

# **Machine Learning in the Banking Sector**

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## **Abstract**

The paper aims to present an overview of previous research on “machine learning” applications in banking, covering key aspects of recent discoveries, their limits, and potential future research directions. It makes two contributions to the body of knowledge. It initially divides the literature to provide an overview of completed research endeavors. Second, it points out a gap in the existing body of research and suggests fresh avenues for investigation. The findings indicate that prior research has had difficulty developing a sound theoretical foundation for the subject. To support the proposed "theories," "notions," and "paradigms," more study is needed. In short, there is a big need for more research because there hasn't been a thorough evaluation of how machine learning has been used in banking.

## **Keywords**

Machine Learning; Artificial Intelligence (AI); Banking sector; Machine learning implementation; Biblioshiny

## **1. Introduction**

AI simulates human cognitive processes through technology, especially computer systems. System learning and development without explicit programming is made possible by “machine learning, an application of AI” (González-Carrasco et al. 2019). Risk management at banks has become more important since the global financial crisis, and continuous attention has been paid to how risks are identified, assessed, reported, and managed (Van Liebergen 2017). Machine Learning helps with various benefits by using its technologies to “enhance customer experience,” “improve service quality,” and “increase productivity” (Sabharwal 2018). This research aims to synthesize the past literature and highlight the importance of Machine learning (ML) in the banking sector. The research questions are focused on are “RQ1: How has the concept of machine learning in the banking sector been investigated in terms of a “year,” “region,” “research technique,” “context,” and “outcomes?”” “RQ2: What are the extant literature’s limitations?” “RQ3: What are the future research directions for machine learning in the banking sector?”.

### **1.1 Objective**

This study provides an overview of the past literature to highlight the importance of machine learning in the banking sector in this current technological advancement era.

## **2. Literature Review**

ML techniques are currently the most valuable tools (Patil and Dharwadkar 2017, February). ANNs have been effectively employed in addressing complicated problems in a variety of domains, including “medical diagnosis,” “forecasting foreign exchange rates,” “speech recognition,” “pattern recognition,” and “computer vision,” due to their “processing power,” “generalization capacity,” and “dynamical features” (Patil and Dharwadkar 2017, February; Ramesh 2017, February; Guerra and Castelli 2021).

The synthesis of the past literature on machine learning in the banking sector is shown in Table 1

Table 1. Synthesis of past literature

Paper Type	References	Aim, Limitation and Future Research Direction
Case Study	Shetu et al., 2021, June; Kaminskyi et al., 2021.	<p><i>Aim:</i>                      With internet banking, gain clients' pleasure.</p> <p><i>Limitation:</i>                      The data was not sufficient</p>
Modelling	González-Carrasco et al., 2019; Ramesh, 2017, February; Shaheen and ElFakharany, 2018; Shoumo et al., 2019, October; Rahman and Kumar, 2020, November; Kaur and Kaur, 2020, November; Aphale and Shinde, 2020; Turkson et al., 2016, September; Tay and Mourad, 2020; Shukla, 2021, July; Athavale et al., 2009, October; Mirmozaffari et al., 2020; Boughaci and Alkhaldeh, 2020 November.	<p><i>Aim:</i>                      These studies have concentrated on applying business analytics insights and implemented intelligence approaches in a big data environment to find similarities among bank activity reports.</p> <p><i>Limitations:</i>                      Limited data</p> <p><i>Future research directions:</i>                      To improve the learning process, we will use stream data rather than batch data such as social media and customer call data in the future. Deep learning techniques will be required for this, as they outperform other speech, image, and sentiment classification and analysis techniques.</p>
Review Paper	Sabharwal, 2018; Guerra and Castelli, 2021; Donepudi, 2017a; Donepudi, 2017b;	<p><i>Aim:</i>                      The purpose of these literature reviews was to illustrate the significance of AI in the banking industry by examining various researchers' work. Additionally, it</p>

	Donepudi, 2019; Gorodetskaya et al., 2021, September; Leo et al., 2019; Gorodetskaya et al., 2021; Milojević and Redžepagić, 2021	emphasized how ML methods may help the banking sector manage risks, notably in the credit scoring procedure.  <i>Limitation:</i> More specific issues, such as predicting ATM load, need more attention.  <i>Future research directions:</i> Combining the strengths of emotive human intelligence with machine speed/space intelligence is possible. They'll coexist in a healthy ecosystem.
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### 3. Methods

From the year 2022, using the Scopus and Google Scholar databases, we gathered 1319 articles of published literature on ML for this review. We utilized search terms TITLE-ABS-KEY (Machine Learning), TITLE-ABS-KEY (Machine Learning AND Banking), and TITLE-ABS-KEY (Machine Learning Implementation AND Banking). Twenty-five publications that were related to the application of machine learning in banking were chosen for further consideration. To find relevant publications, we used the search terms “Machine Learning,” “Implementation of Machine Learning in Banking,” “Machine Learning Readiness,” and “Machine Learning and Banking.” Table 2 shows the main information of the data. Figure 1 depicts the methodology flowchart.

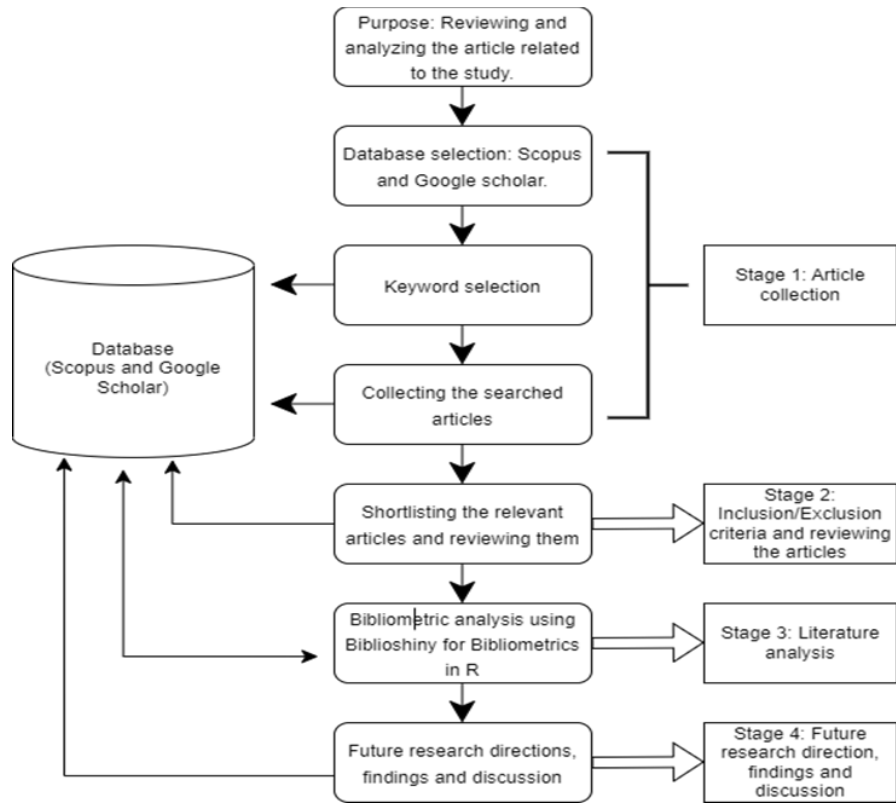


Figure 1. Methodology flowchart

Table 2. Main Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1995:2020
Sources	767
Documents	1319
Average years from publication	3.54
Average citations per documents	6.027
References	39460
DOCUMENT TYPE	
Article	476
Book	3
Book Chapter	53
Conference Paper	670
Conference Review	86
Data Paper	1
Erratum	2
Note	1
Review Paper	27

#### 4. Results and Discussion

Biblioshiny tool in R programming was used to analyze the past reviews. Figure 2’s word cloud illustrates the terminology most frequently used in articles on banking and ML. The most frequently used terms were "machine learning," "banking," and "system." Words are displayed in the “word cloud” in varying sizes based on how often they occur. The order of the words is a bit random, but because of their great size, the most significant words are placed in

the middle to make them stand out more. A thematic map divided into four topographic zones based on importance and saturation was also produced (figure 3). From figure 4 it is evident that the study has great potential in the coming years. There was a steep increase in the number of studies published in 2017. In 2017, there were only 42 documents related to machine learning and banking. Now it has increased to 328 documents in the year 2022. Amin, A is the most influential author with seven documents (figure 5). Amin, A's most cited article was "recognition of hand-printed characters based on the structural description and inductive logic programming," with a citation of 29. Also, the most contributing country to machine learning is India with 410 documents (figure 6).



Figure 2. Word Cloud

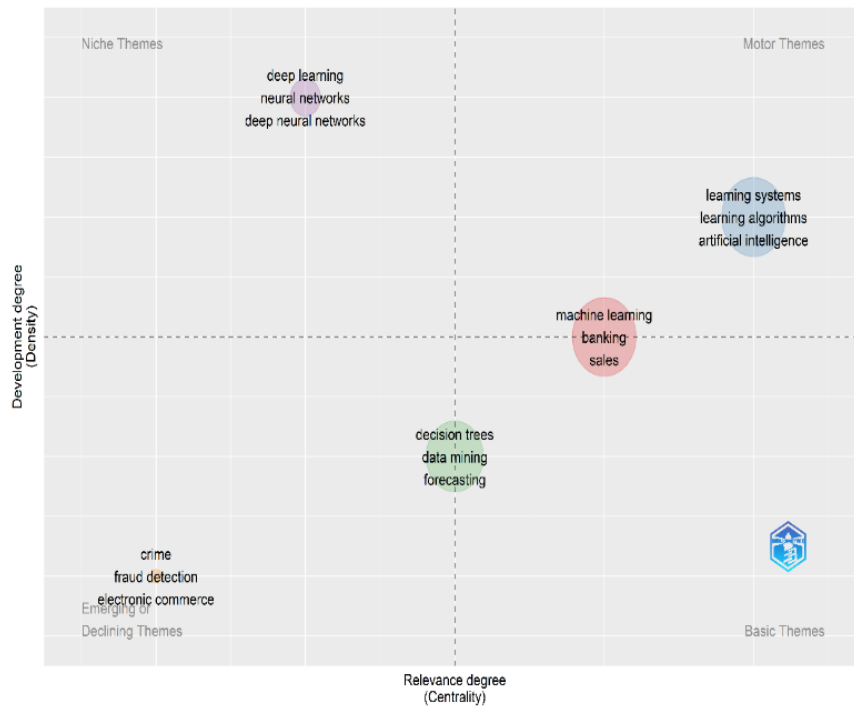


Figure 3. Thematic Map

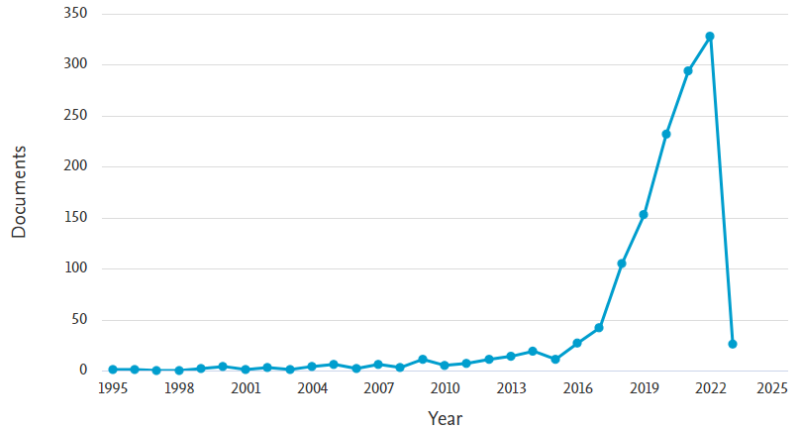


Figure 4. Document by year

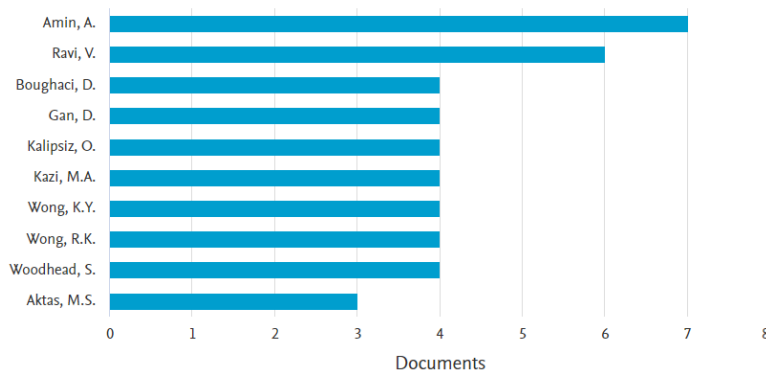


Figure 5. Influential Author

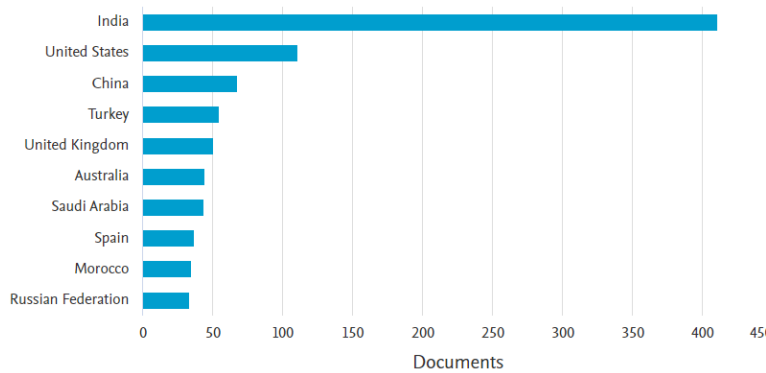


Figure 6. Most contributing country

The foundations to success in business are advanced, smart security systems and efficient client services. In addition, financial firms must use cutting-edge technology to keep ahead of the game to maximize their IT and satisfy the most recent market demands. The use of machine learning in banking is perhaps still in its early phases, and the banking sector is continually evolving. However, banks that use AI and ML will swiftly surpass their rivals (Sabharwal, 2018). When ML is utilized to improve banking operations, it drastically reduces the time it takes to discover questionable transactions. AI may employ additional techniques besides ML, such as rigidly programmed logic rules. A complete AI approach would be mechanized regarding information recognition, data testing, and decision-making based on information testing. The decision tree method is well known for its application to the analysis of ML, which presents significantly more challenges in practice, particularly concerning overfitting historical data, which results in identified subgroups having poor predictive power with new data and in novel scenarios.

## 5. Conclusion

So, we read 25 articles and conducted research. The effect of AI on the digital age, especially in the banking sector, must also be carefully considered. The execution, limitations, possibilities, and effects on operations and jobs were also described. AI and machine learning have enabled the banking industry to meet customer demands. As a result, the majority of previous reviews were unavailable. As there is insufficient data, the concept of ML in the banking sector can be studied by considering the tools and methods used, such as the experiment and predictive model, and others for future research.

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