

Artificial Intelligence and Bank Risk Management: A Literature Synthesis and Future Research Agenda

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Abstract - The main intention of this study is to evaluate the emerging research patterns in the background of artificial intelligence and Bank risk management. This study used two main techniques such as network analysis and descriptive analysis in its bibliometric analysis to assess publishing patterns in the domains of AI and bank risk management. The tools commonly employed for conducting bibliometric analysis include VOS viewer and R studio. Subsequent content analysis is used to examine possible research directions. A total of 116 pertinent papers were retrieved from the SCOPUS database by implementing different Boolean procedures. This analysis emphasizes the top publications, journals, contributions from different countries, and the most commonly utilized keywords. The study conducts a comprehensive analysis of the limited literature and identifies four specific groups: Online fraud detection, Advanced techniques in online fraud detection, Machine learning approaches for credit card fraud detection, and advanced analytical techniques and models for credit card fraud detection. The paper also suggests the primary research areas for future developments in the field of artificial intelligence, including K-model machine learning, neural network-based credit risk prediction, and the application of Generative Adversarial Networks in bank fraud detection.

Keywords -Artificial Intelligence, Risk Management, Banks, Fraud Detection, Bibliometric analysis.

1. Introduction

The Banks play a critical part in maintaining the stability of the monetary structure of any country. During periods of economic uncertainty or downturns, banks encounter heightened risks. The collapse of a bank can have extensive repercussions because of the interdependence and vulnerability of financial institutions. Banking crises have the probable to cause substantial economic disruptions, such as: decreased approach to credit, heightened unemployment rates, and economic recession [NO PRINTED FORM] [1]. The failures of banks have the ability to diminish the belief and faith that the general public has in the financial system, which can result in instances of bank runs and exacerbate the instability of the economy. Taking proactive measures to identify and manage these risks can effectively reduce their influence on the bank's operations and profitability. With the dawn of cutting-edge technologies such as: big data analytics, artificial intelligence, and machine learning, today banks have better equipped technologies to detect potential issues promptly. These tools facilitate more accurate and anticipatory risk management. Financial institutions that possess the skill to recognize and handle future issues have the ability to acquire a competitive advantage. They possess a more advantageous position to navigate challenges and take advantage of favourable circumstances in the market.

Various studies try to encompass review studies such as [2] conducted bibliometric analysis on AI in machine learning in finance, ([3], [4] conducted bibliometric on the role of AI in financial services [5] systematic literature review on the time period of three and half decades in the

context to AI in banking, financial services, and insurance. The surge in research trend can be witnessed after 2020. The studies were mainly focused on artificial intelligence and development of fintech. However, the existing scant studies encompass the role of AI in boosting the techniques of minimizing bank risk. The study seeks to address a void in the current body of knowledge by conducting a thorough examination of how AI can help mitigate bank risk. The findings of this analysis can act as a valuable asset for future research and partnerships in this critical field. Conducting an in-depth bibliometric analysis can provide helpful insights into the present research landscape and help identify important research themes and areas that need further exploration. By combining qualitative and quantitative studies, you can provide a comprehensive perspective on the impact of AI in reducing bank risk. Bibliometric analysis is a useful method employed in research to reveal key bibliometric attributes and research themes [6]. Following our assumptions, this study is the first to offer a thorough bibliometric analysis. in the context of "AI and Bank risk management" to canvass the field historically. This contention is also validated through a Scopus search of "AI" "Bank risk management" and "review" between 2018 and 2024.

The findings of this bibliometric analysis could be of great importance and provide valuable insights for academics, professionals, and decision-makers. It can help them identify the leading authors, countries, publishers, publications, research topics, and areas of expertise in the fields of AI and bank risk management. By delving into the depths of these fields, individuals can gain a deeper

understanding of their knowledge structure and identify the leading authorities within them. Given the circumstances, the review is presented as an innovative endeavour to chart the domains of "AI" and "Bank risk management" from a bibliometric perspective, highlighting the significance of current findings and possible directions for future investigation. Consequently, the current literature analysis examines the research questions (RQs) listed below.

RQ1. What is the publication trend in "AI " and "Bank Risk Management"?"

RQ2. Which are the most significant publications concerning "AI" and "Bank risk Management"?"

RQ3. Who are the most productive contributors and most frequent keywords to the fields of "AI" and "Bank risk Management"?"

RQ4. What can we learn about "AI " and "Bank risk Management" from the existing research?"

RQ5. What future lines of investigation can be pursued to enhance our comprehension of "AI" and "Bank risk management"?"

The remainder of this paper is organized as follows: Section 2 highlights the research methodology. Section 3 exhibits the results of the bibliometric data analysis and the network visualization, along with their interpretations. Section 4 discusses the main findings. Section 5 provides suggestions for future research. Finally, Section 6 concludes the several implications and limitations of the study.

2. Materials and Methods

To conduct a thorough analysis of the existing literature and gather relevant information for our current study, we opted to utilize the Scopus database. This decision was made due to the database's extensive collection of top-notch, peer-reviewed journals and its advanced citation analysis capabilities [7,8]. The choice of Scopus is justified due to its extensive recognition and reliability among the academic world, granting access to an extensive collection of scientific articles, conference proceedings, and books. Scopus provides sophisticated search functions that enable accurate and efficient identification of pertinent material by utilizing keywords, filters, and Boolean logic ("or" and "and") operators for carrying out systematic reviews and meta-analysis in their bibliometric examination of research productivity analyses [7]. The data extraction process specifically targeted papers pertaining to AI and banking risk management from January 2018 to May 2024. This selection was made intentionally to ensure that the most recent and relevant studies were included. The rapid advancement of AI technology in recent years has had a substantial influence on several sectors, including banking. The evaluation encompasses the most recent advancements, applications, and research discoveries in AI that pertain to banking risk management, with a specific focus on studies conducted between 2020 and 2024. In recent years, a

noticeable alteration in financial rules with the specific objective of enhancing risk management, particularly through the incorporation of artificial intelligence (AI) has been seen [8], [9]. Throughout this time frame, significant advancements technological advances have taken place, adjustments made in response to global events like the COVID-19 pandemic, changes in regulations, and economic instability, all of which have had a substantial impact on the banking industry. The review attempts to offer a thorough and current overview of how AI is influencing risk management techniques in banking by specifically examining this period.

2.1. Search Criteria and Article Selection

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were employed in this research to ensure a comprehensive, transparent, and reproducible approach to the systematic literature review [10]. PRISMA is renowned for its stringent criteria in performing and reporting systematic reviews and meta-analyses, hence bolstering the credibility and reliability about the investigation's findings. PRISMA guidelines provide methodological rigor, transparency and comprehensive reporting in the review process [11], [12].

“Artificial intelligence AND bank risk management” OR “Fintech and financial fraud detection in banks”OR “Artificial intelligence, machine learning and credit assessment tin banks” OR “Machine learning AND bank fraud detection” OR “Artificial intelligence AND Financial risk prediction in banks” OR “Blockchain and bank risk management”

The procedure began on May 2, 2024, with the identification of 576 records. We excluded 82 records that did not meet the criteria for papers published between 2018 and 2024. We kept 423 papers after filtering for subject relevance and removed 71 for not closely matching the research topic. Subsequently, we retained only those records that were specifically research articles. This criterion eliminates 253 records, leaving only 170. We identified 160 potentially relevant documents based on the final publication stage and eliminated 10 articles in this round of refinement. The final stage of the screening process involved evaluating the remaining papers for English publication. Consequently, we excluded four additional publications, leaving a total of 155 under consideration. In the end, we excluded 39 records and considered 116 as our final sample.

<Insert Figure 1>

2.2. Bibliometric Visualisation

Network visualization software—which can vary from fully

graphical user interface-based programs like VOSviewer [13] to command-based programs like the Bibliometrix package in R [14] is frequently used in conjunction with bibliometric analysis. By employing RStudio the authors have conducted performance analysis (*RQ1*, *RQ2*, *RQ3*) which is also known as descriptive nature of analysis. This study has analysed publication pattern throughout the years and the most impactful authors, journals, countries and most influential keywords. Using VOS-viewer, the authors have employed bibliographic coupling (*RQ4*). According to , bibliographic coupling is a methodical plotting approach that presumes that dual articles with similar references also have alike content.

3. Results and Discussion

3.1. Performance Analysis

In the ensuing analysis, the authors go for only those papers that VOSviewer used for making clusters under various segments.

Table 1 summarizes the description of the main information of literature used in this study.

<Insert Table 1>

The articles under investigation are listed in the table 1 located above. Through the use of bibliometric analysis, it is demonstrated that 116 articles from 87 different journals were selected to conduct the literature synthesis for the current study. Within the realm of artificial intelligence and bank risk management, a total of 387 researchers have contributed their contributions.

3.1.1. Research Paper Production Pattern (*RQ1*)

<Insert Figure 2>

Figure 2 illustrates the publishing trend of research articles on artificial intelligence and bank risk management. The data suggests that technological advancements have expanded the scope of AI, thereby capturing the interest of researchers and motivating them to pursue studies in this field. In 2023, 30 research articles were published, making up 25.86% of the total 116 articles. 22, 28 papers were released. The bar graph above illustrates a notable increase in research interest among experts in this topic during the COVID-19 outbreak. This increase can be attributed to the significant surge in internet transactions, which has consequently led to an increase in online financial scams.

3.1.2. Most Influential Journals

<Insert Table 2>

The table – 2 above presents the journals that have garnered the highest citations for the papers they have published, as specified in the study. Based on the availability of data, it is clear evident that the top 10 journals in the field have collectively published 27 scholarly papers on the selected study topic. The research papers that were published in these journals have garnered a substantial total of 694 citations. The Information Sciences journal has attained a significant accolade by receiving the highest number of citations, totalling 377 citations across three research publications. The scholarly article titled "Using Generative Adversarial Networks for Improving Classification Effectiveness in Credit Card Fraud Detection" [16] published in the Information Sciences Journal has garnered a total of 335 citations, establishing it as the furthestmost frequently cited publication in the field of study. It has achieved the highest citation rate per piece among the top 10 articles on the list. The academic journal IEEE Access has published a compilation of six scholarly articles in the field of research, which have received a combined total of 145 citations. The International Journal of Advanced Science and Technology receives an average of 38 citations per article and secures the second position in terms of citations per article.

Furthermore, the table displays the categorization of various articles based on their affiliation with the SCOPUS and Web of Science databases. There are three journals associated with SSCI/SCIE among the top ten.

3.1.3. Most Influential Articles

<Insert Table 3>

The table 3 displays the ten most prominent research articles of AI and bank risk management as measured by citations. The set of ten articles has garnered a total of 922 citations from other scholarly publications. Each of the articles included in the top 10 list has accumulated more than 30 citations. The articles investigated the role of various AI based techniques in detection the various frauds in banks.

The article titled "Using generative adversarial networks for improving classification effectiveness in credit card fraud detection" [15] has been widely recognized as most cited article in its category, with a total of 335 citations. This publication, authored by Ugo Fiore from Università degli Studi di Salerno, Italy, and his colleagues, shed an influential contribution to the detecting credit card frauds. It has been published in the esteemed Information sciences journal published under flagship of Elsevier. The authors, by using supervised binary classification algorithms appropriately trained from pre-screened sample datasets, finds that machine learning shows great potential in identifying and flagging unauthorized transactions. The study demonstrates that a classifier trained on the enhanced dataset performs better than the identical classifier trained

on the original data, particularly in the terms of sensitivity, leading to a reliable system for detecting fraud.

The article titled "A benchmark of machine learning approaches for credit score prediction" [16] holds the second position among top 10 cited articles in terms of influence, accumulating a total of 122 citations. It was published in the Expert Systems with Applications in the year 2019. The authors (Vincenzo Moscato and his colleagues from University of Naples, Italy) made an endeavour to explore the use of machine learning in identifying credit risk assessment and preventing monetary losses for institutions. The experimental research was carried out using an authentic social lending platform known as Lending Club.. The dataset utilized for the analysis consisted of 877,956 samples. Various assessment metrics, including as AUC, Sensitivity, and Specificity, were considered. Additionally, they analyze the results in relation to the most advanced methods now available. Ultimately, the three most effective methods have been assessed in terms of their explainability using various explainable Artificial Intelligence (XAI) technologies.

The other influential academic articles also examine the how the AI and machine learning based techniques can be employed effectively in minimizing the credit fraud in banks. The table shows that prominent journals show their keen interest in publishing the articles on this research segment.

Top 10 Countries

<Insert Table 4>

The table 4 displays the top 10 leading countries in terms of paper publishing and citations according to the selected research domain. In terms of scholarly output, it is noteworthy that Indian authors show their maximum interest (30 publications) in publishing their research on the theme of AI and risk management of banks. It is followed by China with 23 publications and USA with 7 publications. In terms of number of citations, Italy secured the top position with 152 citations per articles which is followed by USA with 21.42 citations and China 16.60 citations per articles. The research paper titled "Using generative adversarial networks for enhancing classification effectiveness in credit card fraud detection" [15] was written by Italian academics and is highly regarded as the most referenced article in its field, having a total of 335 citations. In the perspective of developing and developed countries, it is perfectly equitable. Among the top 10 countries, half are classified as developing countries while the other half are classified as developed countries. The authors from developed nations produced 21 publications, which received a total of 679 citations. In contrast, authors from developing countries

published their findings in 67 papers, which received a total of 750 citations. Evidence demonstrates that articles written by researchers from developed countries really make a splash and catch the eye of scholars all over the world.

Top 10 Keywords (RQ3)

<Insert Figure 3>

The most common terms used in studies on AI and bank risk management was analyzed using R-studio are displayed in figure 3. The word "Crime" appeared 32 times in the data, its biggest font size in the chart compared to all other words indicates that it was the most utilized word in the research, followed by learning systems has 15, machine learning 13 times, risk assessment 16 times, fraud detection has been used 18 times where keyword finance 14 times, and risk management 13 times. Popular terms used to describe AI methods include deep learning, decision trees, and support vector machines, fraud detection systems, and machine learning.

4. Thematic Analysis

The following table demonstrates the 4 clusters based on the documents with minimum 10 citations.

<Insert Table 5>

<Insert Figure 5>

Cluster 1 was titled as *Advanced Machine Learning and Neural Network Models for Credit Risk and Fraud Detection*. The first paper entitled "Hybrid Model for Credit Risk Prediction: An Application of Neural Network Approaches" [17] focuses on combining various neural network approaches to accurately predict credit risk. The authors aim to showcase the practical application of hybrid models in this field. The second paper "A Benchmark of Machine Learning Approaches for Credit Score Prediction" [16] received the maximum citations (122) among all the papers in this clusters. The authors have compared different machine-learning techniques to predict credit scores. This comparison serves as a useful benchmark for evaluating the effectiveness of different models. This study serves as a benchmark, evaluating the effectiveness of different models and offering valuable insights into their performance in credit scoring applications. "Generative Adversarial Network Based Telecom Fraud Detection at the Receiving Bank" [18] received second most citations (88) and is among the top cited articles in this research segment. The study uses Generative Adversarial Networks (GANs) for detecting fraud, particularly in telecom transactions in the receiving bank, highlighting the usage of cutting-edge GANs. "Credit Risk Assessment for Unbalanced Datasets

Based on Data Mining, Artificial Neural Network, and Support Vector Machines” [23] addresses the challenge of unbalanced datasets in credit risk assessment using a combination of data mining, neural networks, and SVMs, emphasizing the importance of handling class imbalance. [19] research applies deep neural networks to predict credit card delinquencies. It demonstrates the power of deep learning techniques in assessing credit risk, highlighting their potential to significantly enhance predictive performance in financial contexts. It serves as a benchmark study, evaluating the effectiveness of various models and provides worthwhile insights into their performance in credit scoring applications.

Cluster 2 was nomenclature as *Advanced techniques in online fraud detection*. This cluster comprises of three papers. These papers collectively demonstrate the advancements in integrating sophisticated algorithms and innovative feature engineering techniques to progress the efficacy of fraud detection systems in online transactions. The paper “Integrating Machine Learning Algorithms with Quantum Annealing Solvers for Online Fraud Detection” [20] published in IEEE Access, investigates the incorporation of quantum machine learning (QML) into classical machine learning methods to improve the efficiency of online fraud detection. The paper emphasizes that the QML approach surpassed twelve standard machine learning algorithms, especially in dealing with severely imbalanced datasets, a common occurrence in fraud detection settings. The authors also discovered that Quantum annealing solvers had potential in optimizing the feature selection process, thereby enhancing the overall detection performance. The study “Feature construction for fraudulent credit card cash-out detection” [21] focused on building features to detect fraud. The researchers discovered that unique features boosted fraud detection and false positive reduction by enhancing precision and recall. These papers show advances in incorporating advanced algorithms and novel feature engineering techniques to increase the efficacy of fraud uncovering systems in online transactions.

Cluster 3 was named as *Machine Learning Approaches for Credit Card Fraud Detection*. This title highlights the major issue of detecting and predicting credit card fraudulent in smart societies utilizing different types of machine learning techniques and models, including logistic regression, k-fold validation, naïve Bayesian classifiers, C4.5 decision tree classifiers, and others. The paper “Fraud Prediction in Smart Societies Using Logistic Regression and k-fold Machine Learning Techniques” investigates the utilization of logistic regression and k-fold cross-validation for predicting fraud in smart societies. The k-fold approach assures that the model operates consistently across multiple data subsets, lowering the likelihood of overfitting. The second paper “Credit Card Fraud Detection Using Naive Bayesian and C4.5 Decision Tree Classifiers” , assesses the

effectiveness of naive Bayesian and C4.5 decision tree classifiers in identifying instances of credit card fraud. The study showcases a highly effective model for detecting credit card fraud, employing various machine-learning approaches.” An efficient credit card fraud detection model based on machine learning methods”. The model has been designed to enhance detection accuracy by incorporating a range of machine learning techniques, such as neural networks, decision trees, and support vector machines (SVM). Highlighting the advantages of a hybrid strategy in fraud detection, the model outperforms standard single-method approaches in terms of recall, precision, and accuracy.

Cluster 4 was titled as *Advanced Analytical Techniques and Models for Credit Card Fraud Detection*. These articles examine many aspects of fraudulent transactions, assess different machine learning techniques, and discuss how to use advanced models, such as graph neural networks, to improve fraud detection. The papers in this cluster emphasize the significance of tackling issues like class imbalance and improving model robustness through utilizing cutting-edge machine learning techniques like SMOTE and AdaBoost.

5. Key reflections from Literature Synthesis (RQ4)

The bibliometric features and knowledge structure of Artificial intelligence and bank risk management were mapped using the literature. From 2018 to May 2024, the bibliometric analysis illuminated AI and bank risk management research's publishing pattern, influential articles, key contributors (authors and nations), and themes. Our review's descriptive statistics of sample articles, publication pattern, leading authors, leading countries, themes, and topic analysis answered four research questions and provided the following major takeaways:

- AI and Bank risk management research has risen significantly, with most publications coming after 2021.
- Journals of Information Sciences, IEEE Access and International Journal of Advanced Science and Technology were three prominent publications.
- The top three articles on the basis of publication performance as per citation analysis were: i) “Using generative adversarial networks for improving classification effectiveness in credit card fraud detection (335 citations)” [18] ii) “A benchmark of machine learning approaches for credit score prediction (122 citations)” [16]; iii) Blockchain-enabled logistics finance execution platform for capital-constrained E-commerce retail [19] (93 citations)
- The top three countries were Italy (457 citations, 3 articles), China (382 citations, 23 publications), and India (283 citations, 30 publications).

- e. AI and Bank risk management study subjects fall into four clusters: Online fraud detection, Advanced techniques in online fraud detection, Machine learning approach for credit card fraudulent detection and advanced analytical techniques and models credit card fraud detection.
- f. Research on AI and Bank risk management has emerged around major keywords: Crime, risk management, fraud detection, artificial intelligence and machine learnings.

Further the findings also reflect that through the analysis of massive volumes of data, such as consumer transactions, market trends, and economic indicators, AI can improve the precision and efficacy of risk assessment. Decisions and tactics for reducing risk can be improved as a result of this. Greater openness might result from requiring banks to report on a broader range of distress signs. Stakeholders will have a better idea of the bank's financial status, which can lead to more market discipline.

6. Future Research Agenda

<Insert Table 6>

7. Conclusion

Artificial intelligence has been being utilized in bank risk management to a greater degree. The progress in AI & ML technology motivates current research to examine the existing literature thoroughly. The present study investigates a total of 116 research papers obtained from the SCOPUS database. The 116 papers were chosen using rigorous criteria to examine this subject's most pertinent research papers. The study demonstrates that the research article titled "Utilizing Generative Adversarial Networks to Enhance the Effectiveness of Classification in Credit Card Fraud Detection" published in the Journal of Information Sciences was the most important publication in this domain, with 335 citations. Italy has emerged as the most influential country in terms of citations, with a total of 457 citations from 3 research papers. Among the journals analyzed, the Information Sciences journal stands out as the most influential, having received 377 citations from 3 papers, resulting in an average of 125.6 citations per manuscript. The analysis resulted in the identification of 4 clusters using bibliographic coupling. The four clusters consist of 14 research papers focused on AI technology, online transactions, fraud, and payment card theft. The analysis also revealed that researchers are progressively investigating novel concepts to broaden the range of AI applications in enhancing bank risk management. These include credit risk predictions, online fraud detection using future advancements in neural network techniques, and K-model machine learning techniques.

7.1. Implications of the study

This study has noteworthy implications for researchers, sustainable investors, professionals, legislators and policymakers. Bank authorities can employ AI algorithms to identify atypical patterns in transactions and promptly identify potentially fraudulent activity. This aids in the prevention of financial losses and the safeguarding of clients. Moreover, AI approaches can be employed to examine past data in order to forecast future dangers and market patterns, enabling institutions to actively mitigate prospective concerns. Additionally, it aids banks in decreasing operational expenses and enhancing profitability. Studying AI in banking risk management can result in substantial enhancements in evaluating risks, detecting fraud, improving customer experience, ensuring regulatory compliance, and increasing operational efficiency. Ultimately, this benefits both banks and their customers.

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Table 1: Description of Articles

Main Information About Data	
Time-span	2018:2024
Sources (Journals, Books, etc.)	87
Documents	116
Annual Growth Rate %	15.17
Average citations per doc	13.87
References	4594
Document Contents	
Author's Keywords (DE)	391
Authors	
Authors	383
Authors of single-authored docs	14
Authors Collaboration	
Single-authored docs	14
Co-Authors per Doc	3.41
International co-authorships %	19.83
Document Types	
Article	116

Source: R studio Output

Table:2 Top 10 Influential Journals

Sr. No	Source	Total Citations	Articles	Citation per Article	Indexing	Publisher
1	Information Sciences	377	3	125.6	Scopus/ SSCI	Elsevier
2	IEEE Access	145	6	24.16	Scopus/ SSCI	IEEE
3	International Journal of Advanced Science and Technology	76	2	38	SCOPUS	SERSC
4	Soft computing	34	2	17	SCOPUS/SCIE	Springer
5	International journal of intelligent engineering and system	20	2	10	SCOPUS	Intelligent network and system society
6	Journal of risk and financial Management	11	2	5.5	SCOPUS	MDPI
7	Big data and cognitive computing	9	2	4.5	SCOPUS	MDPI
8	Eastern European journal of	8	2	4	SCOPUS	Technology Centre

	enterprise technologies					
9	Journal of theoretical and applied information technology	7	4	1.75	SCOPUS	Little Lion Scientific
10	Wireless communication and mobile computing	7	2	3.5	SCOPUS	Hindawi

Source: Authors' compilation

Table 3: Top 10 Influential Articles and Authors as per Global Citations

S.no	Article	Author	Journal	Global Citations	Total Citation per year
1	Using generative adversarial networks for improving classification effectiveness in credit card fraud detection (2019)	Fiore U.; De Santis A.; Perla F.; Zanetti P.; Palmieri F. [18]	Information Sciences	335	55.83
2	A benchmark of machine learning approaches for credit score prediction (2021)	Moscato V.; Picariello A.; Sperli G. [16]	Expert Systems with Applications	122	30.50
3	Blockchain-enabled logistics finance execution platform for capital-constrained E-commerce retail (2020)	Li M.; Shao S.; Ye Q.; Xu G.; Huang G.Q.	Robotics and Computer-Integrated Manufacturing	93	18.60
4	Generative adversarial network based telecom fraud detection at the receiving bank (2018)	Zheng Y.-J.; Zhou X.-H.; Sheng W.-G.; Xue Y.; Chen S.-Y. [18]	Neural Networks	80	11.43
5	An efficient credit card fraud detection model based on machine learning methods (2020)	Trivedi N.K.; Simaiya S.; Lilhore U.K.; Sharma S.K. [22]	International Journal of Advanced Science and Technology	75	15.00
6	A big data mining approach of PSO-Based BP neural network for financial risk management with IoT (2019)	Zhou H.; Sun G.; Fu S.; Liu J.; Zhou X.; Zhou J. [23]	IEEE Access	60	10.00
7	Performance Evaluation of Machine Learning Methods for Credit Card Fraud Detection Using SMOTE and AdaBoost (2021)	Ileberi E.; Sun Y.; Wang Z. [24]	IEEE Access	57	14.25
8	Credit risk assessment for unbalanced datasets based on data mining, artificial neural network and support vector machines (2018)	Khemakhem S.; Ben Said F.; Boujelbene Y. [25]	Journal of Modelling in Management	34	4.86
9	Predicting credit card delinquencies: An application of deep neural networks (2018)	Sun T.; Vasarhelyi M.A. [26]	Intelligent Systems in Accounting, Finance and Management	34	4.86
10	Feature construction for fraudulent credit card cash-out detection (2019)	Wu Y.; Xu Y.; Li J. [21]	Decision Support Systems	32	5.33

Source: Authors' Compilations

Table 4 - Top 10 cited Countries

S. No.	Country	Country category	Citations	No. of documents	Average Citation per article
1	Italy	Developed	457	3	152.33
2	China	Developing	382	23	16.60
3	India	Developing	283	30	9.43
4	USA	Developed	150	7	21.42
5	Malaysia	Developing	38	4	9.5
6	Australia	Developed	34	3	11.33
7	Indonesia	Developing	29	6	4.83
8	South Korea	Developed	22	3	7.33
9	Saudi Arabia	Developing	18	4	4.5
10	Germany	Developed	16	5	3.2

Source: Authors' compilation

Table 5 – Bibliographic coupling based Thematic Clusters on Documents

Authors	Title	Journal	Citations
Cluster 1: Online Fraud Prediction			
Chi G.; Uddin M.S.; Abedin M.Z.; Yuan K. [17]	Hybrid model for credit risk prediction: An application of neural network approaches	International Journal on Artificial Intelligence Tools	29
Moscato V.; Picariello A.; Sperli G. [16]	A benchmark of machine learning approaches for credit score prediction	Expert Systems with Applications	122
Zheng Y.-J.; Zhou X.-H.; Sheng W.-G.; Xue Y.; Chen S.-Y. [18]	Generative adversarial network based telecom fraud detection at the receiving bank	Neural Networks	80
Khemakhem S.; Ben Said F.; Boujelbene Y. [27]	Credit risk assessment for unbalanced datasets based on data mining, artificial neural network and support vector machines	Journal of Modelling in Management	34
Sun T.; Vasarhelyi M.A.[26]	Predicting credit card delinquencies: An application of deep neural networks	Intelligent Systems in Accounting, Finance and Management	34
Cluster 2: Advanced Techniques in Online Fraud Detection			
Wang H.; Wang W.; Liu Y.; Alidaee B. [20]	Integrating Machine Learning Algorithms With Quantum Annealing Solvers for Online Fraud Detection	IEEE Access	17
Wu Y.; Xu Y.; Li J. [21]	Feature construction for fraudulent credit card cash-out detection	Decision Support Systems	32
Wang C.; Wang C.; Zhu H.; Cui J. [28]	LAW: Learning Automatic Windows for Online Payment Fraud Detection	IEEE Transactions on Dependable and Secure Computing	15
Cluster 3: Machine Learning Approaches for Credit Card Fraud Detection			

Mishra K.N.; Pandey S.C. [29]	Fraud Prediction in Smart Societies Using Logistic Regression and k-fold Machine Learning Techniques	Wireless Personal Communications	17
Husejinović A. [30]	Credit card fraud detection using naive Bayesian and c4.5 decision tree classifiers	Periodicals of Engineering and Natural Sciences	20
Trivedi N.K.; Simaiya S.; Lilhore U.K.; Sharma S.K. [22]	An efficient credit card fraud detection model based on machine learning methods	International Journal of Advanced Science and Technology	75
Cluster 4: Advanced Analytical Techniques and Models for Credit Card Fraud Detection			
Can B.; Yavuz A.G.; Karşlıgil E.M.; Guvensan M.A. [31]	A closer look into the characteristics of fraudulent card transactions	IEEE Access	11
Ileberi E.; Sun Y.; Wang Z. [24]	Performance Evaluation of Machine Learning Methods for Credit Card Fraud Detection Using SMOTE and AdaBoost	IEEE Access	57
Cheng D; Wang X.; Zhang Y.; Zhang L. [32]	Graph Neural Network for Fraud Detection via Spatial-Temporal Attention	IEEE Transactions on Knowledge and Data Engineering	30

Source: Authors' compilation

Table 6: Future Research Agenda

Sr. No.	Research Area	Work may be done
1	Credit Risk Prediction with Neural Network Approaches	Future studies can investigate neural network topologies, such as recurrent neural networks (RNNs) and long short-term memory (LSTM) networks, to capture temporal connections in credit risk information.
2	Generative Adversarial Network Based Telecom Fraud Detection at the Receiving Bank	Future studies have the potential to extend the utilization of GANs to many forms of fraud detection, including insurance fraud or healthcare fraud, in adding to telecom transactions. . In addition, researchers could investigate combining Generative Adversarial Networks (GANs) with other advanced deep learning models to improve the robustness and accuracy of fraud detection systems.
3	Combining ML Algorithms with Quantum Annealing Problem-solvers for immediate identification of fraud	Future investigators may explore the scalability of quantum annealing solutions in real-time fraud detection systems and their potential connection with large financial networks.
4	Fraud Prediction Using k-fold Machine Learning Techniques	The future scholars can incorporate real-time data streams and online learning techniques to improve the timeliness and accuracy of fraud predictions in smart societies.

Source: Authors' compilation

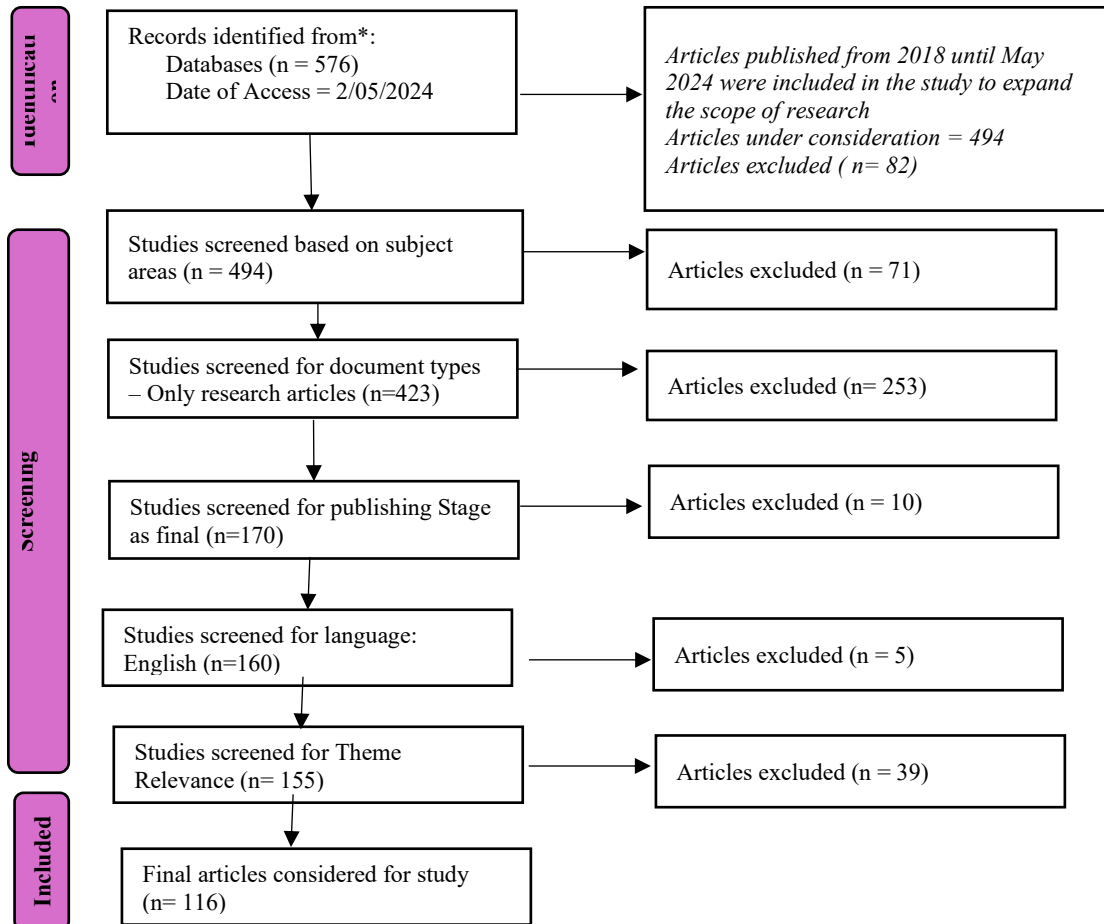


Figure 1: PRISMA Flow Chart (Source: Authors' compilation)

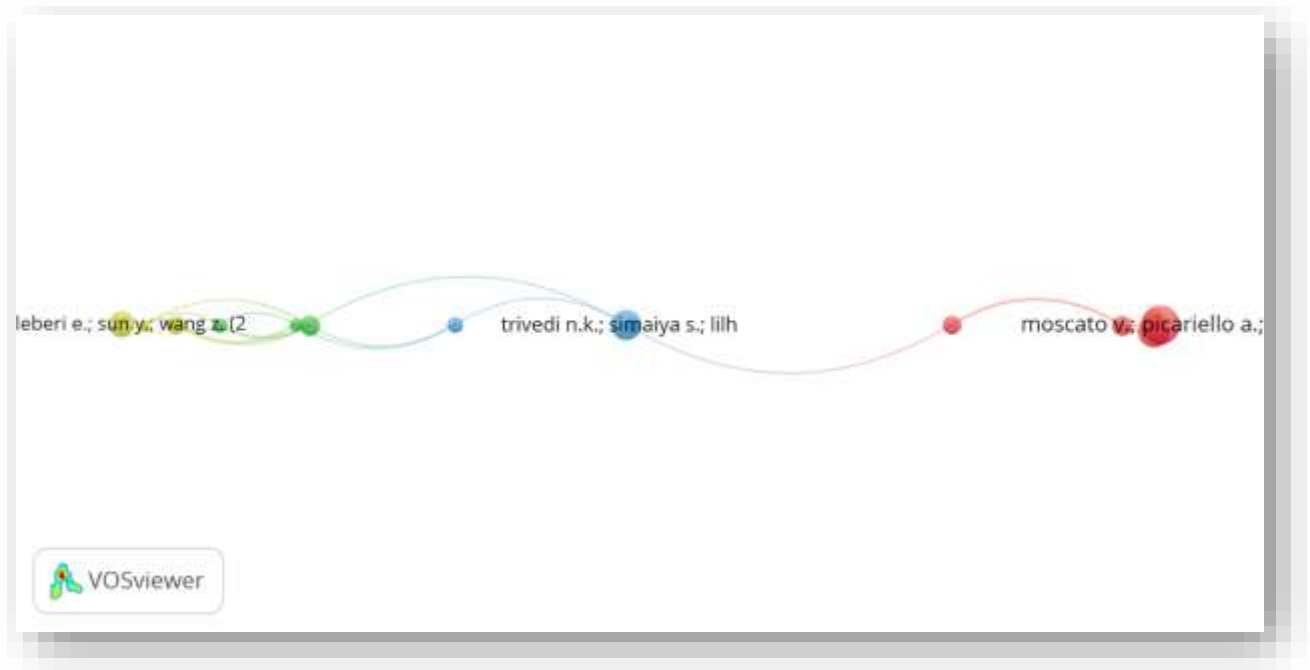


Figure 4: Thematic cluster analysis, source-Vos-Viewer Output