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A Bibliometric Analysis on Automation in the Financial Sector

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Abstract

Ample transformations have affected and changed the financial sector, both in the public domain, but more specifically in the private sector. These were primarily driven by technological advancements and the increasing need of a more efficient, accurate, scalable underlying infrastructure. Artificial Intelligence (AI), Machine Learning (ML), Robotic Process Automation (RPA) have rapidly become the main driving forces for optimising accounting, auditing, fraud detection and other financial processes. These innovations have not only enhanced the overall productivity of financial institutions but have also contributed to cost reduction and improved decision-making processes. Therefore, given the rapid evolution of automation within the financial area, there is a growing pool of research know-how dedicated to exploring its applications, benefits, and challenges. Even so, with an expanding volume of publications, it is crucial to analyse and map the research landscape in order to better understand its development over time. Bibliometric analysis serves as an effective method to evaluate academic contributions and identify key research trends, and highlight influential authors, journals, and institutions shaping this field. The main objective of this study is to conduct a comprehensive bibliometric analysis of automation in the financial sector, offering valuable insights for academics, industry professionals, and policymakers interested in the future of financial automation.

Keywords: finance, bibliometric analysis, robot process automation, machine learning.

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1. Introduction

Many industries have been transformed by automation, and the financial sector is no exception. Automation in financial reporting refers to the application of technology to expedite procedures that were previously completed by hand (Bostan et al., 2024). Driven by the critical demand for efficient and high-quality financial services, financial institutions continuously evolve. At the core of this transformation is the necessity for precise and dependable data management systems (Ionescu & Diaconița, 2023).

Organisations can automate a range of financial processes, including data entry, reconciliation, report generation, and compliance tracking, through the integration of software, artificial intelligence (AI), machine learning (ML), and robotic process automation (RPA) (Alao et al., 2024). The transition from manual to automated systems has significantly enhanced the accuracy and efficiency with which businesses process and analyse vast amounts of financial data (Tyagi et al., 2021).

Traditionally, financial reporting was heavily dependent on human input, which made it susceptible to errors, delays, and inefficiencies (Doğuç, 2021). Accounting teams were burdened with labour-intensive tasks such as transaction verification, balance sheet preparation, and adherence to complex regulatory frameworks. Automation mitigates human error and optimises workflows, enabling organisations to generate more accurate financial reports in a fraction of the time (Roszkowska, 2021). Furthermore, sophisticated automation tools facilitate the creation of real-time reports, granting management immediate insights into financial performance—an invaluable asset in fast-paced business environments.

Financial institutions (FIs) handle vast numbers of financial transactions daily and must process an extensive volume of documentation. Essential operations such as customer onboarding, know-your-customer (KYC) verification, risk assessment, and money transfers demand substantial data processing and manual intervention. Additionally, after onboarding, customers require ongoing interactions via call centres, chatbots, and emails, leading to further labour-intensive processes. These cumulative demands occupy a significant portion of employees' time and increase the likelihood of human error.

Robotic process automation (RPA), a subset of regulatory technology (RegTech), provides financial institutions with a viable alternative to expanding valuable employee resources on repetitive and monotonous tasks. RPA employs software bots that follow predefined internal business rules and policies to execute repetitive, rule-based processes. By training these bots to adhere to standardised workflows, financial institutions can achieve higher efficiency, improve processing speed, and significantly reduce errors (Doğuç, 2021).

To overcome these challenges and enhance operational flexibility, organisations are increasingly turning to more adaptive technologies such as machine learning (ML) and DevOps methodologies (Dragomirescu et al., 2025). The combination of these approaches allows businesses to enhance accuracy, efficiency, and scalability in financial processing while aligning operations with broader sustainability objectives. Technologies such as optical character recognition (OCR) and natural

language processing (NLP) enable automated reading and classification of invoices, which, when integrated with DevOps frameworks, streamline testing and deployment processes. By minimising manual intervention in these workflows, businesses can achieve highly accurate and efficient invoicing systems.

Bibliometric analysis has become an essential tool for examining the evolution of research in various domains, including financial automation (Grecu et al., 2025; Passas, 2024). This method facilitates the identification of key trends, leading authors, influential institutions, and collaborative networks within the field.

The purpose of this article is to conduct a bibliometric analysis to assess the trajectory of automation research in the financial sector. The study is structured around the following research questions:

- What are the key research trends and thematic areas in financial automation?
- What are the emerging technologies and future directions in financial automation research?
- What are the most frequently cited papers, and what insights do they provide?
- Who are the most influential authors and institutions in this field?

This study uses bibliometric analysis, a popular quantitative technique for assessing scientific literature, to examine the evolution of automation research in the financial industry. The data included in the investigation, which spans the years January 1999 through December 2024, was taken from the Scopus database. The bibliometric approach uses a number of methods to investigate the field of research, specifically:

- Temporal distribution analysis (to examine publication trends over time),
- Keyword co-occurrence mapping (to identify thematic clusters),
- Co-authorship network analysis (to highlight collaboration patterns),
- Citation analysis (to determine influential papers and authors),
- Geographical distribution of publications, and
- Research area segmentation.

When combined, these methods allow for a thorough and organised summary of the development of financial automation research. Through the use of specialised data visualisation tools like VOSviewer and Gephi, the study seeks to pinpoint important subjects, patterns, and influential figures in this field. This paper's remaining sections are organised as follows:

- The research approach, including methods for gathering and analysing data, is described in **Section 2**.
- The main conclusions and patterns found by bibliometric analysis are covered in **Section 3**.
- **Section 4** brings the study to a close by summarising the key findings and outlining potential avenues for further investigation.

This project will conduct a bibliometric analysis in order to give academics, business professionals, and policymakers interested in the future of financial automation a thorough picture of automation research in the financial sector.

2. Methodology

This paper employs a bibliometric analysis approach as its methodology. Under this approach, the authors run the following analyses: Temporal Distribution Analysis, Research Areas, Analysis of the Most Cited Authors (Co-Authorship), Co-Occurrence of Keywords, Publication Activity by Country, Analysis of the Most Cited Papers.

Over time, bibliometric analyses have become a fundamental tool in the quantitative analysis of scientific publications (Grecu et al., 2025). By using this tool, the performance and structure of academic research can be measured through quantitative indicators. Bibliometric analysis has emerged as a reference method for exploring and evaluating large datasets of scientific information, particularly due to its rigor and its ability to thoroughly examine developments and trends within a specific field of study, as demonstrated by Donthu's studies (Donthu & Kumar, 2021). Although it was not initially used in business research, in recent years it has become increasingly popular thanks to its various applications and the development of advanced bibliometric tools such as VOSviewer 1.6.18 and Gephi 0.10.1, as well as access to scientific databases like Web of Science and Scopus (Aria & Cuccurullo, 2017) (Donthu & Kumar, 2020) (Verma et al., 2020) (Linnenluecke et al., 2017) (Rossetto et al., 2018).

This approach makes it possible to analyse the performance of authors, institutions, countries, and journals, giving a detailed picture of the intellectual architecture of a field (Badareu et al., 2025). In order to map the intellectual structures in dynamic disciplines like digital health, where it aids in understanding research evolution and its impact (Moed & Burger, 1985), Wang (Wang et al., 2010) emphasise the importance of bibliometric analysis in assessing research trends and academic collaborations. Additionally, the structure of knowledge within the subject can be shown through the use of co-citation and co-occurrence analysis, which offers insightful information on the linkages between study topics (Ravikumar et al., 2014). Because bibliometric analysis may be used to systematically identify publishing trends, important contributors, and theme clusters in agricultural funding research, it was chosen for this study. This method permits a thorough overview of the topic and guarantees objectivity in data processing.

This study maps and evaluates the development of automation research in the financial industry using a quantitative bibliometric approach. By employing quantitative metrics including publication volume, co-authorship networks, citation impact, and topic clustering, bibliometric analysis makes it possible to evaluate vast amounts of scholarly publications in a methodical and repeatable manner. This approach is especially well-suited for detecting patterns of collaboration, significant contributions, and trends within a specific field of study.

The Scopus database, which was chosen for its comprehensive and excellent coverage of peer-reviewed scholarly papers in technology, business, and finance, provided the data for this investigation. A structured search was carried out on

March 12, 2025, encompassing the period from January 1, 1999, to December 31, 2024. The "title, abstract, and keyword" fields were filled with the following five keyword queries:

- “Machine Learning in Finance”
- “AI in Financial Automation”
- “Business Process Automation in Finance”
- “RPA in Financial Automation”
- “Financial Process Automation”

Included were just conference papers and journal articles. Before analysis, all of the recovered data was cleaned and prepared by exporting it into Microsoft Excel 2019. Title, authors, affiliations, source title, abstract, keywords, and citation counts were among the details contained in the data export. To maintain dataset integrity, duplicates and entries written in languages other than English were manually eliminated.

The bibliometric analysis was carried out using two specialised tools:

- For building and displaying bibliometric networks, such as co-authorship and keyword co-occurrence networks, use VOSviewer.
- For sophisticated network analysis and graphical depiction of intricate collaboration and citation patterns, use Gephi.

These resources made it possible to have a better grasp of the research domain's influential nodes, level of collaboration, and thematic evolution.

Six fundamental bibliometric methodologies were used in the analysis, each of which was intended to examine a distinct aspect of the research environment. First, the frequency of publications throughout time was examined using Temporal Distribution Analysis, which aided in tracking the field's historical evolution and research momentum. Second, by identifying conceptual connections between phrases that appear often, Keyword Co-occurrence Mapping revealed topic clusters and new study trends. Third, by examining the connections between authors and their affiliated institutions, Co-authorship Network Analysis shed light on trends in academic collaboration. Fourth, Citation Analysis evaluated the frequency of citations to determine the scientific effect of individual works and authors. Fifth, publications' geographic origins were traced using Geographical Distribution Analysis, which highlighted the top research-producing nations. Finally, by classifying articles by subject area, Research Area Segmentation made it possible to comprehend interdisciplinary overlaps, especially within disciplines like computer science, finance, and engineering. When combined, these methods provided a thorough and multifaceted understanding of the state of automation research in the financial industry.

These methods were chosen to offer a thorough, multifaceted perspective on the study of financial automation. By showcasing both well-established and

unexplored fields of study, each helped to address the research questions stated in the introduction.

The selection of this methodological framework was based on accepted bibliometric procedures. It makes it possible to map the research environment structurally and thematically in addition to measuring scientific productivity and impact. The study guarantees impartiality, reproducibility, and transparency in assessing scholarly contributions to the subject of financial automation by using this methodical approach.

3. Results

The main conclusions of the bibliometric analysis of the scholarly literature on the automation of financial operations using robotic process automation (RPA), machine learning (ML), and artificial intelligence (AI) are presented in this chapter. The results are organised along several dimensions, such as author contributions, geographical distribution, keyword co-occurrence, research topics, temporal evolution, and citation effect, by utilising a variety of analytical approaches and visualisation tools discussed in the following sub-chapters.

The goal is to provide a thorough summary of the state of the research, identify trends and patterns, and highlight the key figures and themes in this developing subject.

3.1 Temporal Distribution Analysis

The Temporal Distribution Analysis is a methodological approach used to examine the occurrence, frequency, and variation of events or phenomena over a specified period of time. This type of analysis is instrumental in identifying temporal patterns, trends, and anomalies, thereby facilitating a deeper understanding of how processes evolve or fluctuate within defined time intervals. By organising data chronologically—such as annually, in this specific case—Temporal Distribution Analysis enables to uncover significant insights related to timing, duration, and cyclical behaviours and it is widely applied across various fields.

The primary objectives of Temporal Distribution Analysis are to support decision-making, enhance predictive capabilities, and improve strategic planning through the temporal evaluation of data-driven evidence.

Using the Temporal Distribution Analysis on the current data shows that research on AI in financial automation has experienced notable growth. For instance, a study analysing the integration of AI into finance from 2000 to 2024 observed an increase in related publications from 2 in 2000 to 204 in 2024, highlighting the expanding interest and importance of this research area.

3.2 Research Areas

To facilitate a more comprehensive analysis of this topic, multiple keywords were employed during the search process to ensure a broad and detailed exploration of relevant literature and data sources. As a result, the number of publications that corresponded to these keywords was variable:

- The search that included the following keywords: “Machine Learning in Finance”, and that were published after 1999, resulted in 4785 papers.
- The search that included the following keywords: “AI in financial automation”, and that were published after 1999, resulted in 272 papers.
- The search that included the following keywords: “Business process automation in finance”, and that were published after 1999, resulted in 163 papers.
- The search that included the following keywords: “RPA in financial automation”, and that were published after 1999, resulted in 117 papers.
- The search that included the following keywords: “Financial process automation”, and that were published after 1999, resulted in 10 papers.

The variation in the number of publications retrieved from different keyword searches is a typical outcome in bibliometric analysis and can be attributed to several key factors. First of all, certain terms, such as "Machine Learning in Finance", are widely adopted and have become broadly utilised in the academic context. As a result, they yield a significantly higher number of publications. In contrast, more specialised or emerging terms like *"RPA in financial automation"* or *"Financial process automation"* may not be as commonly used in titles, abstracts, or keywords, resulting in fewer search results.

The breadth and specificity of the keywords impact the scope of the search. For example, *"Machine Learning in Finance"* encompasses a broad range of topics, applications, and methodologies, whereas *"Business process automation in finance"* is more narrowly focused, likely limiting the number of relevant publications.

At the same time, broader terms often intersect with multiple disciplines (e.g., computer science, finance, data science), thus appearing in a wider variety of journals and conferences. Narrow or niche terms might be confined to specialised publications, leading to fewer results. Also, the emergence of terms over time plays a very important role. Some keywords may have gained popularity only recently. For instance, "RPA" (Robotic Process Automation) is a relatively newer term compared to "Machine Learning," and its application in finance might still be developing, resulting in fewer published works since 1999.

3.3 Analysis of the Most Cited Authors (Co-Authorship)

The analysis of the most cited authors based on co-authorship networks provides valuable insights into the intellectual structure and influential contributors within the research domain. By examining citation frequency in conjunction with collaborative patterns, it is possible to identify key authors whose work has significantly shaped the field. Authors with high citation counts often serve as central nodes in co-authorship networks, indicating not only the impact of their research but also their active engagement in scholarly collaboration. This interconnectedness enhances the dissemination and evolution of knowledge within the academic community. The findings highlight those authors who have consistently contributed to the development of the topic through both individual scholarship and strategic research partnerships. Most relevant to mention, based on the distinction defined earlier (different topics chosen as points of analysis), are the following: Pramanik, S., Singh, R., Saputra, M., Ahrendt, C., Kotsiantis, S., Tsai, C.F., the predominant country of origin being India and United States, with subject areas of Computer Science and Engineering.

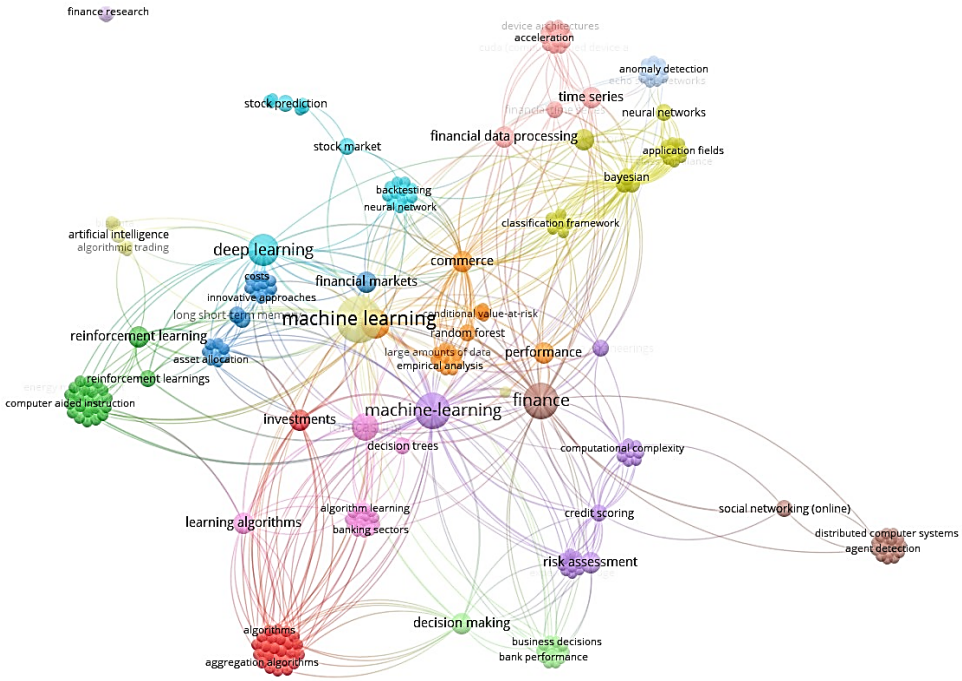
3.4 Co-Occurrence of Keywords

The analysis of keyword co-occurrence provides insights into the thematic structure and intellectual landscape of the research field. By examining the frequency with which specific keywords appear together across multiple publications, it is possible to identify core topics, emerging trends, and the relationships between various research themes. Co-occurrence mapping highlights the conceptual connectivity between terms, revealing clusters of related keywords that represent distinct research areas or methodological approaches. This analysis enables a deeper understanding of how topics evolve and interlink within the domain, guiding researchers toward influential subfields and underexplored areas. The resulting keyword network serves as a valuable tool for visualising the dynamics and focus areas within the literature.

The images attached below are a result of an analysis performed using the VOSviewer tool, in order to better understand the evolution of research trends in the field of Finance. The dataset was the same one sourced from Scopus, comprising documents published between 1999 and 2024. The analysis focused on author keywords and a co-occurrence map was generated for each of the query, showing the relationships between these keywords, with node size reflecting the frequency of each keyword and line thickness representing the strength of co-occurrence.

First of all, filtering articles by *"AI in Financial Automation"* generated most of the clusters, showing how AI is a very complex subject in Finance, with many applications and direct links to terms such as "investments", "decision making", "financial data processing" and so on.

Figure 1. Co-Occurrences of keywords for "AI in Financial Automation"

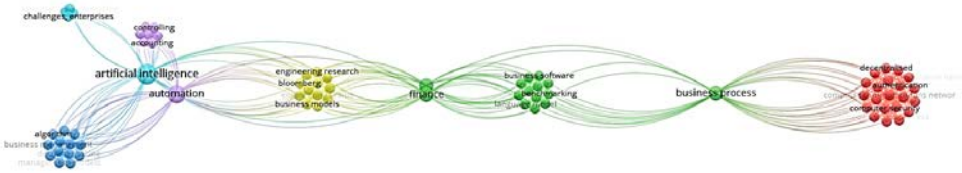


Source: authors' own creation.

A rich and complex network of study subjects was found by using the term co-occurrence analysis based on the query "AI in Financial Automation" (Figure 1). The resulting map, which was created with VOSviewer, shows artificial intelligence as a central node that regularly appears with terms like "risk management", "investments", "decision making", and "financial data processing". This implies that artificial intelligence (AI) in finance is a multifaceted research area that is intimately related to strategic decision-making processes rather than being restricted to technical applications. The broad and dense clustering of terms highlights the adaptability and significance of artificial intelligence in revolutionising financial services and also demonstrates the quick uptake of AI solutions across other financial disciplines.

The next three analysis showed similar results, with better defined clusters. The query based on *"Business Process Automation in Finance"* shows the relationship between "Artificial Intelligence" (even if not specifically mentioned in the search terms), "finance", "business software" and "computer security".

Figure 2. Co-Occurrences of keywords for "Business Process Automation in Finance"

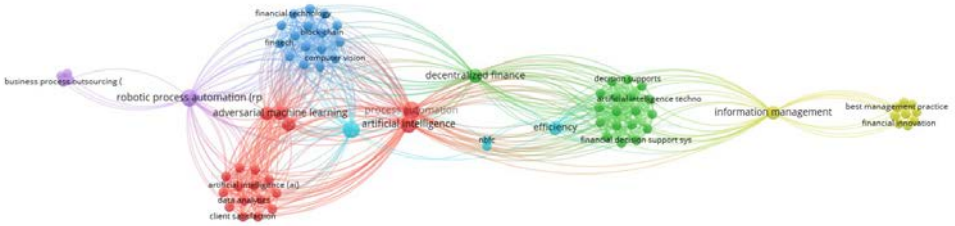


Source: authors' own creation.

On the other hand, the co-occurrence map created for "Business Process Automation in Finance" (Figure 2) showed a tighter theme clustering and a more defined structure. The selected key phrases, including "artificial intelligence", "finance", "business software", and "computer security", demonstrate how automation research in finance is greatly interwoven into larger business and IT infrastructures rather than being in a vacuum. This suggests that academics are concentrating on the safe implementation of automation technologies in financial institutions, guaranteeing operational scalability, data safety, and compliance. The focus on infrastructure and systems further demonstrates that automation is regarded as a key component in creating strong digital financial ecosystems.

The search based on *"RPA in Financial Automation"* revealed three major clusters. The first cluster, centred around keywords like "financial technology", "blockchain", represents the dominant research theme. The second cluster focused on "artificial intelligence", "data analytics", indicating a significant importance of AI in Finance. The third cluster, comprising keywords such as "decision supports", "artificial intelligence technology", points to the growing application of AI in financial processes decision-making.

Figure 3. Co-Occurrences of keywords for "RPA in Financial Automation"



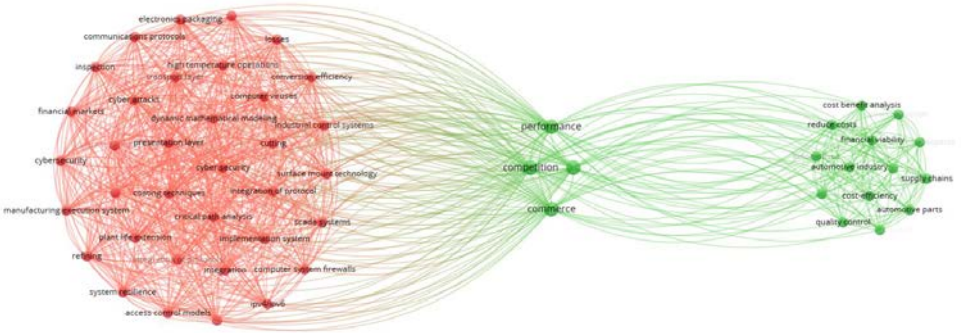
Source: authors' own creation.

Lastly, a structured but more generalised set of keyword associations was shown by the co-occurrence map for the wide keyword "Financial Process Automation" (Figure 4). Although the clusters were well-organised, they had a greater range of terms, some of which went beyond merely technical ones. This

more comprehensive search produced keywords that were not directly related to the basic ideas of digital automation, suggesting that a more general question produces more varied results. Even yet, the analysis supported a significant emphasis on automation-enabling technologies and offered a helpful comparison to help comprehend the significance of careful keyword selection in bibliometric research.

Finally, in the last search, by *"Financial Process Automation"* (Figure 4), the key words are very structured, clusters very well defined, but since the search is more general, it shows even terms that are not relevant to the Technology field.

Figure 4. Co-Occurrences of keywords for "Financial Process Automation"



Source: authors' own creation.

3.5 Publication Activity by Country

The analysis of publication activity by country reveals the geographical distribution of research efforts and the global leadership in the field of Machine Learning, Artificial Intelligence, and Robotic Process Automation in financial processes. Among the countries analysed, India, China, and the United States stand out as the most cited, highlighting their central roles in advancing both theoretical and applied research within this domain.

India demonstrates a rapidly growing presence in this area, driven by a strong IT services sector, increasing academic engagement, and rising interest in the automation of financial operations. China contributes significantly through state-backed innovation programs and its expanding fintech industry, leading to high-impact research outputs. The United States maintains its position as a global leader, contributing foundational research and fostering cutting-edge innovation through its academic institutions and financial technology firms.

The prominence of these countries suggests a competitive yet collaborative international research landscape, where technological advancement and financial automation are strategic priorities. This distribution of activity also reflects the global interest in leveraging intelligent systems to optimise financial processes, reduce operational costs, and enhance decision-making capabilities across institutions.

3.6 Analysis of the Most Cited Papers

Conference papers, with a majority in regards of publication types, serve as a valuable resource for researchers and professionals seeking the latest developments and research findings in the fields of computer science and information science.

“Lecture Notes in Networks and Systems” (Kacprzyk, 2019), cited 18 times, refers to advancements and research findings in the field of networks and systems, potentially focusing on areas like cybersecurity, machine learning applications, or other related topics.

"Communications in Computer and Information Science", cited 9 times, aim to provide insights into the advancements and research findings in the areas of computational intelligence and communication networks, highlighting the latest trends and developments in these fields. This volume features 27 revised papers selected from 140 submissions, addressing various aspects of communications and information security.

Table 1. Most cited papers

Title	Author full names	Year	Source title
Stocks of year 2020: prediction of high variations in stock prices using LSTM	Bathla, Gourav (57197866300); Rani, Rinkle (55232407400); Aggarwal, Himanshu (7003719927)	2023	Multimedia Tools and Applications
Alternative risk measurement for the banking system and its nexus with economic growth	Song, Malin (26422516400); Zheng, Huanyu (57226532466); Chen, Jingyi (58055022600); Shen, Zhiyang (56567084700)	2023	Computers and Industrial Engineering
Shrinkage estimation with reinforcement learning of large variance matrices for portfolio selection	Mattera, Giulio (57576773900); Mattera, Raffaele (57195606492)	2023	Intelligent Systems with Applications

Title	Author full names	Year	Source title
A Bayesian-based classification framework for financial time series trend prediction	Dezhkam, Arsalan (54897977700); Manzuri, Mohammad Taghi (6506067964); Aghapour, Ahmad (57912775400); Karimi, Afshin (57208365344); Rabiee, Ali (58893706100); Shalmani, Shervin Manzuri (57219757992)	2023	Journal of Supercomputing
Imbalance example-dependent cost classification: A Bayesian based method	Mediavilla-Relaño, Javier (57208864152); Lázaro, Marcelino (35580325600); Figueiras-Vidal, Aníbal R. (7006625369)	2023	Expert Systems with Applications

Source: authors' own creation.

1. Stocks of year 2020: prediction of high variation stocks using hybrid LSTM models

Authors: Bathla, Gourav; Rani, Rinkle

Journal: Multimedia Tools and Applications (2023)

In order to forecast volatile markets during the pandemic-driven year of 2020, this study investigates the use of hybrid Long Short-Term Memory (LSTM) models. The application of LSTM, a type of recurrent neural network, shows how financial automation is moving towards deep learning methods for investment decision-making and real-time forecasting. The integration of machine learning with complex data sources, such as news, social media, or high-frequency trading data, is suggested by the publication in a multidisciplinary journal.

2. Alternative risk measurement for the banking sector using machine learning techniques

Authors: Song, Malin; Zheng, Huanyu

Journal: Computers and Industrial Engineering (2023)

In order to overcome the conventional limits of financial ratios and stress

testing, this paper suggests innovative machine learning techniques for risk assessment in banking. It is indicative of a new trend in financial services called algorithmic governance, in which credit, liquidity, and market risks are regularly re-evaluated using machine learning algorithms. The work's emphasis on optimisation and decision assistance is highlighted by publication in a respectable operations research journal.

3. Shrinkage estimation with reinforcement learning for portfolio management
Authors: Mattera, Giulio; Mattera, Raffaele
Journal: Intelligent Systems with Applications (2023)

In order to automate portfolio decisions under uncertainty, this study blends reinforcement learning with shrinkage estimation, a statistical regularisation technique. Portfolio theory's use of AI learning agents demonstrates how financial automation is progressing towards adaptive systems that can make dynamic investment decisions. This indicates a rise in interest in automated trading systems and financial robotics.

4. A Bayesian-based classification framework for bank customer credit evaluation
Authors: Dezhkam, Arsalan; Manzuri, Mohammad Taghi
Journal: Journal of Supercomputing (2023)

In contrast to conventional scoring systems, the Bayesian classification model for assessing creditworthiness presented in this study offers gains in predicted accuracy. In light of growing legal pressure for ethical AI and model transparency in financial automation, the emphasis on customer-level analytics is in line with the requirement for scalable, explainable AI in banking.

5. Imbalance example-dependent cost classification for bank marketing using hybrid models
Authors: Mediavilla-Relaño, Javier; Lázaro-Carrascosa, Emilio
Journal: Expert Systems with Applications (2023)

This research uses hybrid AI models to handle class imbalance and cost-sensitive learning with a focus on bank marketing optimisation. It suggests a useful application of AI in automated decision-making for campaign management and client interaction. The study is in line with the larger trend towards automated, individualised financial services.

4. Discussion/Conclusion

The bibliometric analysis underscores the dynamic and evolving nature of AI research in financial automation. The increasing volume of publications and the diversification of research themes reflect AI's growing significance in transforming financial services and operations. Results identify the scholarly growth of this literature, as well as leading authors, journals, institutions, countries, and articles.

One major aspect resulting from the analysis is that AI's application in analysing large datasets and social media for financial insights has gained attraction in the past years. A prominent topic is the development of AI algorithms for automated trading strategies. AI algorithms are transforming automated trading by enabling systems to analyse vast market data, detect patterns, and execute trades with speed and precision. Techniques like machine learning and reinforcement learning allow strategies to adapt in real time, improving performance while minimising risk. As these intelligent systems evolve, they raise important considerations around market transparency and regulation.

Another prominent topic is the use of AI for forecasting financial markets and economic indicators. Artificial intelligence is increasingly being used to forecast financial markets and economic indicators by analysing large volumes of complex, high-frequency data. Machine learning models can identify relationships that traditional models often miss. These tools enhance the accuracy of predictions and policy decisions. As AI models continue to improve, they offer the potential for more responsive and adaptive forecasting in dynamic economic environments.

To answer the first research question: **"What are the key research trends and thematic areas in financial automation?**", the bibliometric analysis and co-occurrence mapping of keywords related to financial automation reveal a dynamic and interdisciplinary research landscape. Thematic clusters indicate that key research trends are centred around artificial intelligence and Machine Learning, Blockchain, and Robotic Process Automation, reflecting the growing emphasis on innovation, transparency, and compliance in automated financial systems. Strong connections between terms like "algorithmic trading", "risk assessment", "cyber security", "cost efficiency", and "automation" are highlighted by the co-occurrence network analysis, indicating a convergence of technologies targeted at improving operational efficiency, decision-making accuracy, and regulatory adherence. Overall, financial automation is developing toward more secure, scalable, and intelligent systems, with an increasing emphasis on explainability, ethical issues, and platform and institution interoperability.

In terms of **"What are the emerging technologies and future directions in financial automation research?"**, it looks like the direction is integrating as much as possible Artificial Intelligence methodologies. AI is no longer just an auxiliary tool but a foundational tool for automating financial decision-making, analysis, and operations. As described in the above co-occurrence analyses, it is being embedded in sectors such as risk management, reporting, security. This allows real-time monitoring and predictive modelling used to identify credit, market, and operational risks, review and interpret complex legal and compliance documents or identify anomalies and detect suspicious activities faster and more accurately than rule-based systems. Financial automation is unquestionably driven by AI in the future. The focus of current research is more autonomous, context-aware, and reliable AI systems that go beyond efficiency to provide strategic insights, control systemic risks, and preserve financial ethics. As these approaches develop, AI will change how financial institutions function, compete, and innovate.

One thing to mention about the current bibliometric research is that results are impacted by the way databases index publications (based on titles, abstracts, author keywords, and assigned subject areas). If a relevant publication does not explicitly include the chosen keyword in these fields, it may not be captured in the search.

Even if the study covered a large number of articles, and consequently, subject areas and topics, a general idea that can be extracted is that emerging technologies and future directions in financial automation research are evolving rapidly due to advancements in artificial intelligence, big data, and blockchain technologies. Usually these technologies, and not only, are used together in order to enhance efficiency, accuracy, and transparency in financial operations. AI and ML are at the forefront, driving innovations in fraud detection, credit scoring, algorithmic trading, and robo-advisory services. Robotic Process Automation continues to evolve into intelligent automation by incorporating decision-making capabilities.

Looking ahead, financial automation research is expected to explore more hyper automation, combining RPA, AI, process mining, and data analytics to enable end-to-end workflow automation, as well as ethical AI frameworks to ensure regulatory compliance. Additionally, the use of real-time data integration and personalised financial services are gaining popularity, in the reporting and climate risk analysis fields. These developments mark a shift toward autonomous and adaptive financial systems, highlighting a future where automation not only enhances operational efficiency but also contributes to more inclusive and resilient financial ecosystems.

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