

Review Article

Exploring the Role and Application of Artificial Intelligence and Machine Learning in Digital Financial Inclusion: Identifying Key Themes and Trends Through Bibliometric Analysis in the Era of the Digital Revolution and Technological Advancement

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Abstract - This paper aims to conduct a comprehensive bibliometric review of the research landscape concerning Artificial Intelligence (AI) and Machine Learning (ML) applications in the financial sector, focusing on digital financial inclusion. To achieve this, articles indexed in Elsevier's Scopus database were chosen over those in Web of Science (WOS) and Google Scholar to identify key research clusters. During the review, 6,642 articles were screened, resulting in 3,097 articles meeting the inclusion criteria. The analysis reveals that the number of publications in this field has grown exponentially in recent years, with "digital banking services" emerging as the most relevant source. Additionally, the analysis underscores the need for enhanced international collaboration in AI research for financial inclusion. Through co-citation and co-word analysis, the study identifies prominent scholars and key concepts in the field, offering valuable insights for future research directions. While this study provides valuable insights, limitations such as database selection and sample size are acknowledged, paving the way for future research improvements in this domain.

Keywords - Digital finance, Financial inclusion, Artificial intelligence, Machine learning, Bibliometric analysis, Citation analysis.

1. Introduction

Digital Finance (DF) arises from advancements in financial technology. It encompasses all electronic financial services and products, such as lending, investing, payments, insurance, and financial information, delivered through digital platforms [1]. On the other hand, digital financial inclusion is gaining prominence in discussions aimed at empowering individuals in the lower socioeconomic strata to become more financially engaged [2]. Collaborative efforts between banks and non-bank entities are underway to expand financial access using digital strategies, particularly targeting those who have been excluded or underserved [2]. Leveraging Artificial Intelligence (AI), both banks and non-banking institutions are enhancing access to financial services (Alameda, 2020; Mhlanga, 2020). In recent years, it has fundamentally reshaped the operational landscape of businesses. The Banking, Financial Services, and Insurance (BFSI) industry has recently experienced a substantial rise in the adoption of AI and machine learning-based applications, as reported by Pattnaik et al. (2024). These applications can

enhance client interactions, streamline operations, support decision-making, and spot fraudulent activity. Artificial intelligence integration has garnered significant interest in digital banking, resulting in noteworthy breakthroughs. These developments include a wide range of services, including automated cybersecurity measures, biometric identification, conversational bots, speech recognition, facial recognition, machine learning for fraud detection, and humanoid robots [4]. Like this, using AI in financial organizations provides several incentives, including improved client satisfaction and faster responses. For instance, the United Banking for Africa (UBA) in Nigeria has a financial chatbot named Leo that helps users with money transfers and bill payments. Similarly, Konfio in Mexico enables repayments on loans for Enterprises in under twenty-four hours, which is a substantial improvement over the lengthy process of traditional financial institutions. [5]. Moreover, Artificial Intelligence (AI) offers a more efficient, accurate, and cost-effective approach to analyzing potential borrowers. By considering a broader array of variables, AI



enables well-informed decisions supported by data [6]. This study aims to conduct an extensive bibliometric analysis to explore the use of Artificial Intelligence (AI) and deep learning in the financial sector, specifically focusing on their role in digital financial inclusion services. The objective is to identify and examine the prominent trends, patterns, and advancements present in research articles, academic publications, and scholarly works that connect these two domains.

The financial industry has seen a transformation in the previous ten years because of the rapid rise of Information and Communication Technologies (ICTs), particularly the Internet and smartphones, which have affected both the supply and demand sides of the market. As a result, Digital Financial Inclusion (DFI) has emerged, giving access to financial services to those who were previously unbanked and removing obstacles related to cost, location, and transparency [7]. Alternative banking models, such as payment banks, small-scale banks, and mobile money platforms, have emerged in response to the need to improve access to financial services, with a focus on serving those without traditional bank accounts. Furthermore, new non-bank fintech businesses are now included in the financial inclusion campaign and are vying for a bigger piece of the banking industry's value chain. [8]. Financial inclusion began as a plan to help poor people and those without bank accounts access financial services. Now, it is seen to fight extreme poverty in developing and poor countries. Many people who support financial inclusion think of it to spur development and lift people out of poverty [9].

Given the diverse and ever-changing research landscape, it is crucial to periodically summarize the literature comprehensively to guide future scholarly efforts [3]. Regarding different fields such as biomedical research and healthcare [10], educational leadership [11], [12], and lean manufacturing [13] applied the science mapping approach. Furthermore, much research using statistical methods has been done on finance and financial inclusion. However, to our knowledge, few studies employed a science mapping approach to analyze the research status and future trends. In addition, none of these studies focused on the role of artificial intelligence in digital financial inclusion.

However, existing reviews in the financial inclusion field, such as those by [14] (Tepe et al.,2021) and [16], only provide fragmented insights. [14] emphasized the broad application of machine learning techniques and examined research articles with an emphasis on AI and machine learning applications in financial management. Their main advice for further research was in the areas related to financial fraud, fintech, and asset pricing. Conversely, (Tepe et al. 2021) focused mostly on financial technology while reviewing financial services, access, and technology.[16] specifically reviewed cryptocurrency and blockchain

literature. While these studies offer valuable insights into fintech, they lack comprehensive coverage of publications and fall short in suggesting future research directions in the digital financial inclusion domain. To bridge the existing gap, the paper systematically examines scholarly publications, citations, and thematic trends, leveraging the groundwork laid by [14], [3] And offers reliable responses to the following queries:

RQ1: What are the publications and citation trends in AI, ML, and financial inclusion?

RQ2: Which countries mostly contributed to the top cited articles on the role of AI and ML in financial inclusion?

RQ3: What are the top productive journals in the field, and what are their characteristics?

RQ4: Who are the top authors in the field of AI, ML, and digital financial inclusion?

RQ5: What are the key concepts that have frequently been utilized in the domain of AI and financial inclusion?

The following sections are included in the remainder of the paper. The prior research is summarized in Section 2. In Section 3, the technique and statistics are presented. The primary results, including the research domain's trends and patterns, as well as are covered in Section 4. The paper's main conclusions are outlined in Section 5 accompanied by recommendations for further research topics.

2. Literature Review

Financial inclusion is an important issue on the global agenda currently. It entails making sure that all individuals and organizations, no matter how prosperous or impoverished, have access to formal financial services, including digital payment platforms, insurance, savings accounts, and credit options. These amenities are critical for fostering economic growth, reducing poverty, and advancing society as a whole [18]. [19] found that the utilization of artificial intelligence in banking, particularly in robot advisory services, was crucial for acceptance. Ethical evaluations of financial services also played a significant role. Surprisingly, prior experience with basic financial services did not significantly impact the acceptance of robot advisory.

[20] Leveraging Artificial Intelligence (AI) on existing data can help Financial Service Providers (FSPs) to predict customer responses, and effectively reach underserved populations. Likewise, [21] indicated that to help households that have been shut out of financial services obtain credit, financial organizations like banks and credit lenders are investing more in artificial intelligence and machine learning. Nonetheless, machine learning-based internal models present the possibility of evaluating business finances using annual statements, requiring comparison with statistical techniques [22]. In their study, [23] discovered that unbanked individuals exhibit the strongest inclination towards mobile financial services for opening accounts, with a preference

rate of 15.33 percent. This holds significant policy implications for developing countries aiming to implement strategies for achieving universal financial access. Njanike and Mpofu (2024) studied the factors influencing financial inclusion in several African nations and discovered a significant positive relationship between social inclusion and financial inclusion. This demonstrates how important financial inclusion is in the fight against poverty and social marginalization since it allows citizens access to a range of financial services that they can leverage for their advantage.

[25] observed that, in comparison with conventional models, the optimized system demonstrates slower increases in running time with growing data magnitude, highlighting its efficiency by outlining the security techniques for Information Management Systems (IMS) in financial services security and highlighting the increasingly important role of data security in the swiftly evolving digital finance era. In addition, [26] authorities should create an environment that supports the expansion and integration of financial technology; future research avenues should center on examining the impact of electronic financial services on underserved populations, exploring alternative funding sources, and utilizing the potential of emerging technologies to promote financial inclusion and economic growth.

[27] shows that formal financial inclusion significantly increased the possibility of people using Digital Payment Solutions (DPS) for in-store and online purchasing, as well as for paying regular bills, during crises like COVID-19. In addition, there was a clear gender difference in the use of DPS for online purchasing, with a preference for men. [28] applied panel vector autoregression to examine the effects of digital financial inclusion on 16 LFDCs and 29 HFDCs between 2015 and 2020. DFI reduces economic growth in LFDCs because of stricter environmental regulations, but it also improves environmental quality and technical advancement. While DFI promotion leads to economic growth, HFDCs experience a decline in environmental quality.

In contrast to previous empirical research, a recent study has shown that the expansion of financial inclusion in Turkey has a significant impact on income equality. The results of this study have important implications for the country. They suggest that while the relationship between the level of financial inclusion and income inequality is not negative, increasing the income of low-income groups across different financial sectors could improve income equality [29].

Utilizing data from GLSS6 and GLSS7 (2012/2013 and 2016/2017), generalized Poisson and multinomial probit models are applied [30] to highlight the importance of agricultural development aspects and infrastructure, including banks and roads in determining the degree of financial inclusion. [31] adopted the Index of Financial

Inclusion (IFI) approach to compare financial inclusion in several Asian countries. Additionally, the relationship between socioeconomic status and financial inclusion was investigated using the Ordinary Least Square (OLS) method with a Fixed Effects Model approach.

The results indicate that, in the Asian countries under investigation, the functionality factor has a greater overall influence on financial inclusion, with GDP per citizen revealing a partial influence. [32] demonstrated that financial institutions and other financial institutions mostly employ algorithms like logistic regression, random forests, decision trees, and support vector machines for fraud detection, credit risk assessment, and client segmentation. While these technologies improve decision-making and banking services, there are legal concerns with managing large databases.

[33] assessed how Artificial Intelligence (AI) could boost the accuracy of financial reporting in Islamic banking using the UTAUT research paradigm. Following data from 364 Islamic banking professionals analyzed using PLS-SEM, it was found that, in addition to social influence, performance and effort expectation were the main factors influencing the adoption of AI. [34] Digital currency markets exhibited an impressive jump in growth despite policy steps that diminished banks' dominance of the market and advocated three transmission mechanisms, highlighting low and medium levels of involvement until the year 2018.

3. Materials and Methods

It is vital to select the best source while looking for bibliometric data, especially regarding a specific field of study. Elsevier's Scopus platform was selected during this study instead of Google Scholar and Web of Science (WOS). For bibliometric analysis, Scopus was found to be the most appropriate platform for searching and extracting data. WOS fails to offer an exhaustive overview of earlier research and encompasses just a tiny amount of social science papers. In contrast to the Web of Science, Scopus incorporates approximately 70 more sources. (WOS).

Although Google Scholar possesses less stringent indexing standards than WOS and Scopus and delivers inconsistent search results, it was not utilized in this study [11]. On February 9th, 2024, an initial search was conducted in the Scopus database utilizing the following search terms: "IA," "deep learning," "digital financial inclusion," and "fin-tech."

Subsequently, in adherence to established bibliometric protocols, a comprehensive screening and evaluation process was undertaken, involving a total of 6,652 articles. Ultimately, 3,097 articles were identified as meeting the specific selection criteria outlined for this study. You can find the visualization of the search criteria and the step-by-step filtration process below.

Table 1. Article selection and search criteria

Criteria for sorting	Accept	Reject
Date of search : 06/02/2024.		
Search engine : Scopus.		
Search string : ("AI" OR "artificial intelligence" OR "deep learning" OR "technology" AND "financial inclusion" OR "digital financial inclusion" OR "financial service" OR "mobile banking" OR "e-banking" OR "electronic banking")	6,642	
Date filter : 2000-2024	6,447	195
Subject filters : Finance, economics, econometrics, business management, accounting, social science, arts, and humanities.	3,949	2498
Document type : Limited conference papers, reviews, and articles	3,161	788
Language filter : Only English	3,097	64

3.1. Search String

TITLE-ABS-KEY ("AI" OR "artificial intelligence" OR "deep learning" OR " technology" AND "financial inclusion" OR "digital financial inclusion" OR "financial service" OR "mobile banking" OR "e-banking" OR "electronic banking") AND PUBYEAR > 2000 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ARTS")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English")).

3.2. Data Extraction and Cleaning

Due to constraints placed on the database, just the initial 2000 entries could be exported from the data that was collected from the databases of the Scopus website. Following this, specific cleaning methods were applied to the data. Firstly, verification of the entries within the fields (columns) was conducted to ensure no important data was overlooked. Secondly, cross-checking of the data within the columns was performed to confirm alignment with the field titles. For the sake of data accuracy, any erroneous or missing records were removed right away. The data was then cleaned up and moved to a different Microsoft Excel (xls) file. The new file was saved as a Text (tab-delimited) file to make analysis easier and to make it easier to load into the VOSviewer.

3.3. Bibliometric Analysis

Bibliometric techniques enable researchers to examine consolidated bibliographic data, offering insights into the

configuration, social connections, and focal areas within a discipline [37]. The utilization of this technique is swiftly expanding within the realms of management and organizational studies, evident in the increased adoption of these methodologies in recent scholarly works [37]. Nevertheless, bibliometric methodologies serve dual objectives: performance assessment and scientific mapping.

Performance assessment scrutinizes individuals' and organizations' research and publication achievements, while scientific mapping unveils the underlying structure and fluctuations within scientific domains. These methodologies inject a quantitative dimension into the otherwise subjective evaluation of literature, potentially furnishing empirical support for conceptual frameworks in scholarly reviews [37].

In our paper, we employed five significant bibliometric techniques that are frequently employed in research. Citation analysis, co-citation analysis, and bibliographic coupling utilize citation data to gauge influence and similarity, while co-author analysis delves into collaboration patterns based on co-authorship data [38]. Conversely, co-word analysis identifies relationships among concepts based on their co-occurrence in documents (Callon et al., 1983). Using citations as a measure of authority, a citation analysis frequently results in top-N lists of the most referenced research, authors, or journals in a subject [36].

Co-citation analysis reveals linked material by creating relationships between documents, authors, or journals with common citations (McCain, K. W.,1991; Small, 1973.). Bibliographic coupling assesses the similarity between documents by scrutinizing the overlap in their reference lists [41]. Co-author analysis scrutinizes social networks among scientists through collaborative efforts on scientific articles.

Nonetheless, it presupposes that authorship mirrors substantial contributions, which may not always hold owing to honorary authorship or uncredited contributions [41], [42]. Co-word analysis scrutinizes the content of documents to delineate relationships between concepts, thereby constructing a semantic map of the field's cognitive structure (Callon et al., 1983). Moreover, researchers visualized the network structure using VOSviewer [44]. Numerous scholars have emphasized the benefits of utilizing bibliometric analysis in financial research (Bahoo et al.,2020).

Specifically, both academic and professional circles acknowledge that bibliometric analysis functions as an efficient mechanism for mitigating mistakes made by humans (Ellegaard and Wallin, 2015) and emotional distortions [45] through the utilization of automated data processing. [46] illustrated how literature reviews may strengthen theory as well as practice by delivering innovation, value, significance, longevity, clarity, rigor, and comprehensiveness.

4. Results and Discussion

4.1. The Pattern of Publications and Citations

Figure 1 illustrates the trend in scientific publications focusing on the adoption of artificial intelligence in the finance industry, particularly its role in digital financial inclusion, over the past twenty years. The annual number of publications increased gradually between 2000 and 2015, from 25 to a little around 100. But after 2015, there was a noticeable increase in publications, with certain years—like 2023, which saw 540 publications—having more than 100 publications. Additionally, the overall number of publications with a high citation score has varied over time and appears to be declining, particularly around 2021, 2022, 2023, and 2024 (with 5212, 5123, 1511, and 17 citations, respectively). Despite this, the typical yearly volume of publications is rising gradually, indicating a growing interest in and understanding of the subject.

However, the average citation count per publication varies from year to year, suggesting that while research in the field is expanding, it may take time for publications to gain recognition and citations. Overall, these trends suggest that digital financial inclusion remains a popular and important topic in academia. It is predicted that as time moves on, the proportion of highly cited articles among all publications will continue to increase, indicating a deeper understanding and increased significance of the subject in the long run.

4.2. International Cooperation and Contributions

In Figure 2, the analysis highlights the significant contributions of various countries to the most-cited literature on digital financial inclusion. The data reveals that the United States has significantly contributed more than other countries, with 491 publications in the most-cited literature on digital financial inclusion. India's contribution surpasses that of many competitors, including Malaysia, Indonesia, South Africa, Australia, Germany, and Canada, with more than twice the number of publications. Notably, the top three contributors, the United States, India, and the United Kingdom, collectively accounted for 1,229 publications, indicating their substantial lead in highly cited literature on the topic. Conversely, countries such as Germany and Canada, which appeared in the analysis, contributed fewer than 100 publications. This highlights a need for further research in artificial intelligence in the financial sector worldwide, particularly in Europe, Asia, and Africa.

Furthermore, the collaboration network analysis conducted using VOSviewer reveals the extent of engagement between countries in the dataset. Figure 4 shows that India, the UK, and the US are among the top contributors, each maintaining around 70 links with other countries in the network. Other significant contributors include China, Taiwan, and Australia, with approximately 60 links each. Several countries demonstrate substantial collaboration, while others maintain moderate to low levels

of engagement. This suggests a high level of engagement and cooperation among these nations in the scholarly domain. However, there are variations in collaboration levels, with some countries having fewer links, indicating less involvement in collaborative research endeavours. Overall, the study reveals insightful information about the dynamics of international collaboration within the framework of the dataset.

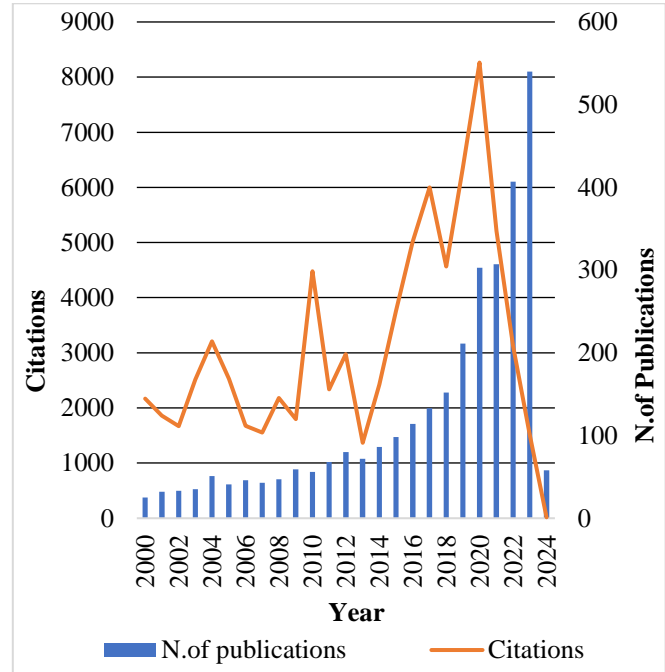


Fig. 1 Total publications and citations yearly

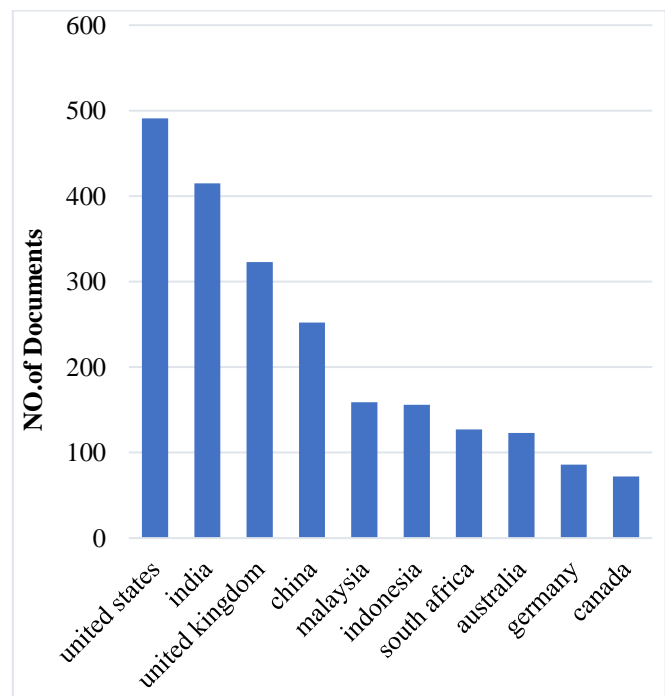


Fig. 2 Highly contributed nations

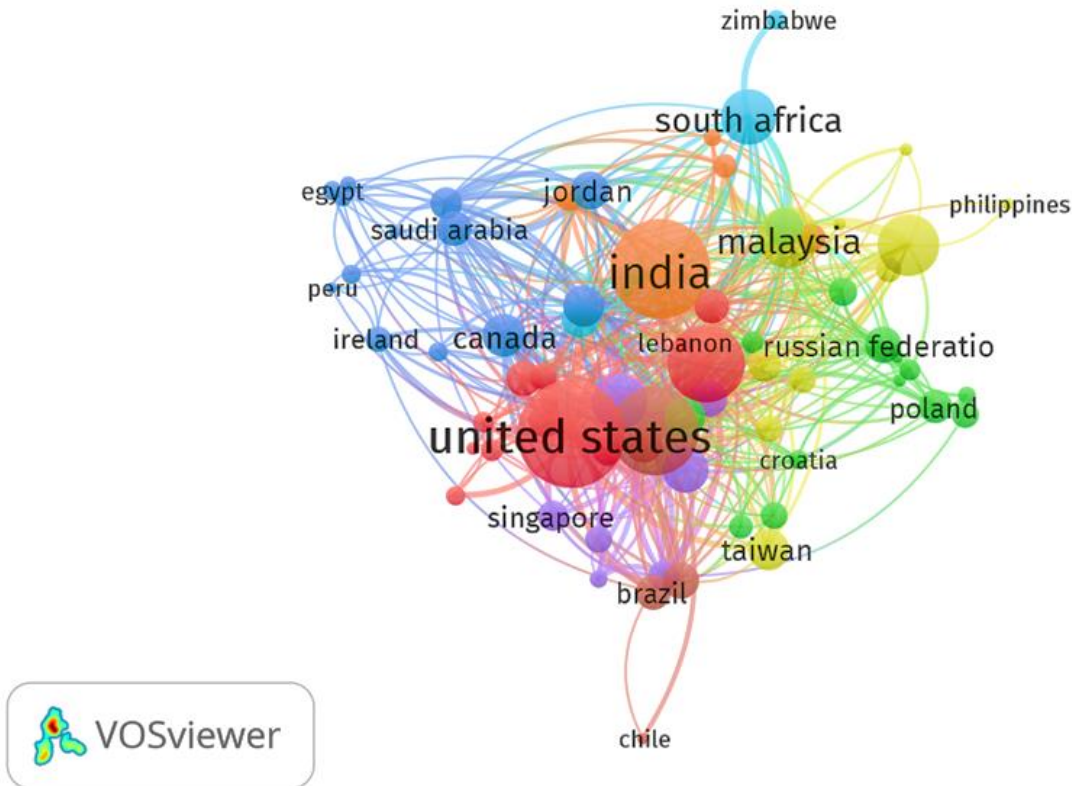


Fig. 3 Country collaboration network based on most cited publications

Table 2. Top-most frequently cited journals

Journal Name	TP	TC	CPP	CiteScore	SNIP	SJR	Quartile
International Journal of Bank Marketing	85	5356	63	9.9	1.910	1.09	Q2
Sustainability (Switzerland)	81	1500	19	5.8	1.198	0.664	Q2
Journal of Internet Banking and Commerce	43	723	17	0.7	0.835	N/A	
Technological Forecasting and Social Change	39	1281	33	17.2	3.008	2.644	Q1
Journal of Financial Services Marketing	29	500	17	3.9	1.517	0.457	Q2
Journal of Risk and Financial Management	26	181	7	2.8	0.476	0.258	Q3
Banks and Bank Systems	24	172	7	2.2	0.562	0.23	Q3
International Journal of Electronic Finance	23	229	10	0.9	0.359	0.15	Q4
Journal of Islamic Marketing	21	592	28	6.3	1.524	0.65	Q2
Cogent Economics and Finance	19	134	7	2.4	1.109	0.37	Q3

Note: TP indicates Total publication; TC stands for Total citations; CPP refers to Citation Per Publication; SNIP stands for Source Normalized Impact Per Paper; SJR stands for Scimago Journal Ranking.

Table 3. Prominent authors in the field of financial inclusion

Rank	Scholar	Articles	Citation	Total Link Strength
1	Robert J. Kauffman	12	2069	699
2	Asongu Simplice	11	205	1056
3	Heikki Karjaluoto	10	2123	5591
4	Yujong Hwang	8	507	5285
5	Tiago Oliveira	8	1790	7185

4.3. Key Journals

Here, we aimed to present the leading journals that have published the most highly cited articles related to AI and Digital Financial Inclusion (DFI), along with their unique characteristics. Our findings show that over 50 distinct journals have satisfied the criteria for selecting the most frequently cited articles on AI in DFI.

However, we focus on the top 10 journals that have published the most cited publications, as outlined in Table 2. These journals are arranged based on the total number of publications that have contributed to the most frequently cited articles in this field. The analysis has revealed a significant trend: a substantial portion of the top-ranking journals publishing highly cited articles on AI in DFI, especially within the top ten, are also classified as Q1 and Q2, according to ScimagoJR. This implies that the most impactful publications in AI within DFI originate from journals with significant scholarly influence. Of particular interest is the fact that the International Journal of Bank Marketing (IJOBM) stands out with the highest number of publications (85 articles).

In Table 2, both the Technological Forecasting and Social Change and the International Journal of Bank Marketing have the highest CiteScore and SNIP values. Furthermore, while Technological Forecasting and Social Change holds the highest SJR value, it contributes fewer publications compared to the International Journal of Bank Marketing in the field of AI in DFI. However, it is worth noting that the dominance of a journal in the DFI field does not strictly align with its CiteScore, SNIP, or SJR values.

This suggests that the thematic focus of journals plays a significant role in their contribution to highly cited publications within specific knowledge domains. Moreover, three of the top five journals by total citations primarily

focus on banking and marketing: the International Journal of Bank Marketing, the Journal of Internet Bank and Commerce, and the Journal of Financial Service and Marketing. Although re-sorting by total citations based on most-cited articles might change their rankings, the International Journal of Bank Marketing consistently maintains its position as a key journal in the field of AI in digital financial inclusion.

4.4. Co-Citation Network Analysis

Table 3 highlights the top scholars who have made significant contributions to the most-cited articles in the field of digital financial inclusion. While over 100 authors have contributed to these highly cited publications, a subset of five authors has been emphasized based on a criterion of at least three documents per author. Among these scholars, Robert J. Kauffman stands out for his prolific output, having authored the highest number of publications (12 articles) with a cumulative citation count of 2069, making him the most cited among all the scholars. Another important scholar is Simplicio Asongu, who has 10 articles in the list and 2123 citations. Despite being ranked second, Asongu's total links and citations are higher than Robert J. Kauffman's.

The high total link strength of Asongu Simplicio indicates extensive collaboration with other scholars who have contributed to the most-cited publications in the field. This metric reflects the level of scholarly interconnectedness among researchers in the Scopus index of highly cited publications. Additionally, Heikki Karjaluo is another noteworthy contributor with 10 articles in the highly cited publications. Following closely are Yujong Hwang and Tiago Oliveira, each with eight articles in the highly cited list. Despite their smaller number of articles, Hwang and Oliveira have significantly higher total link strength impacts compared to Robert J. Kauffman and Heikki Karjaluo.

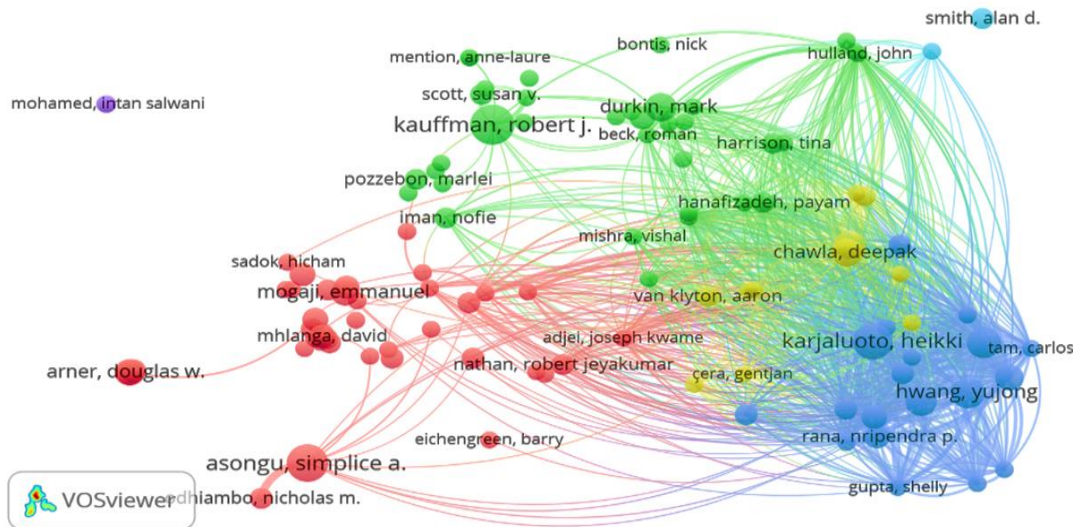


Fig. 4 Author co-citation map based on top-most cited articles.

Figure 4 depicts an author co-citation network or map, which illustrates the similarities or connections among scholars in the discipline of digital finance based on the most frequently cited articles in the Scopus database. To be included in the analysis, authors needed to have a minimum of 5 citations, resulting in 112 authors meeting this criterion. Each node on the author co-citation map represents a different scholar, with the size of the node indicating the extent of author co-citation. Additionally, the colored clusters visible in Figure 5 shed light on the digital finance industry within the highly cited publications. It is important to note that in the co-citation maps, scholars who were not directly involved as authors of the top articles can still be observed, as their work was co-cited with authors of the highly cited papers. The authorship co-citation analysis from VOSviewer provides a visually engaging representation of the intellectual collaboration and influence inside the research network.

The colorful clusters provide insight into the relationships between authors and their contributions to the educational realm. Interestingly, the different sizes of nodes within each cluster represent the authors' relative prominence, with larger nodes implying greater impact or citation counts. The blue cluster stands out among these clusters as being very noteworthy. It has the most nodes and a dense network of connections, indicating authors who have

a big impact and are well-known in their disciplines. Despite having just one node, the purple cluster nonetheless identifies a unique group of writers whose contributions, while perhaps specialized, are yet significant. On the other hand, the. Conversely, the blue, red, and green clusters, with their larger nodes and intricate connections, signify the collective influence of authors across broader domains.

4.5. Key Concepts

Our objective in this section is to uncover the most frequently used key concepts (authors' keywords) in the 100 most-cited articles that discuss the nexuses between AI and financial inclusion. We aimed to identify the primary ideas explored in these highly cited articles. For analyzing the co-occurrence of phrases—both those selected by the journals and those chosen by the authors—we used VOSviewer. The results of the analysis are shown in Figure 5.

These findings allow for the classification of the data in these publications into four major categories. The first cluster, highlighted in red, includes terms like "financial services," "mobile banking," "perceived trust," "TAM," and "SEM." This cluster probably delves into research about improving trust and user-friendliness in mobile banking and other financial services through AI. It could entail doing analysis using models like the Structural Equation Modeling (SEM) and Technology Acceptance Model (TAM).

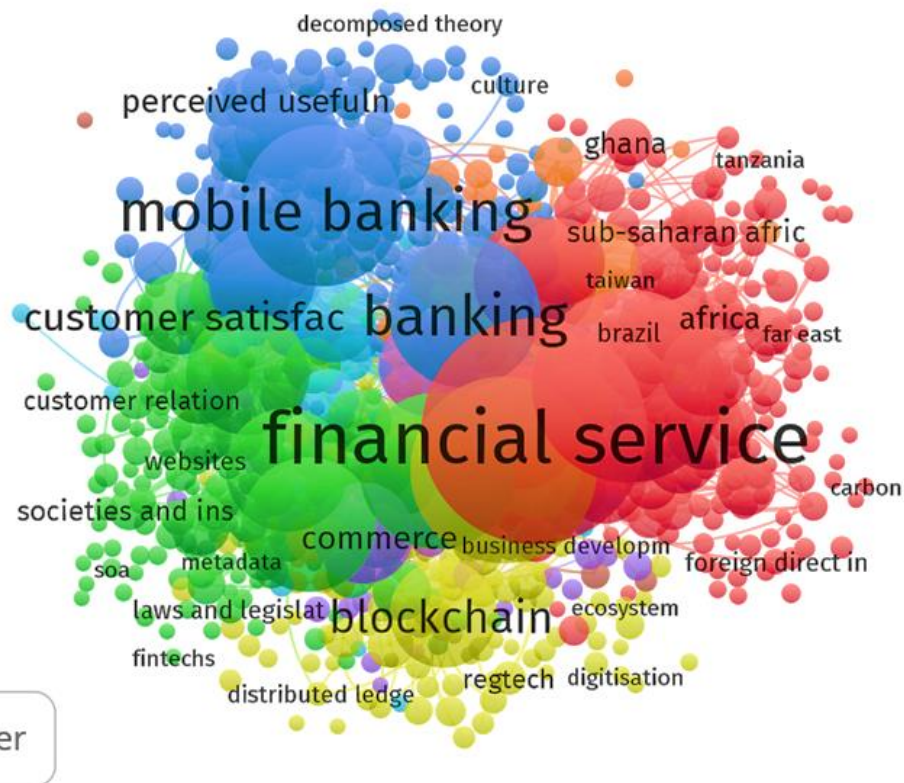


Fig. 5 Co-occurrence analysis highlights key themes and trends in AI and financial inclusion research.

On the other hand, the second cluster, shown in green, revolves around terms like "cryptocurrencies," "blockchain," "regtech," and "financial inclusion." This cluster likely examines how cryptocurrencies and blockchain technology can offer financial services to people without access to traditional banking, along with the regulations needed to govern these technologies. The third cluster, depicted in blue, features phrases such as "poverty alleviation," "microfinance," "developing world," and "gender role." This cluster probably investigates how AI can aid in reducing poverty and advancing financial inclusion in developing nations, especially emphasizing the significance of financing and the potential effects of AI on gender roles. Meanwhile, the fourth cluster, highlighted in purple, underscores the importance of "data mining," "credit scoring," "risk assessment," and "AI." This indicates that there is research exploring how AI can be utilized to mine financial data, evaluate individuals' creditworthiness, identify fraudulent activities, and innovate new financial products and services. These co-word clusters imply that the top 100 publications that have received the most citations include a broad range of research on the use of AI in digital financial inclusion services.

5. Conclusion

The analysis this research provides yields a distinctive conclusion on the review procedure. The examination employed a scientific mapping technique, which is based on quantitative bibliometric research methods, in addition to quantitative and qualitative analysis. These techniques are being utilized increasingly to describe the organization and advancement of scientific subjects and fields. Using bibliometric methodologies, science mapping investigates the relationships between disciplines, fields, specializations, and specific articles. The study obtained bibliometric data from Scopus using the search terms "IA," "deep learning," "digital financial inclusion," and "fin-tech." Following established bibliometric protocols, a thorough screening and evaluation process was conducted, involving a total of 6,652 articles. Ultimately, 3,097 articles were identified as meeting the specific selection criteria outlined for this study.

The examination showed a consistent rise in scholarly works from 2000 to 2024 that addressed the use of AI in the financial industry. The number of publications increased significantly after 2015, reaching 100 in some years. For example, there were 540 published documents in 2023. In addition, research publishing trends show that the most highly cited publications were released between 2015 and 2020. In contrast, the United States leads the world in digital financial inclusion research with 491 publications, followed by India in this area of international cooperation and collaboration. The top three contributors—including the UK—have 1,229 articles to their name. Collaboration analysis reveals differences in research collaboration, with some nations exhibiting reduced involvement and others,

such as the United States, the United Kingdom, and India, among the top contributors, displaying substantial engagement. The report, taken as a whole, emphasizes the necessity of more international cooperation in AI research for financial inclusion. The study also looked at the characteristics of the prestigious journals that have published the most referenced studies on the effect of artificial intelligence on Digital Financial Inclusion (DFI). The findings show that over 50 distinct publications have fulfilled the requirements to be included in DFI's list of the most often referenced articles on artificial intelligence. However, as shown in Table 2, our focus is on the top 10 journals that have generated the greatest number of referenced papers.

In addition, we concluded our discussion with two main points: the co-citation analysis which highlights the prominent scholars that have contributed substantial contributions to the most-cited articles in this field of financial inclusion. While more than 100 authors have participated in these highly cited publications, a subgroup of five authors has been identified using a criterion of at least three documents per author. Among these scholars, Robert J. Kauffman stands out for his prolific output, having authored the highest number of publications (12 articles) with a cumulative citation count of 2069, making him the most cited among all scholars. And key concepts by analyzing the most frequently used key terms (authors' keywords) in the 100 most-cited articles discussing the role of AI in digital financial inclusion. Our goal is to identify the primary ideas explored in these highly cited articles, achieved through the utilization of VOSviewer to analyze the co-occurrence of phrases, including those chosen by the authors and those selected by the journals.

Even though this study was designed to be as comprehensive as possible, there are still some limits that must be noted. The paper provides some recommendations and identifies future research trends in the field based on our findings. First, we relied upon a single source, the Scopus database, for data sources, adhering to international norms and previous research. While this guaranteed the standards of the literature, it might have overlooked substantial work that was accessible in other databases, raising questions concerning the sample's reliability. As a result, expanding the database sources for upcoming studies may improve our conclusions.

Secondly, the data that We utilized for the investigation was limited to the top-cited papers. The outcomes might have been quite distinct if I had included every document that was discovered during the initial search. Thus, it is important to understand the following set of results considering these constraints. Lastly, although the bibliometric techniques employed in this paper offer several benefits, they are not appropriate when examining finer details. As things are, the only thing we can hope for is

advancements in the field to rectify these shortcomings. Nevertheless, despite these drawbacks, the study offers insightful information for the advancement of artificial intelligence and finance in the future.

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