, these works enhance understanding of the processes that affect the efficacy of the research field.

The rationale for the top ranking in this area may differ from its significance in the literature. Consequently, it is essential to examine the references given in these papers to enhance comprehension of their significance and influence on study. The referenced sources will elucidate the degree of influence these works exert on research and their contributions to the advancement of knowledge in this domain.

References Analysis

The reference analysis in the essay provides valuable insights into the philosophical foundation of the discipline. The sample comprises 11.832 commonly referenced references and quotations, which may aid in pinpointing the most prominent articles in the literature of artificial intelligence and financial services. Table 3 will provide a detailed summary of the most often employed quotations and their relevance to this topic. By analyzing commonly cited references, authors may identify essential knowledge and notable trends in this field.

The analysis of the references reveals two predominant topics: artificial intelligence in the financial services sector and the deployment of robo-advisors in service industries. The most often referenced works are notable for their significant theoretical and methodological contributions to understanding these relationships (Belanche et al., 2019; Zhang et al., 2021).

Table 3. Most Local Cited References

No	Cited References	Citations
1	Zhang L, Pentina I, Fan Y. Who do you choose? Comparing perceptions of human vs robo-advisor in the context of financial services. J Serv Mark. 2021;35(5):634-46.	8
2	Belanche D, Casalo LV, Flavian C. Artificial intelligence in fintech: Understanding robo-advisors adoption among customers. Ind Manag Data Syst. 2019;119(7):1411-30.	7
3	Davenport T, Guha A, Grewal D, Bressgott T. How artificial intelligence will change the future of marketing. J Acad Mark Sci. 2020;48(1):24-42.	7
4	Huang MH, Rust RT. Artificial intelligence in service. J Serv Res. 2018;21(2):155-72.	7
5	Jung D, Dorner V, Weinhardt C, Pusmaz H. Designing a robo-advisor for risk-averse, low-budget consumers. Electron Markets. 2018;28(3):367-80.	7
6	Lui A, Lamb GW. Artificial intelligence and augmented intelligence collaboration: Regaining trust and confidence in the financial sector. Inf Commun Technol Law. 2018;27(3):267-83.	7
7	Atwal G, Bryson D. Antecedents of intention to adopt artificial intelligence services by consumers in personal financial investing. Strateg Change. 2021;30(3):293-98.	6
8	Belanche D, Casalo LV, Flavian C. Artificial intelligence in fintech: Understanding robo-advisors adoption among customers. Ind Manag Data Syst. 2019;119(7):1411-30.	6
9	Haenlein M, Kaplan A. A brief history of artificial intelligence: On the past, present, and future of artificial intelligence. Calif Manag Rev. 2019;61(4):5-14.	5
10	Huang MH, Rust RT. Artificial intelligence in service. J Serv Res. 2018;21(2):155-72.	5

Source: Processed Data, 2024

The study found important connections between different references, highlighting how concepts and assumptions in the literature on AI and robo-advisors interact with each other in complex ways. We use some references to support specific points, while others provide a strong theoretical foundation for further investigation. Some research is frequently cited to analyze artificial intelligence in service (Huang & Rust, 2018), while others is routinely employed to clarify client acceptance and impressions of robo-advisors (Jung et al., 2018; Lui & Lamb, 2018).

The analysis of the references reveals two predominant topics: artificial intelligence in the financial services sector and the deployment of robo-advisors in service industries. The most often referenced works are notable for their significant theoretical and methodological contributions to understanding these relationships (Belanche et al., 2019; Zhang et al., 2021).

The study found strong connections between different sources, highlighting how ideas and hypotheses in the literature about AI and robo-advisors interact in complicated ways. The literature deploys some references to support specific points, while others provide a solid theoretical foundation for future research. Some research is frequently cited to analyze artificial intelligence in service (Huang & Rust, 2018), while others is routinely employed to clarify client acceptance and impressions of robo-advisors (Jung et al., 2018; Lui & Lamb, 2018).

While certain references concerning artificial intelligence in services retained their relevance, the study also indicated an increasing interest in contemporary research. Some new research on AI and robo-advisors shows that we need to learn more about how AI can be used in the financial services industry, especially when it comes to how clients see and use AI (Atwal & Bryson, 2021; Zhang et al., 2021).

This comprehensive study offers a detailed analysis of the framework, trends, and contributions within the current literature on artificial intelligence and robo-advisors. This knowledge is essential for conducting advanced research and for formulating a more refined conceptual framework to understand the complex dynamics of artificial intelligence and robo-advisor adoption in the financial services sector.

To analyze the co-citation of the referenced works, the writers scrutinized papers cited a minimum of five times to discern the intellectual foundations of the research on the topic. The co-citation map for the reference (Figure 5) serves to illustrate the findings. The principal component analysis is conducted to examine the co-citation reference network depicted in Figure 5.

Topics On Artificial Intelligence

The research articles in the sample utilized a total of 1251 unique keywords for categorizing their subjectFigure 6 illustrates 48 keywords extracted from research publications, each occurring at least five times. The closeness and density of the connecting lines signify the intensity of the association between terms, with each sentence represented as a node. This elucidates the relationships and patterns among the fundamental concepts employed in research. This method effectively improves comprehension of the subject's essence and the interconnections among various themes in the book. This chart facilitates the identification of the most relevant and crucial terms in the study.

A deeper understanding of the keywords in this research clarifies important research issues and trends in the literature. A substantial connection exists between "artificial intelligence" and "financial services," highlighting the focus of academic study on both areas. This view aligns with previous findings, including the cognitive framework, pertinent researchers, and the cited sources.

Furthermore, the inclusion of data regarding the authors' country of origin and industry, indicated by keywords such as "China" and sectors like "banking," "commerce," and "financial institutions," enhances the un-

derstanding of the research's origins and the industries pertinent to the subject matter. This environment highlights technology-driven industries. This knowledge is crucial for understanding the background and direction of the research, as well as for identifying the underlying theoretical framework. This data helps enhance comprehension of research topics and prospective research directions.

This study highlights that the application of artificial intelligence (AI) in financial services is a rapidly evolving and intricate field within business and technological research. An analysis of publications from 2019 to 2024 demonstrates a substantial rise in research outputs, peaking in 2024, which signifies an intensified academic and practical interest during this period. This expansion corresponds with the extensive acceptance and incorporation of AI technology in financial operations, propelled by digital transformation trends intensified by the COVID-19 epidemic. The pattern indicates a field evolving from preliminary study to a more established stage, offering a robust platform for future research that can investigate uncharted subtopics and frameworks.

This study examined English publications from 32 distinct ethnicities.The analysis revealed collaborative networks among scholars, emphasizing active international partnerships that facilitate the exchange of diverse ideas. We employed co-authorship and co-

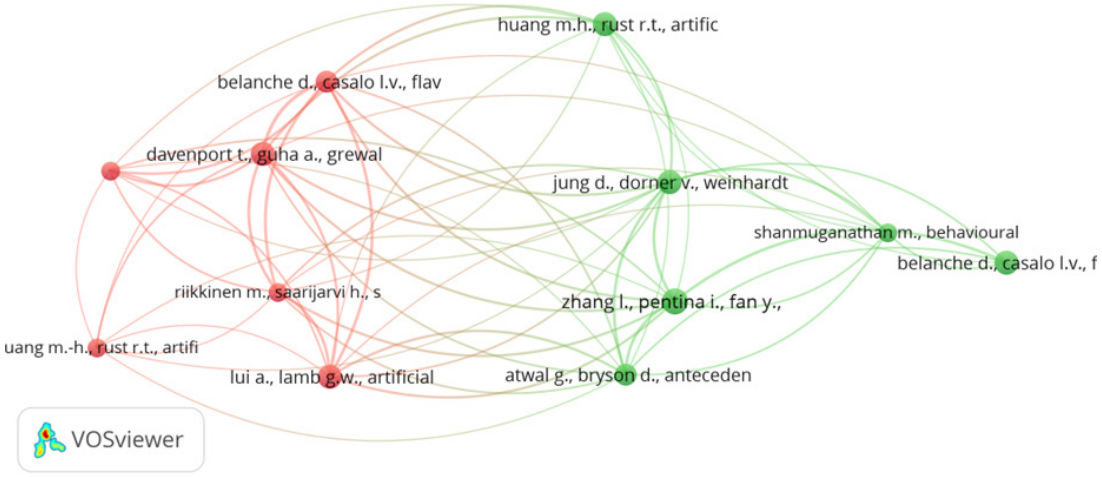

Figure 5. Co-citation: Map of Cited References

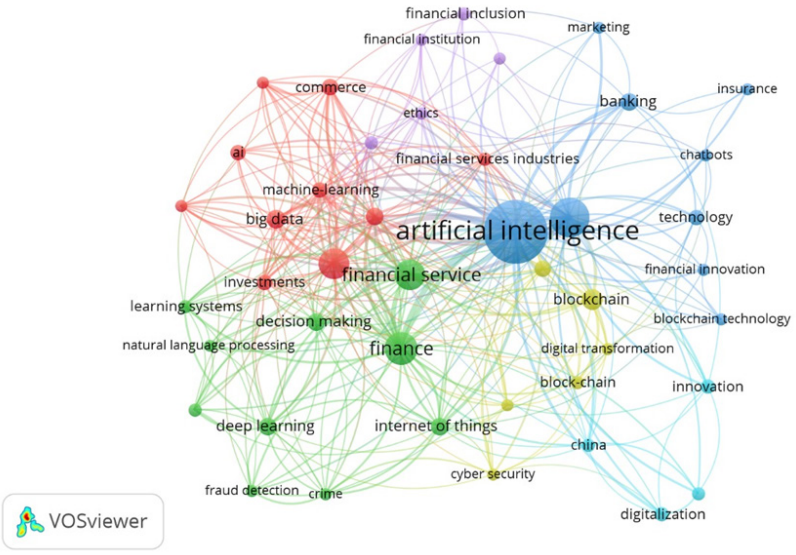

Figure 6. Keyword Co-occurrence Map

citation mappings to delineate the networks. They concentrated on collaboration across groups of nations such as the US, China, and the UK, alongside emerging economies like India and Nigeria. These clusters highlight opportunities for new collaborative initiatives that could involve underrepresented regions, fostering a more global perspective on AI in financial services.

Journals such as IEEE Access, International Journal of Bank Marketing, Journal of Behavioral and Experimental Finance, and Journal of Business Research were identified as critical sources, signifying that significant AI-focused research is taking place at the intersection of technology, finance, and marketing. Bibliometric indicators, such as the H index, g index, and m index, offer insights into the impact and efficacy of these publications. Co-citation analysis showed theme connections between well-known publications, highlighting the main ideas and theoretical bases that support the subject.

Artificial intelligence in financial services frequently converges with fields such as data science, regulatory policy, and risk management. The employed methodologies and models are influenced by principles from computer science and economic theory, illustrating the interdisciplinary character of study in this domain. This all-around view stresses how important it is to combine technical knowledge with business sense and moral concerns in order to fully utilize AI's transformative potential in the financial services industry.

This study emphasizes the rise of subtopics, such as the application of AI in improved credit scoring, fraud detection, and customized financial services. These technologies underscore the transition towards utilizing machine learning and natural language processing to improve operational efficiency and customer experience. The research highlights the challenges in reconciling AI advancements with regulations intended to protect people and reduce systemic dangers.

The insights obtained can assist financial institutions and governments in formulating policies that align technological advancement with regulation and ethical accountability. The findings underscore the potential advantages of integrating AI to foster innovation while preserving trust and security within financial entities.

CONCLUSION

This study provides a thorough analysis of the publication environment for AI applications in financial services, based on data from 226 articles and contributions from 606 authors. Using bibliometric metrics like the h-index and total citations, such as Zhang X, Ashta A, and Bhatia A, a study can find important authors who have had a big impact on the field. Their research has laid the groundwork for understanding the influence of AI on various financial operations, such as risk evaluation and client engagement. The study underscores the significance of their contributions and the necessity for citations to elucidate the impact of their research. The reference analysis underscores significant contributions to the field, demonstrating that fundamental studies persist in influencing the discourse, while contemporary research expands the scope, especially in domains like as automated trading and AI-driven fraud detection. This dual focus demonstrates the continuous progress of AI research, integrating established ideas with innovative technology developments. The keyword analysis reveals notable patterns and essential themes in the literature, encompassing credit scoring, personalized banking, and compliance with regulatory frameworks.

By visualizing these relationships, scholars can improve their understanding of the interactions among technology, finance, and regulation. The specifics of the nations and sectors engaged suggest a globally distributed research program with significant contributions from both developed and emerging economies. This methodology establishes a robust basis for subsequent study. It promotes further investigation into the application of AI in particular domains and the integration of

ethical considerations in the advancement of these technologies. In conclusion, the theme clustering analysis shows that technological innovation is a dominant topic with significant focus.

The research trend has shifted from national systems and open innovation in the early period to green innovation and sustainability in recent years. Research opportunities are seen in low-density areas such as digital technologies and technological innovation systems, which are still under-explored. The author collaboration map reveals several important collaboration clusters, including leading authors indicating that although there is strong collaboration within some groups, significant contributions also come from individual authors or small groups. Overall, these findings provide strategic guidance for future research that can fill existing gaps and strengthen collaboration among researchers in the field of technological innovation.

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