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Artificial intelligence and machine learning adoption in the financial sector: a holistic review

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ABSTRACT

The evolution of new technologies has spurred a growing body of literature exploring their application and impact on the financial sector, particularly the integration of artificial intelligence (AI). This paper delves into the rapid adoption of AI and machine learning within the financial sector, highlighting their potential to enhance financial stability and productivity. By reviewing research from 2018 to 2023, the study categorizes AI applications in finance into three main areas: cybersecurity, customer services, and financial management. Furthermore, the research identifies and classifies various threats posed to the integrity and stability of the financial system by AI, along with associated challenges for policy and regulatory frameworks. It also addresses the risks and obstacles inherent in deploying AI within financial markets and banking sectors, offering recommended strategies to mitigate these limitations. Despite the recognized advantages, the comprehensive understanding of AI's benefits and drawbacks remains incomplete due to its evolving nature and varied applications in banking. Clear policies governing AI usage are imperative to safeguard financial consumers and promote a fair and transparent financial market. These guidelines should prioritize human decision-making and foster an unbiased approach to policymaking, ultimately fostering innovation within the industry.

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1. INTRODUCTION

Technology is signaling the beginning of a significant shift in financial services provided by financial institutions from human-centered to computer-centered, as conventional forms of financial activity revolutionize. The financial technology sector is growing rapidly, indicating the steady shift of the financial industry towards one that is computer and data-driven. Financial institutions must also modify their distribution networks, technological infrastructure, and business strategies to reflect these new circumstances. We are in an era of remarkable technological advancements. Digital technologies are driving transformative change. The economic paradigm is changing. There has been an impact from the development of information technology as well as from the widespread use of computers, mobile devices, and the internet. New technology is radically altering the marketplaces for products, factors, businesses, and jobs. Fintech innovations, artificial intelligence (AI), and blockchain technology are a few examples. The latest advancements in AI and related technologies are thrusting the boundaries of the digital revolution. The rate of digital transformation has increased due to the COVID-19 pandemic. The future is drawing nearer than expected [1]. There are a variety of viewpoints on

AI and its potential to increase efficiency in various industries. AI is being used by financial institutions more and more to enhance business processes and broaden their product and service offerings. The advent of AI is often denoted as the fourth industrial revolution.

In addition to looking into cutting-edge AI applications that are transforming the financial industry and altering the financial ecosystem, this study intends to discover domains for AI applications in the financial sector that have the potential to significantly improve many of its operations. The article also addresses the regulatory issue, the significance of appropriately managing AI risks, and the difficulties associated with applying AI given its present applications in financial services. The rest of the paper is given as follows. The use of AI in various financial system components is examined in section 2. The authors present the patterns connected to AI and its application in the financial sector in section 3 of their review of earlier research. The collection of prior research publications from 2018 to 2023 is used in section 4 to assess the difficulties in implementing AI in the financial sector. Section 5 then looks at future developments, potential solutions to these difficulties, and a conclusion.

2. OVERVIEW OF ARTIFICIAL INTELLIGENCE

A real AI system is one that "learns" from the data it retains to carry out tasks and address issues that ordinarily call for human intelligence, either on its own or with the assistance of a human expert. AI is an interdisciplinary field recognized by the European Union (EU) as a critical area, a major engine of economic growth, and a source of answers to several social issues [2]. AI is being used increasingly in the finance industry and is expected to play a bigger role in future years. However, it is still unclear exactly how the financial sector will change because of the use of AI.

Machine learning (ML) systems with varied degrees of autonomy that may be taught to forecast, recommend, or make judgments based on a predefined set of human-defined goals are known as AI systems. Systems for AI are becoming increasingly reliant on massive untapped data sources and data analytics, or "big data". ML models receive this kind of data and utilize it to automatically learn from past experiences and data to improve predictability and performance without the need for human training [3].

The COVID-19 pandemic has exacerbated a trend toward digitization that was already well-established before the outbreak, including the application of AI. Between 2020 and 2024, it is anticipated that global AI spending will more than quadruple, from USD 50 billion to USD 110 billion [4]. Growing data availability and more affordable processing power have made it possible for AI to be used in finance in areas including asset management, algorithmic trading, credit underwriting, and blockchain-based financial services [5].

AI uses in the financial sector: Being among the first industries to employ AI, the financial industry hopes to gain several advantages from its application, including the ability to provide better services faster and for less money. This is because the industry is technologically advanced and tends to use analytics more wisely. The financial industry cannot adopt AI unless it can link with technology capabilities and comprehend the business needs of financial organizations, institutions, and markets. These are strong instruments that have significantly changed this industry [2]. In the financial industry, AI has a growing spectrum of uses. Automating, analyzing, and making decisions have become commonplace in financial markets, banks, and insurance companies, leading to the development of new business models. According to an accenture analysis, AI applications will be the primary way for banks to communicate with their customers in the future [6].

Table 1 outlines the anticipated potential influence of AI technology on several areas and industries of the financial services business. It focuses on the potential that AI provides for producing new income streams, automating and reengineering processes, improving customer service, strengthening risk management techniques, and accelerating client acquisition. The table presents a quantitative picture, with percentage values suggesting AI's relative potential in each industry, including deposit and lending, payments, market infrastructure and professional services, and investment management. This overview enables a comparative examination of where AI technologies might have the most influence across the many disciplines of the financial services industry.

Table 1. Statistical data on AI usage in the financial services industry's primary business domains [7]

	Deposit and lending (%)	Payments (%)	Market infrastructure and professional services (%)	Investment management (%)
Creation of fresh revenue opportunities	46	44	52	61
Process automation and re-engineering	43	56	42	50
Customer support	52	44	55	45
Risk management	56	56	53	55
Acquisition of clients	39	50	44	50

Risk management: The most common use of AI now is in risk management, which is closely followed by revenue generation from new goods and procedures. Peer-to-peer lending (P2P) has been a popular funding

technique for consumers and small enterprises in the past ten years due to the continual development and promotion of credit risk assessment algorithms based on ML models. The P2P lending platform's supply and demand for capital directly links investors and borrowers, doing away with the need for intermediaries in the transaction process [7]. Cao and Zhai [8] shows that the application of ML-based credit rating models has recently been extended to the loan and mortgage markets for small and medium enterprises (SMEs). The development and use of AI and ML in financial systems, as well as their effects on macroeconomics and microeconomics, are summarized in the study [9]. It has become evident that there are certain risks and problems associated with the use of AI. Finally, based on the issues raised by AI regarding financial risk management, various recommendations and techniques for the suitable implementation of AI in financial risk management are given.

Use of AI in financial markets: AI could help disintermediation even further by bringing AI inference right onto the chain to replace off-chain third-party information sources. AI may enable automated credit scoring based on consumer internet data, insurance underwriting, trading based on financial data, and investment advising services. Theoretically, completely autonomous chains [5] might be built using AI-based smart contracts that adapt and self-learn without human intervention.

The use of AI in quantitative finance was examined in the study [7]. They said that an increasing amount of research uses AI as a financial innovation, namely in asset pricing and stock market return prediction. Earlier attempts use complex ML models only as a tool for fitting data; they don't include any financial concepts. Such activity includes directional movements and original stock price prediction. Applications of ML-based models have been noted in other domains of asset pricing, including cross-sectional bond return forecasting and bond risk premium forecasting [10]. While ML models are widely utilized in asset pricing, they have also found application in other risk management areas, such as credit risk assessment.

AI is also used in the financial sector to detect fraud. Recently, the National Stock Exchange of India (NSE) said that they are focusing their efforts on applying ML to discover market patterns, as well as monitoring the exchange to avoid manipulation of its high-frequency trading (HFT) markets [6]. AI has provided a fresh and inventive approach to finance by providing more widely applicable results for stock market forecasting through its use in financial market price prediction. A vast amount of research has attempted to use AI and ML to forecast stock market returns and volatility [11].

Use of AI in the banking sector: Financial and banking services have undergone a paradigm shift because of AI. The exponential rise of Fin-tech businesses has been critical in this change [12], [13]. AI genuinely appears in the current environment with its new advancements and ways that allow for improved access and comfort for individual users. AI makes customer service better by enabling chatbots and other self-help systems that relieve contact centers of some of their workload, especially in the banking sector. These days, voice-activated virtual assistants offer smarter services to customers at every level, such as monitoring account activity, scheduling payments, and checking balances [6].

Employing AI to assess applicants' solvency and pinpoint lending risks for a range of services is becoming more and more common among financial institutions. AI has been utilized, for example, to predict the likelihood of customer credit card defaults. Additionally, banks use AI to collect information on the accounts, social media activity, spending habits, geolocation, and financial transactions of their customers. Through the collection and input of client data into an AI system, financial institutions can use algorithms to enhance customer loyalty by building a tailored or curated ecosystem [14].

Truby *et al.* [15] conducted a systematic review of the Application of AI in the banking sector. By concentrating specifically on the banking sector and conducting a more in-depth inquiry utilizing a variety of analytical techniques, they sought to distinguish their report from earlier assessments. According to the study's findings, the literature on AI and banking covers three crucial subject areas: strategy, process, and customer. AI is relevant to the credit application and decision-making processes in banking; these processes directly affect client acquisition and accessibility. To show how AI is incorporated and used in the process of applying for credit solutions online, Truby *et al.* [15] proposed the customer credit solution application-service blueprint (CCSA).

Acquire customer: The banking sector has paid a price for these advancements, even if they have allowed consumers to access many banking services whenever and whenever they choose. As observed in [16] AI will enable global banking institutions to redesign their business models fundamentally, offer ground-breaking goods and services, and, most importantly, shield customers from negative customer experiences. Consumers are targeted in the acquisition phase to get them onto the website and turn them into active consumers. Customers are exposed to advertisements that are personalized for them on the front stage, which also contains targeted adverts. Personalized outreach, accelerated onboarding, and up- or cross-selling based on AI-generated insights from live user data are the top three AI use cases for client acquisition, according to current adoption rates. Comparing this to the other implementation fields mentioned earlier, it can seem like a smaller one.

Visit the bank’s website and apply for a credit solution: AI may revolutionize the client acquisition process for banks, particularly in the realm of online credit applications. Banks may enhance customer experience by using AI-driven customization, intelligent chatbots, predictive analytics, dynamic content optimization, voice assistants, fraud detection, and omnichannel integration, right from the moment a consumer

visits the website. Customized product suggestions, directed application procedures, simplified form completion, and live fraud detection provide a simple, safe, and captivating experience. This AI-powered strategy not only improves the user experience but also boosts the chances of successful credit product applications, promoting lasting client connections and driving business expansion for the bank.

Receive a decision: Following the online process for gathering the data, data mining and ML will help with the analysis and offer the best credit decisions. At this point, the robot-advisor provides the customer with a credit decision. As the application is sent to the advisory network, then to the underwriting stage, and ultimately returned to the consumer, the traditional techniques for credit determinations typically take up to two weeks. The increasing acceptance of AI-driven solutions for organizational performance, as opposed to more traditional techniques of planning and risk model generation, has given financial institutions greater opportunities for business efficiency [17].

Customer contact call center: At this point, improving banking channels can help with AI integration. For instance, banking institutions can utilize ML to enhance appointment scheduling and shorten service times. Intelligent document processing systems may accelerate processes like account openings, loan applications, and compliance checks by swiftly extracting and analyzing information from documents provided by the customer. Moreover, recommendation engines driven by AI can provide tailored suggestions for products or services, considering user profiles and activity patterns. This enhances the effectiveness and personalization of cross-selling and up-selling opportunities.

3. LITERATURE REVIEW

This section explains the study conducted in the fields of finance, customer service, and cyber security. The research proposal aims to identify the obstacles and constraints associated with the application of AI in the sectors and offer solutions to address these issues. Fintech, an acronym for financial technology, encompasses an array of innovative business models with the capacity to completely transform the financial services industry. The fintech business model offers a variety of automated financial products in response to the increasing use of the internet. AI and ML are two examples of the technology that is driving industry 4.0, and both fintech businesses and established incumbents can profit from its integration. AI and ML-powered personal mobile applications are starting to flourish in the market and provide benefits over traditional approaches. AI is being used by financial services companies and other financial sector enterprises more and more. Since AI technologies and techniques are now widely available in the financial sector due to the explosion of data and the declining cost of processing power, this trend is expected to continue. To enumerate the conclusions about the idea of applying AI in the financial sectors, research articles from 2018 to 2023 have been chosen.

3.1. Financial management

A summary of the development of AI in context is given by the research [18]. It attempts to present AI as a fundamental shift with numerous potential issues that the company must consider, rather than just a cost-saving auto-motion tool. Financial services companies are already using AI to improve client interactions, control expenses, and comply with regulations. Payment and banking services are now using AI to solve business problems.

Fourie and Bennett [19] explained treasury management and its progress in the development of business. Cash management, which is one of the treasury's main duties, necessitates cash forecasting. Because these technologies can aid the business in forecasting cash flow, this necessitates the usage of AI and ML. For the goal of teaching the ML model, centralized treasury management can be useful in supplying correct data. This will reduce the business's expenses. ML predictive models in the banking industry can assist in determining whether the borrower will be able to repay the loan or not. The banks can approve the loan based on this projection. The bank will be helped by this to use the money in a lucrative way.

Although AI has been used in trial projects in the banking industry, where data is highly valuable, its genuine uses have not yet been made public [20]. This research employs panel data from 28 semi-structured interviews with AI specialists in the banking and finance sectors to investigate the factors that facilitate and impede the effective implementation of AI in the banking industry. It was found that process capabilities and AI-oriented role models are essential before the trained algorithms reach the stage where the AI applications can operate without human involvement or ethical hesitations.

Based on panel data from 22 semi-structured interviews with experts in AI in finance, Thowfeek *et al.* [21] examines the factors that contribute to and obstruct successful AI adoption in the banking sector. The technology organization environment (TOE) framework is used to organize the results using a theoretical lens. This framework is an organizational theory that includes three elements by adopting the technological inventions the process is developed is being explained. Technologies both internal and external to the company have been determined to be relevant. Guidelines for the effective use of AI demonstrate that

AI-specific role models and process competencies are required before trained algorithms have reached a quality on which AI applications would run without human intervention and ethical considerations.

By focusing on some of the most pressing unresolved business issues in this sector, Kruse *et al.* [22] will investigate the changing aspects of AI ecosystems in the banking and finance sector and how they are quickly emerging as major disruptors. In this field, it is feasible to examine AI through a variety of prisms, but primarily by examining its implications and applicability against the backdrop of the banking and financial services sector. The application of AI that has been happening in the financial sector will be looked at in this review [23]. There are a variety of viewpoints on AI and its potential to increase efficiency in various industries. The banking sector is the same. There have been worries that the financial sector may potentially be negatively impacted by AI.

3.2. Customer service

Financial services are getting closer to their customers thanks to AI. AI is being used by financial organizations to create more personalized, engaging, and less sterile customer experiences. Many financial and even non-financial companies, for example, deploy AI "chatbots" to respond to simple online customer inquiries. The primary concern with all applications of AI is the administration, protection, and privacy of personal data. The banking sector must depend more heavily on AI systems and algorithms and trust them with sensitive personal data to improve client services and products [14]. In three field-based tests, Smith and Nobanee [24] employed an experimental methodology to find out which online customer support applications AI or human consumers preferred when searching for banking services. According to the research, customers were more likely to use AI for low-complexity work because they believed it was better at addressing problems than human customer service, but they were more likely to use human customer service for high-complexity jobs because they believed it was superior.

According to Xu *et al.* [25], across the globe, the financial services industry is being impacted by AI technologies. Financial service providers can use new and massive data sources to overcome challenges in establishing customer identification and the high cost of supplying rural and low-income clients, to name just two. By utilizing these technologies in developing regions, they can further automate their business processes. incapacity to provide financial services to many clients because of creditworthiness. Accruing financial AI adoption by businesses must be done responsibly for inclusion advantages to materially—the existence of competitive market environments and ongoing investment in the required infrastructure [26].

To monitor the functioning of AI methodology in the banks and customer reactions, the research [27] focuses on AI in banking and financial services in Chennai. The financial transaction data generated by the widespread usage of digital payments and banking can be mined by banks and other financial organizations to better track, predict, and respond to client behavior. To ascertain the information used in banking and financial services, data is collected from secondary sources based on the literature review. A common questionnaire is created to compile the crucial data that clients possess about AI applications. According to the research's findings, private banks and other financial institutions use a variety of AI services to benefit their clients and ensure client satisfaction. The outcome also revealed that by developing creative planning to enhance AI workplace practices, clients have higher faith in representatives' dedication to banking and financial services.

AI consists of simply two fundamental ideas. The first stage is to study human brains and cognitive processes; the second is to use ML to help illustrate those processes. AI in banking encompasses more than just chatbots. AI has affected several sectors of the economy, including finance. The primary reason for this project was to understand how AI is changing current banking [28]. The idea of AI, how it has changed banking, and how it affects human labor are the primary subjects of this study. This study offers an overview of the present applications of AI in the banking industry and how it is transforming banking in India, given how rapidly and dramatically the industry is evolving.

The banking industry is undergoing ground-breaking changes as explained in [29] with the focus on the client becoming increasingly important. Consumers who regularly use cutting-edge technologies and are tech-savvy expect seamless banking experiences. Customers may now access most financial services from anywhere at any time thanks to these advancements, but the banking sector has paid a price for them. This study also sheds light on both the benefits and drawbacks of AI use in Indian banking sectors. Because of the descriptive nature of this study, all necessary and pertinent information has been gathered from a variety of journals, magazines for published papers, and websites.

According to Lee [30] about the most prominent form of AI in the banking industry. Those interested in industry disruption could find risk management, real-time fraud prevention, and AI-driven customer service to be the most appealing. Stockbrokers, investment bankers, and asset managers may benefit significantly from deep learning's (DL) utilization of patterns to forecast future behavior, at least for the time being.

3.3. Artificial intelligence-based cyber security

The proliferation of cyberspaces by criminals to advance their illicit activities is a result of the development of information technology [31]. AI is a tool that the banking and financial industries work hard

to employ to lower cybercrime and associated risks. Numerous prospects presented by AI techniques aid in the growth and prosperity of the banking sector. Trust in AI must be maintained by upholding transparency and understandability. Resources about customer behavior and interests are made available by AI techniques. The AI platform known as robo-advice is utilized for platform management. AI is also involved in protecting personal data. AI has given the banking sector the necessary framework to identify transaction fraud. AI and cybersecurity are closely related domains. Various forms of cybercrimes are recognized and prevented using AI-based fraud detection systems. However, there are substantial costs associated with the application and conservation of AI. Because of AI-related techniques, the unemployment rate is also rising [32].

Mishra [33] presents an AI-based strategy for managing the banking sector's cyber security. Banks and other financial companies prioritize cybersecurity more because of the sensitive data they maintain for their clients. The protection of customer assets is the most evident justification for cyber security in banking. Banks use encryption software to protect their online transactions and customer data from cyberattacks.

Patel *et al.* [34] proposes KiRTi, a credit-recommender system for public blockchain that uses DL to enable smart lending between potential borrowers (PB) and potential lenders (PL), doing away with the need for credit-score (CS) to be generated by third-party credit-rating agencies (CRAs). For this reason, loan approvals from PL to PB are expedited through automated security, sanctioning, and payout processes. KiRTi records PB past transactions, current assets, and liabilities in a public blockchain as time-series sequenced data and achieves an accuracy of 97.5% in comparison to conventional approaches.

According to Statista in Figure 1, based on a survey conducted between April and May 2022, the most popular uses of AI in the financial services sector were voice assistants, chatbots, and conversational AI in the customer experience and marketing business segment, as well as financial reporting and accounting in the operations and finance segment. Other daily operations that made use of AI were marketing personalization and cloud pricing optimization. Only a small portion of company leaders believed that AI was essential to their companies in 2022, despite the wide adoption of the technology in the financial sector.

Large language models (LLMs) and natural language processing (NLP) were the most often utilized AI-enabled applications in the financial services sector, according to a survey conducted in 2023. According to the survey, fraud detection, portfolio optimization, and recommender systems were other widely used AI applications. These uses are illustrated in Figure 1.

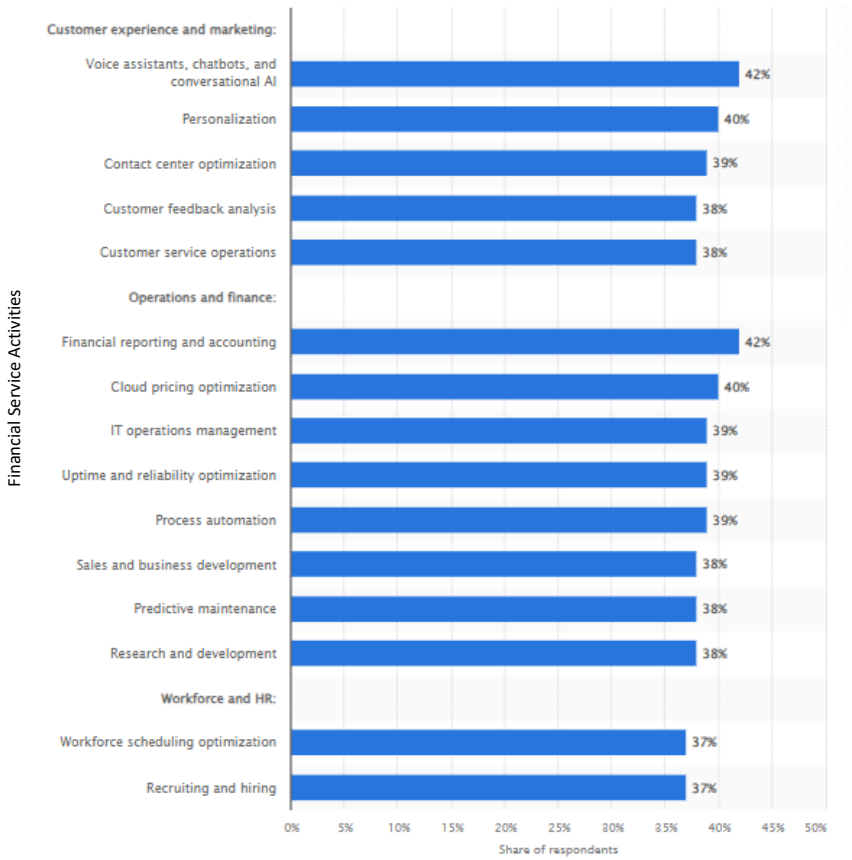

Figure 1. AI usage in financial services activities daily globally by business segment in 2022

4. RISKS AND CHALLENGES OF DEPLOYING ARTIFICIAL INTELLIGENCE IN FINANCE

The usage of AI in financial services is growing quickly with better customer experience, advanced loan and credit decisions, improved security, and greater efficiency. This advancement also implies that AI's problems are growing, as many businesses spend extensively on this technology to promote efficiency and creativity. However, this increase in AI investment also creates new difficulties for data security and transparency. Organizations must be aware of the anticipated difficulties and implement controls to avoid backtracking as data management procedures change in response to the deployment of new AI solutions. In this context, the World Economic Forum has warned that AI will harm the financial system in the future by disrupting the employment market and posing financial risks [6].

First and foremost, the application of AI in finance has significant challenges regarding data quality. The caliber of the data used to train AI models has a significant impact on their correctness and efficacy. Therefore, bad data can provide erroneous outcomes and faulty forecasts. Concerns regarding the possibility of biased models arise from the usage of AI in finance. Biases in AI models can occur for a few reasons, including the accuracy and representativeness of the data, the choice of features, and the modeling technique.

Since AI frequently interacts with vast volumes of sensitive and personal data, data privacy and security concerns are the major issues. Second, there are significant issues with AI decision-making's transparency and explicability. Some AI models, like DL, are "black box" in nature, making it difficult to understand how decisions are made. This might cause public mistrust of AI decision-making. Lastly, AI may cause a loss of jobs, particularly in low-skilled positions that are automatable. Therefore, we need to think carefully and have in-depth conversations about a variety of topics, including technology, politics, and ethics, to fully take advantage of the benefits presented by AI and successfully handle the issues it brings [35].

The requirement to make sure that these systems comply with current laws and standards is expanding as AI becomes more ubiquitous in the financial services industry. Maintaining customer confidence and making sure financial systems run securely and steadily depend on regulatory compliance. The complexity and lack of transparency of AI-based systems, however, can provide compliance issues. During the data collecting, model creation, and system integration phases of AI deployment, among other phases, there may be cybersecurity threats. The integrity of the models produced, for instance, may be jeopardized if a hostile actor targets the data pipelines of a financial institution and manipulates the data required for AI training.

The application of AI in finance raises ethical issues that must be resolved. Because AI algorithms have the potential to be biased and discriminatory, there are moral questions about fairness and possible harm to certain people or groups. When it comes to financial services, where AI systems can have a big impact on people's lives by making judgments about loans, investments, and insurance underwriting, these ethical considerations are especially important. As a result, it is crucial to set moral principles and benchmarks for the creation and application of AI in banking. While AI systems can speed up and automate decision-making, they can also introduce errors or reinforce biases without human interaction. Due to this absence of human supervision, undesirable outcomes and moral dilemmas may result. Despite being taught on past data, AI systems may become less effective when confronted with novel or unexpected circumstances. This problem is particularly pressing in the financial industry because of the quick changes that can occur in markets, laws, and consumer behavior. Apart from these challenges, the research findings, and the limitations of different research from 2019 to 2023 [36]-[52] are listed in Table 2 (see at Appendix).

From Table 2, it is noted that as far as the limitations are concerned in the management of banking risks, the solutions suggested are related to the technology risk and its measurement is the area for future research while using the AI and ML concepts in the banking sector. Also, it is required to perform the conduct risk to know more about the operational applications. It is recommended to conduct risk measurement and risk assessment for further studies. In the case of AI for decision-making in the era of big data, it is suggested to replace human decision-makers with the interaction and integration of AI. Also, it is recommended to use a higher amount of data for further implementations. It is required to provide an analysis of the application of DL models for the data processing sector in the finance and banking areas. The main issues of using AI in the banking and financial sector are job loss and user acceptance issues, lack of creativity and adaptability, and the loss of emotional human touch, which are to be rectified. The application of AI, ML, DL, and big data analytics found positive effects in the risk management areas. A thorough, specific, appropriate, and stringent AI and ML technology for risk management should be emphasized. AI application in the digitization of bank services should redefine its capabilities and operational bounds for a better solution. When deploying RegTech, the inconsistent nature of the law needs to be considered. When used properly, RegTech can enhance reporting capabilities while lowering costs and raising compliance. RegTech can modify the bank's procedures under the constantly evolving textual laws by employing NLP.

The challenges of AI in the banking sector as a diagrammatic representation are given in Figure 2. The diagram makes clear that the issues with accountability and governance include lines of responsibility, model governance arrangements, and outsourced infrastructure models. Biases, unfair treatment, and discriminatory outcomes, data privacy, and confidentiality are cited as non-financial dangers. Explainability

problems include pro-cyclicality, the inability to modify strategies during a stressful period that exacerbates systemic risks, and the explanation of how and why the model produces results. incompatible with internal governance and regulatory/supervisory structures, implying that managing AI algorithms and ML models will be challenging. Overfitting, model drifts, unanticipated repercussions at the business level, and correlations mistaken as causation are some of the disadvantages of robustness and resilience. The policy framework concerns encompass the following: potential incompatibilities with current legal frameworks, technology-neutral approach, AI complexity challenges, and risk of policy, skill, and employment fragmentation. The policies, procedures, and processes for the application of AI-based automation are adopted with more attention to ethics, integration, and execution to overcome these obstacles. The issues posed by the banking industry can also be resolved by collaborating with technology suppliers, incorporating AI into business planning, increasing internal investment in business development, and reorganizing information technology roles.

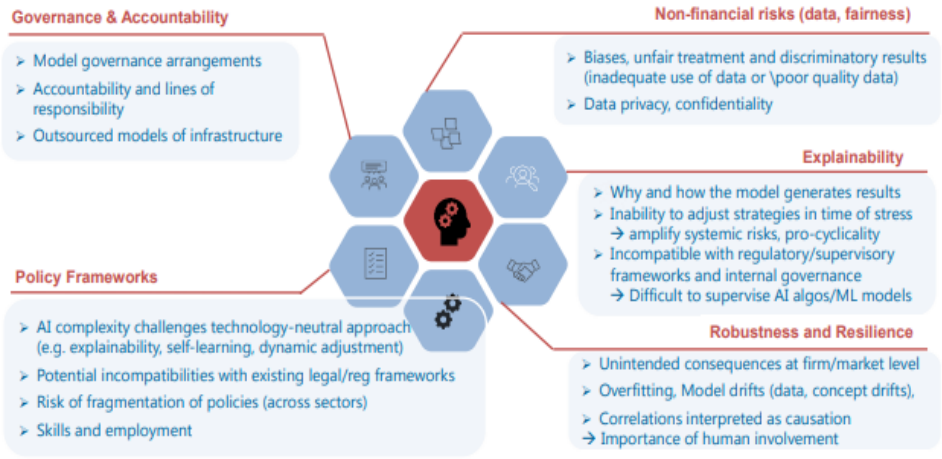

Figure 2. Challenges of AI in the banking sector [5]

5. CONCLUSION

AI has the potential to drastically impact several aspects of the financial sector, including banking, investing, financial services, credit risk assessment, asset management, criminal detection, and regulatory compliance procedures. AI and ML have the potential to make finance more accessible, effective, and equitable. The study reviewed the adoption of these new technologies in different components and areas of the financial sector. From the review, it appears that the literature on this topic has significantly expanded and has covered a wide range of uses. In parallel, risks and challenges accompanying these applications have been also expanding, as the paper highlighted. There will be a lot of important concerns to deal with in the future, such as workforce changes, laws, and ethics. It will be very difficult for governments and other agencies to promote innovation and safeguard consumers against misuse or unforeseen repercussions at the same time.

APPENDIX

Table 2. Challenges of AI in the financial and banking sector (*Continue*…)

No	Authors	Research name and year	Tools/techniques	Findings	Limitations
1	Leo *et al.* [36]	Machine learning in banking risk management: a literature review, 2019	ML in the management of banking risks	According to the report, research has been done on the use of ML in managing banking risks, such as credit, market, operational, and liquidity risks. The applicability of operational risk management strategies is limited, particularly in risk identification, assessment, monitoring, and reporting. Using a large volume of internal data, ML can be used to efficiently build operational risk management capabilities.	A better understanding of technology risk, its measurement, and reporting is considered a new field for further research. This research contributes to risk management such as risk mitigation and risk detection at the bank, however, this study is not focused on risk management systems which include risk measurement and risk assessment.

Table 2. Challenges of AI in the financial and banking sector

No	Authors	Research name and year	Tools/techniques	Findings	Limitations
2	Duan *et al.* [37]	Artificial intelligence for decision making in the era of big data–evolution, challenges, and research agenda, 2019	AI technology-human interaction, and AI implementation	Artificial intelligence (AI) systems are becoming an indispensable component of digital systems and are significantly influencing human decision-making because of the growing ubiquity of big data, sophisticated algorithms, more processing power, and improved storage.	The use of AI in general for decision-making was addressed. The limitations of using AI to complement or replace human decision-makers are taken into consideration. To further research on the application of AI for decision-making in the Big Data era, the study makes twelve research recommendations for information system researchers in the areas of conceptual and theoretical development, technology-human interaction, and AI implementation.
3	Huang *et al.* [38]	Deep learning in finance and banking: A literature review and classification, 2020	DL models for data processing in the financial and banking areas	The best models for specific domains are examined and based on the viability of different DL models' suggestions are developed. As a result, an overview of three key factors: data preprocessing, data inputs, and assessment procedures is provided. Also, the detrimental effects of overfitting and sustainability when using DL models are examined and several potential remedies are offered.	DL is widely used in NLP, audio-visual recognition, and computer vision. However, a comprehensive examination of the applications of DL in banking and finance is lacking in the literature currently in publication.
4	Ghandour [39]	Opportunities and challenges of artificial intelligence in banking: systematic literature review, 2021	Systematic literature review (SLR) to list out the opportunities and challenges regarding the use of AI in the banking sector	Additional prospects include process automation, customer satisfaction and loyalty, smart wallets, problem-solving and decision-making, transactional security and cybersecurity developments, and the promotion of digital financial inclusion. Banks can provide more accurate projections and react appropriately and promptly to emerging issues by utilizing AI technologies such as ML, neural networks, predictive analytics, and others.	The top challenges in AI that need to be addressed are as follows: issues related to job loss and user acceptance; privacy violations; loss of creativity and adaptability; strict requirements for operations and implementation; digital divide; availability of copious amounts of high-quality data; alignment of the AI-business strategy; and loss of the emotional "human touch." However, most studies conducted nowadays are descriptive and based on secondary data sources.
5	Milojević and Redzepagic [40]	Prospects of artificial intelligence and machine learning application in banking risk management, 2021	Model risk factors include "black box" problems, data accessibility, collection & protection, transparency, ethics, and the availability of qualified employees to create and use innovative methods.	The paper offers a road map for a successful rollout in the fictitious situation of a gradual deployment of AI and ML in risk management. The main elements for successful implementation are recommended by the research. The research offers suggestions based on a methodical and gradual methodology. This information should result in reduced costs, better risk management, and enhanced client services. Financial organizations can improve their risk management procedures by using the study's conclusions.	With caution and forethought, further uses of AI, ML, DL, and big data analytics might be beneficial, especially when it comes to managing risk in the following areas: credit, market, liquidity, operational risk, and other relevant areas. Model risk or "black box" difficulties, data accessibility, collecting, and protection, transparency, ethics, and the availability of trained personnel to develop and implement novel techniques are among the issues and unresolved questions that the study highlighted.
6	Guerra and Castelli [41]	Machine learning applied to banking supervision a literature review, 2021	Application of ML techniques to risk assessment in banking, which is a supervisory evaluation.	The most pertinent ML methods include ensembles, boosting techniques, tree-based models, support vector machines (SVM), k-nearest neighbors (KNN), and artificial neural networks (ANN). Redesigning stress tests and creating early warning systems (EWS) for bankruptcy are two recent themes. The study question was expanded to incorporate publications from additional viewpoints: i) Credit default assessment, ii) novel approaches to stress testing, iii) detecting systemic risk, and iv) additional fin-tech and sup-tech polls.	Owing to the diverse composition of the incorporated literature, this study chose to compare them using a more comprehensive approach. An in-depth examination and critique of each subject would be appropriate but outside the purview of this piece. The study's limitation is the absence of contributions using supervisory data, underscoring the need for additional research in this field. However, there is growing evidence that machine-learning techniques can enhance data analysis and decision-making in the banking industry.

Table 2. Challenges of AI in the financial and banking sector

No	Authors	Research name and year	Tools/techniques	Findings	Limitations
7	Kumar *et al.* [42]	ML technologies for digital credit scoring in rural finance: a literature review, 2021	Systematic literature review techniques have been used for this investigation.	The goal of this study is to identify the gaps in the various AI-ML-based credit scoring techniques now used by banking and non-banking organizations. This study likely provides insight into how these ML algorithms are applied to meet the various requirements set forth by the financial institutions for their rural borrowers.	It would be fascinating to learn more about the effective integration of traditional and digital approaches by financial organizations, especially in the absence of ethical dilemmas.
8	Hentzen *et al.* [43]	Artificial intelligence in customer-facing financial services: a systematic literature review and agenda for future research, 2021	To present a thorough analysis of the literature on artificial intelligence (AI) in financial services that interact with customers.	The results demonstrate a gap between theory-driven and data-driven research, with most studies using experimental research designs to investigate consumer adoption behaviors of AI in banking environments or evaluate the effectiveness and precision of AI algorithms to assist in credit scoring. Further empirical research is required, with a focus on client financial habits and the role of artificial intelligence-related ethics, laws, and policies with financial services like insurance and pensions.	Reviewing artificial intelligence in financial services that interact with customers is the main concept and Back-office and operational situations could be the subject of future research.
9	Goodell *et al.* [44]	Artificial intelligence and machine learning in finance: Identifying foundations, themes, and research clusters from bibliometric analysis, 2021	Artificial intelligence (AI) and ML are two related technologies that are emergent in financial scholarship.	Three areas are analyzed: (1) financial fraud and distress; (2) sentiment inference, forecasting, and planning; and (3) portfolio design, valuation, and investor behavior. These were discovered by locating eight bibliometric coupling-specific clusters of finance using AI and ML, as well as nine co-citations.	Understanding the application of machine-readable data has implications for financial systems and financial research. Machines can build complex, high-dimensional models that yield accurate evaluation of new data thanks to high-power computing enabled by sophisticated hardware and software. The application of AI and ML in particular is fundamentally altering the process of trading and making investing decisions.
10	Shetty *et al.* [45]	Impact of artificial intelligence in the banking sector regarding private banks in India, 2022	A variety of hypotheses were developed and evaluated to fulfill the goals of valuable suggestions that would benefit the customer for their easy transaction and the banker to reduce the burden of work.	Some banks have become difficult to access once AI was implemented, and initially, consumers were not prepared to take on risk. Data for the study came from both primary and secondary sources. This study was conducted to determine whether artificial intelligence (AI) facilitates labor or transactions and how the adoption of AI in banks has affected bankers and customers.	AI in banking applications isn't just for retail banking services; banks may use it to enable frictionless, 24/7 client association and enhance the customer experience. AI is benefiting investment banking's back and middle offices as well as all other supervisions about money.
11	Wandmacher *et al.* [46]	Artificial intelligence in business management: a literature review on AI applications on risk assessment in the financial industry, 2022	This paper is based on a qualitative meta-analysis to identify the various areas of application of AI in financial risk assessment.	This study outlined the various business uses of artificial intelligence and illustrated their effects. Furthermore, this study identifies potential business applications of AI as well as applications that are not yet ready for deployment. Lastly, potential directions for future business research on AI are highlighted.	The goal of future study should be to work on the application in various use cases by including technology, economics, business practices, and ethics. The primary goal of research is to standardize research methodologies. For example, ethical and behavioral finance expertise should be incorporated into pattern recognition to maximize data input and produce more pertinent results. Improving the quality of knowledge requires a fundamental unification of research. It may be up to academic research to organize and categorize the use of AI in commercial concerns.

Table 2. Challenges of AI in the financial and banking sector

No	Authors	Research name and year	Tools/techniques	Findings	Limitations
12	Lakhchini *et al.* [47]	Artificial intelligence & machine learning in finance: a literature review, 2022	Bibliometric review method	For a technical literature review, we goose-step the five stages of the scoping review methodology along with [48] bibliometric review method. The findings are gathered and categorized into seven areas: i) HFT and algorithmic stock market prediction; ii) risk management and financial distress; iii) financial fraud detection and anti-money laundering; iv) sentiment analysis and investor behavior; v) cybersecurity and data protection; and vi) big data analytics, blockchain, and fintech.	Regarding the use of personal data for political or commercial gain, a small group of multinational corporations leading the AI revolution and handling big data may or may not uphold the rights of individuals. As a result, AI systems need to provide public safety and security and act as a force for good in society. As a result, the main features of the numerous applications of the term AI are depicted.
13	Velev and Zahariev [50]	Challenges of bank service digitalization by artificial intelligence: the case of Bulgaria, 2022	The purpose of the article is to identify the difficulties associated with potential vital financial services that could be digitalized by AI.	AI is currently capable of carrying out tasks, learning and storing information, and doing precise data analysis. The banking sector's use of AI reduces human operations that are prone to error. Many parts of the typical tasks and responsibilities of banking staff can be optimized and simplified using ML, automation technologies, and AI handwriting and speech recognition assistants.	One of the technology's primary flaws is how constrained AI is. Although it is not always a solution, this is a tool. AI can converse and carry out repetitive tasks, but it is unable to express emotion. The distinction between man and machine is highlighted in this situation. AI technology is continually being improved by the engineers who support it, who are attempting to redefine its capabilities and operational bounds.
14	Nazareth and Reddy [51]	Financial applications of machine learning: A literature review, 2023	This thorough review is conducted using PRISMA, a systematic literature review methodology.	The main contributions of this review are the detailed examination of the characteristics and traits of the data that was used to train the model, the evaluation of the validation techniques, and the model's effectiveness in resolving each financial issue. Six financial sectors are examined in the study: stock markets, portfolio management, FX markets, cryptocurrencies, financial crises, bankruptcy, and insolvency.	The study also examines bibliometric data to determine the state of ML research in finance today. The report concludes by outlining potential directions for future research that might raise new issues in ML and finance.
15	Koerselman [52]	The impact of AI on the banking industry, 2023	A systematic literature review and analysis will be performed to find the effect that AI has had on the banking industry.	Artificial intelligence is currently the next FinTech solution that banks must adapt to. It might enhance most bank activities. SVM and neural networks, two DL techniques, may accurately classify fraudulent transactions. Chatbots are now available around the clock, which has greatly shortened response times and improved customer support procedures.	Employees still frequently complete simple inquiries. NLP is used mostly by chatbots as their primary AI mechanism for processing textual data. The prediction powers of AI have largely replaced manual processes in financial management. Artificial Intelligence has significantly impacted credit risk assessment by quickly analyzing large volumes of data to determine a customer's creditworthiness. The inconsistent nature of laws makes RegTech a challenging tool to use.

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