Application of Artificial Intelligence and Machine Learning to Finance

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Abstract

A review of 26 papers selected from Google and Google Scholar showed that the extent of artificial intelligence (AI) and machine learning (ML) adoption in finance is high and increasing rapidly. Fintech firms dominate over incumbents in all respects. Many new applications of AI and ML are being integrated into the financial services sector. The future is bright for AI and ML in finance. The various applications of AI and ML in finance can be categorised into personalised services and products, creating opportunities, managing risk and fraud, enabling transparency and compliance, automating operations and reducing costs. These applications have different impacts/outcomes on the organisation, customers and the government. The adoption and implementation of AI and ML in finance are subject to many challenges and problems. The main challenges are ethics, customer trust, cyberattacks, regulatory compliance, talent acquisition and culture. There are many opportunities also. To utilise the opportunities, challenges need to be addressed using appropriate methods. Overall, the adoption and implementation of AI and ML in finance is an exciting development that is affecting the global population in various ways.

Keywords: Application of artificial intelligence and machine learning to finance

Introduction

Artificial intelligence (AI) and machine learning (ML) have revolutionised numerous industries, and finance is no exception. The integration of AI and ML technologies in finance has brought about significant advancements, transforming traditional banking and financial practices. These technologies have the potential to revolutionise decision-making processes, risk management, fraud detection, investment strategies, and customer service in the financial sector.

AI and ML can analyse vast amounts of data at unprecedented speed and accuracy, making them invaluable tools for financial institutions. By utilising these technologies, finance professionals can extract actionable insights and make informed decisions based on historical data patterns, market trends, and predictive analysis.

In risk management, AI and ML models can analyse complex data sets and identify potential risks or anomalies in real time. This enables financial institutions to proactively mitigate risks, prevent fraud, and ensure compliance with regulations. ML algorithms can also enhance credit scoring models by assessing borrowers' creditworthiness based on a wider range of factors, improving accuracy and reducing human bias.

Furthermore, AI-driven algorithms can provide personalised investment strategies and recommend suitable financial products for individual customers. These technologies can analyse customers' financial history, risk tolerance, and investment goals to offer tailored recommendations, optimising their investment returns. Chatbots and virtual assistants powered by AI can also improve customer service by answering queries, resolving issues, and providing real-time financial advice.

In trading and investment, AI and ML algorithms can process vast volumes of financial data to identify patterns, execute trades, and predict market trends with higher precision. This enables asset managers and traders to make data-driven decisions, enhance portfolio management, reduce risks, and optimise investment returns.

Despite the evident benefits, it is crucial to acknowledge the potential challenges associated with AI and ML in finance. Ethical considerations, data privacy, and cybersecurity are among the key concerns that need to be addressed to ensure the responsible application of these technologies.

Thus, the use of artificial intelligence and machine learning in finance has transformed the industry, enabling more accurate and efficient decision-making, risk management, fraud detection, investment strategies, and customer service. As these technologies continue to advance, their impact on the financial landscape is expected to grow, allowing for further innovation and improved financial services for customers and businesses alike.

This paper aims to review the applications of AI and ML in finance. The research questions on which the answer is sought are-

1. To what extent AI and ML have been adopted globally in finance?
2. What are the applications of AI and ML in finance?
3. What are the impacts/outcomes of using AI and ML in finance?
4. What problems and challenges occur when AI and ML in finance?

Methodology

Google and Google Scholar were searched using the above four research questions as the search terms. Abstracts which do not contain any relevant information, non-English texts, books, book sections, editorial comments and dissertations were excluded. This search, identification and selection strategy yielded 26 papers. These papers are discussed in four sections corresponding to the four research questions listed above.

Results

According to a US Congressional report by Tierno (2024), the adoption of AI/ML in finance has often been aimed at addressing specific challenges, such as maximising profits while minimising risk. Despite the industry's traditional and historically regulated perceptions, regulators are wary of technology bypassing technology-neutral regulations. Financial services use different AI/ML

technologies for various purposes, including powering chatbots in customer service, identifying investment opportunities, executing trades, and preventing fraud. Policymakers face pressure from various stakeholders, including financial service providers and technology companies, who may promote AI/ML to save time and money while ensuring accessibility, accuracy, and regulatory compliance. However, concerns over bias, systemic risk, manipulation, affordability, and employment consequences abound. The key question is whether the existing regulatory framework is adequate or if a more tailored approach to the technology's evolving capabilities is needed.

To what extent AI and ML have been adopted globally in finance?

A recent survey of financial institutions by WEF (2020) shows that 77 per cent of all respondents anticipate that AI will be of high or very high overall importance to their businesses within two years. Biswas, et al. (2020) estimates the potential value of AI in the banking sector to reach $1 trillion. Bholat, et al. (2020) and McKinsey (2020) find that a considerable number of financial institutions expect AI/ML to play a bigger role after the pandemic. Some data presented by this IMF report (Boukherouaa, et al., 2021) are presented in Fig 1 sourced from Schizas, et al. (2019) and Fig 2 sourced from Financial Stability Board (2020).
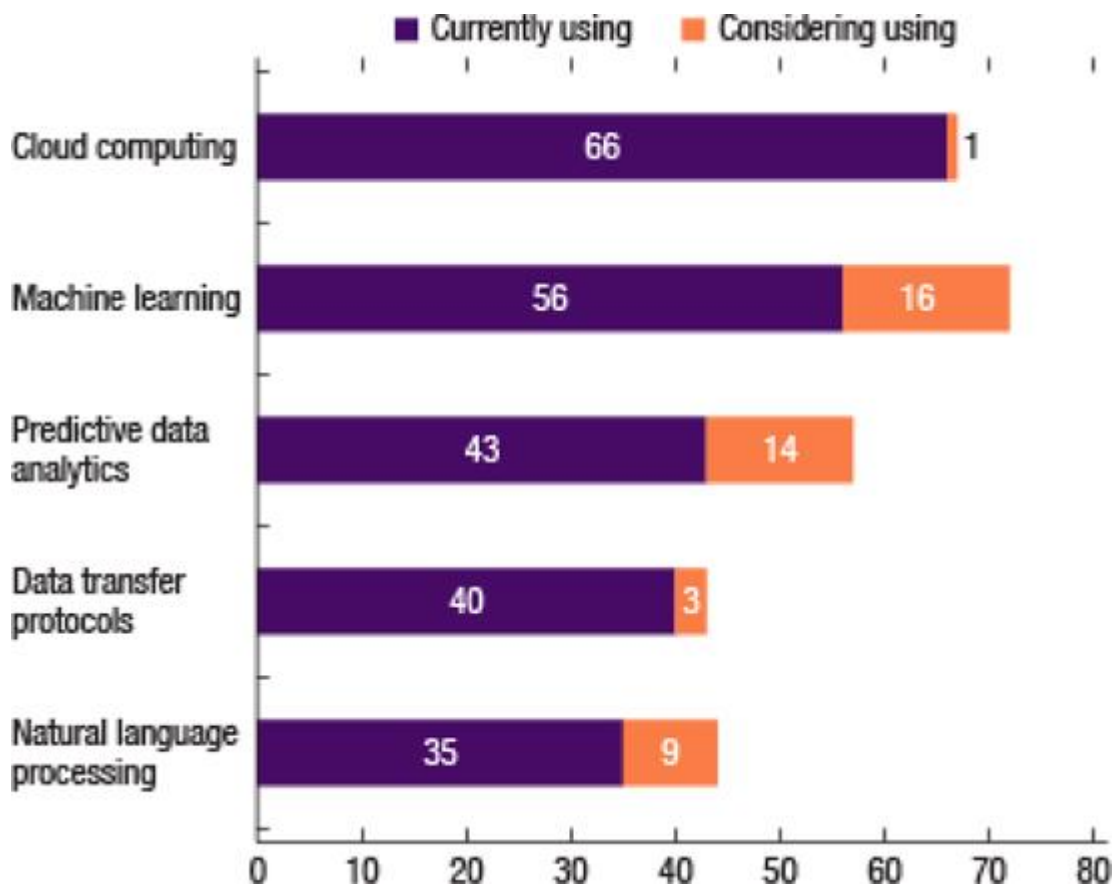

Figure 1 Top five technologies used for RegTech in finance *(Schizas, et al., 2019).*

According to Fig 1, cloud computing was used for RegTech by the highest percentage (66%) of financial institutions followed by ML (56%). While only 1% of the financial institutions were still considering using cloud computing, 16% of them were still considering using ML. Another 14% were still considering the use of predictive data analytics.
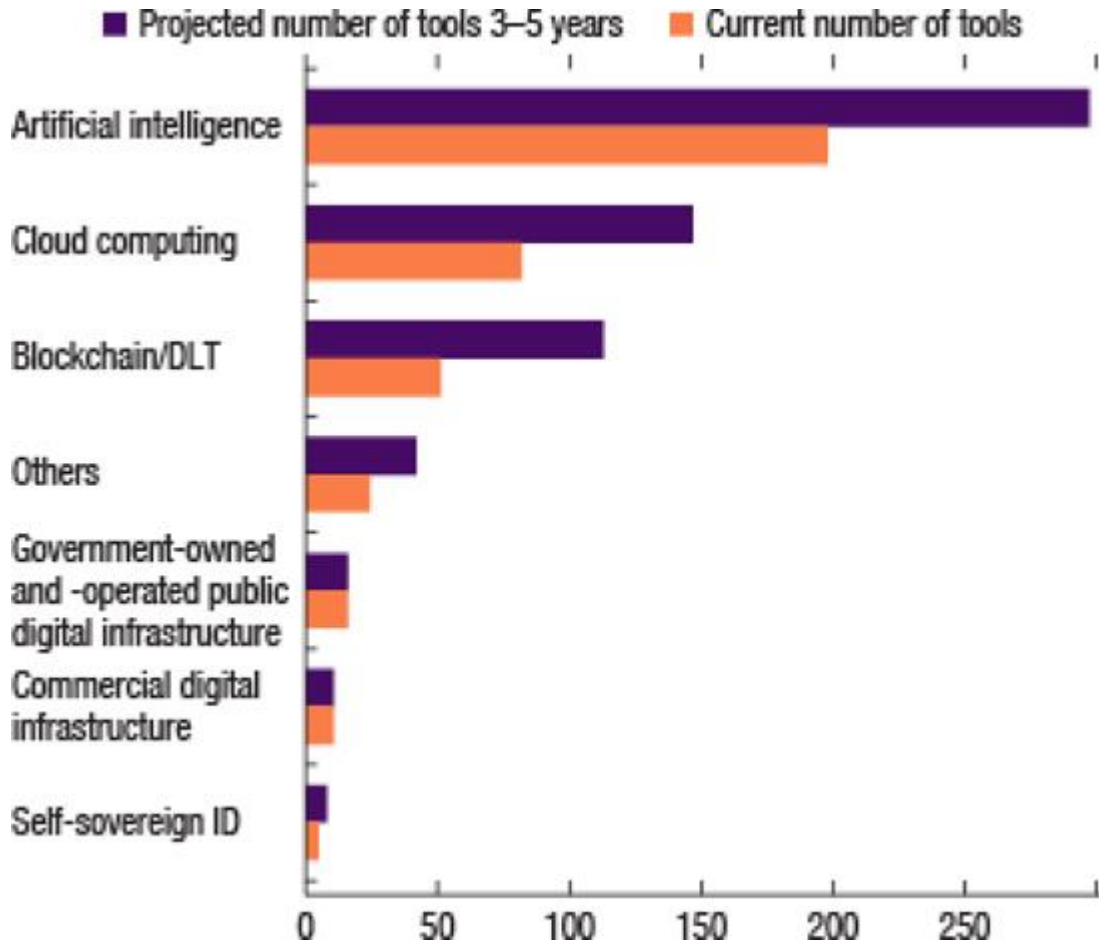

Figure 2 The technology used in supervisory tools (Financial Stability Board, 2020).

Regarding technologies used in supervisory tools, AI topped with both current and projected use in 3-5 years. This was followed by very low levels of both in the case of cloud computing and bl/DLT. The use of these technologies by government-owned and operated public digital infrastructure was very low levels of both.

A joint survey was conducted by the World Economic Forum (WEF, 2020) and the Cambridge Centre for Alternative Finance (CCAF). The survey, which had 151 responses from various sectors in the financial services industry, revealed that artificial intelligence (AI) is expected to become a crucial driver of business in the industry shortly. While AI is currently seen as more relevant to fintech companies, incumbents are striving to catch up within two years. The adoption of AI is expected to have a broad impact on key business functions, including new product development, process automation, risk management, customer service, and client

acquisition. Currently, only 16% of respondents use AI in all of these areas. Risk management has the highest current AI implementation rate, followed by new revenue generation through AI-enabled products and processes. AI is predicted to be a significant factor in the success of specific sectors, such as asset management for investment returns and credit analytics for lenders. Fintech companies tend to use AI differently than incumbents, focusing on creating AI-based products and services and employing autonomous decision-making systems. Incumbents primarily use AI to improve existing products. Fintechs report a higher positive impact on profitability due to AI compared to incumbents. Both sectors face obstacles in implementing AI, including data quality, access to talent, and regulations. Mass adoption of AI may amplify market risks and biases, and some firms do not feel well-prepared to address these challenges. Simple machine learning algorithms, natural language processing, and computer vision are more commonly used than complex solutions. Additionally, nearly half of the participants view large technology companies leveraging AI capabilities as a major competitive threat. Table 1 outlines the AI adoption status among the firms surveyed. A mere 16% of respondents are using AI across all aspects. The area with the highest rate of current AI implementation is risk management at 56%. This is followed by leveraging AI to generate new revenue through AI-enabled products and processes, which has a 52% adoption rate. Risk management topped with 56% for already implemented firms. Generation of new revenue potential through new products/processes topped with 28% for currently implementing firms. Process engineering and automation topped 21% for firms that have not implemented but will implement in the next two years. Thus, priorities shifted for each type of AI use. Established companies mainly aim to utilise AI to enhance their existing products. This focus may contribute to why AI seems to significantly boost FinTech firms' profitability more, with 30% reporting a notable increase due to AI, compared to only 7% of traditional incumbents. By 2030, incumbents predict AI will replace around 9% of their jobs, whereas FinTechs foresee a 19% growth in their workforce due to AI. Across all sectors and types of entities, major challenges to AI implementation include data quality and access, talent acquisition, and unfavourable regulations. Widespread AI adoption is expected to amplify certain market-wide risks and biases, with at least 20% of firms feeling unprepared to counteract these issues. Simpler machine learning algorithms, natural language processing, and computer vision technologies are more commonly used than more complex AI solutions. Nearly half of all participants regard 'Big Tech '1 leveraging AI capabilities to enter Financial Services as a major competitive threat. AI adoption status of sampled firms is provided in Table 1.

Table 1. AI adoption status of sampled firms (WEF, 2020).

AI use	Implemented	Currently being implemented	Not implemented, but planning to implement in the next two years
Risk management	56%	21%	18%
Generation of new revenue potential through new products/processes	52%	28%	15%
Customer service	50%	24%	15%
Process re-engineering and automation	47%	26%	21%
Client Acquisition	46%	23%	15%

A comparison of incumbent and fintech firms is provided in Fig 3. Fintechs had been way ahead of incumbents in terms of already implemented and currently implementing status in all business domains. The slow adoption of AI by incumbents in all business domains is reflected by its higher percentage of not being implemented yet but may do so in the next two years.
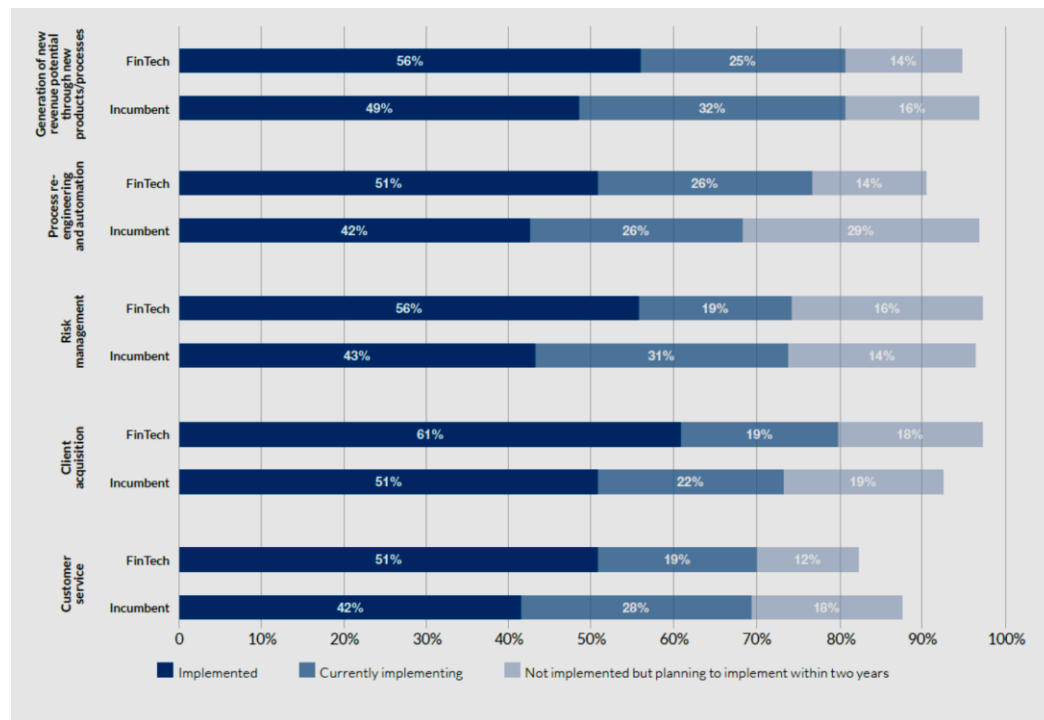

Figure 3 Comparison of incumbent and fintech firms *(WEF, 2020).*

As Fig 4 shows, AI currently not highly or lowly important, becomes very important in the next two years in terms of significantly increasing percentage of the latter.
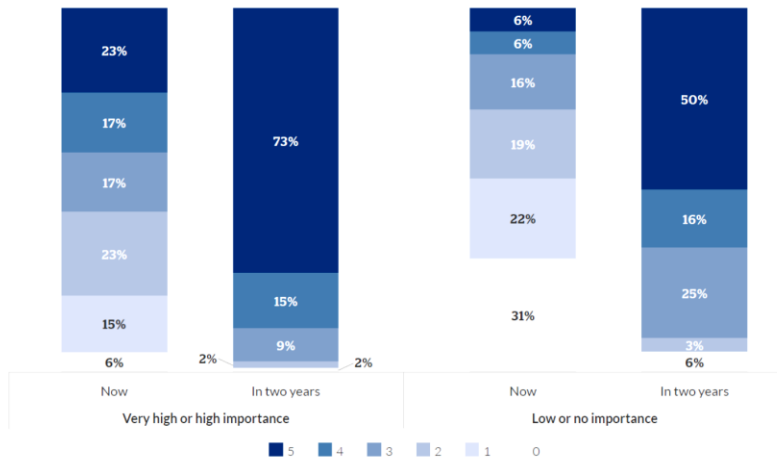

Figure 4 The importance status of AI in various business domains *(WEF, 2020)*.

There is a positive relationship between the percentage of R&D expenditure on AI and the firms' profitability as shown in Fig 5.
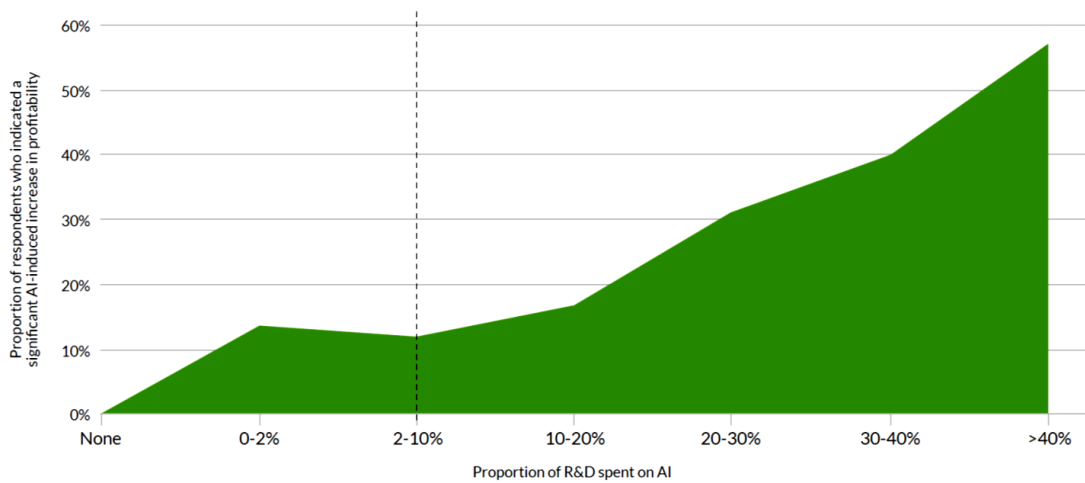

Figure 5 Relationship between percentage R&D expenditure on AI and profitability *(WEF, 2020)*.

The increasing importance of AI in important financial sectors is evident from the data presented in Fig 6.
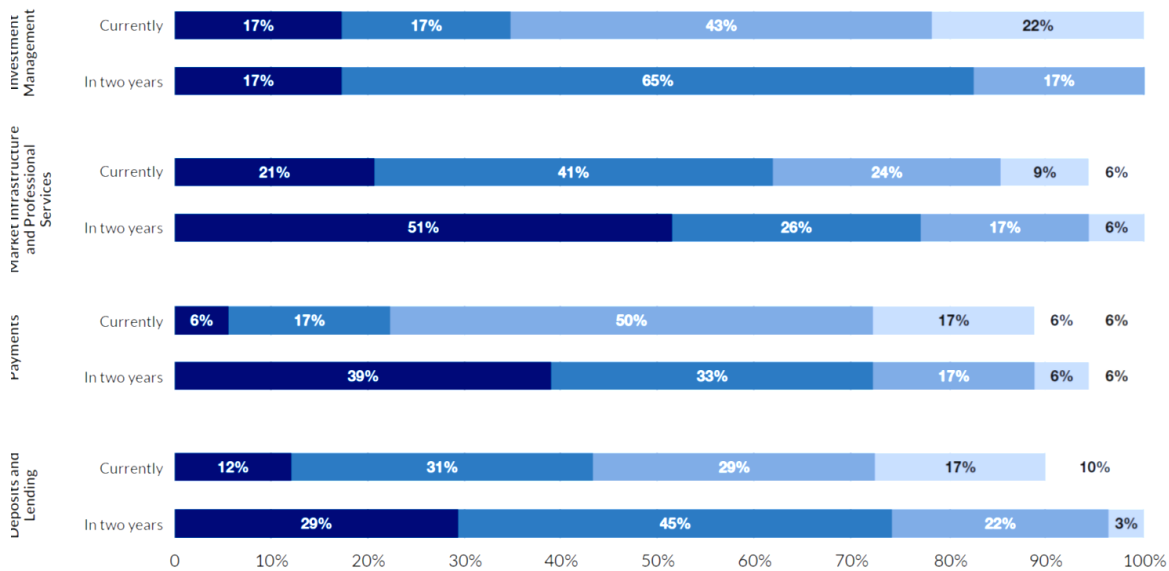
Figure 6 Increasing importance of AI in important financial services sectors *(WEF, 2020)*.

Many obstacles to the adoption and implementation of AI were identified by the survey respondents. They are presented in Fig 7. The data-related obstacles are the quality of data, access to data and systematic bias of data. The implementation-related obstacles are access to talent, trust and user adoption of AI, technological maturity, market uncertainty and cost of hardware/software.
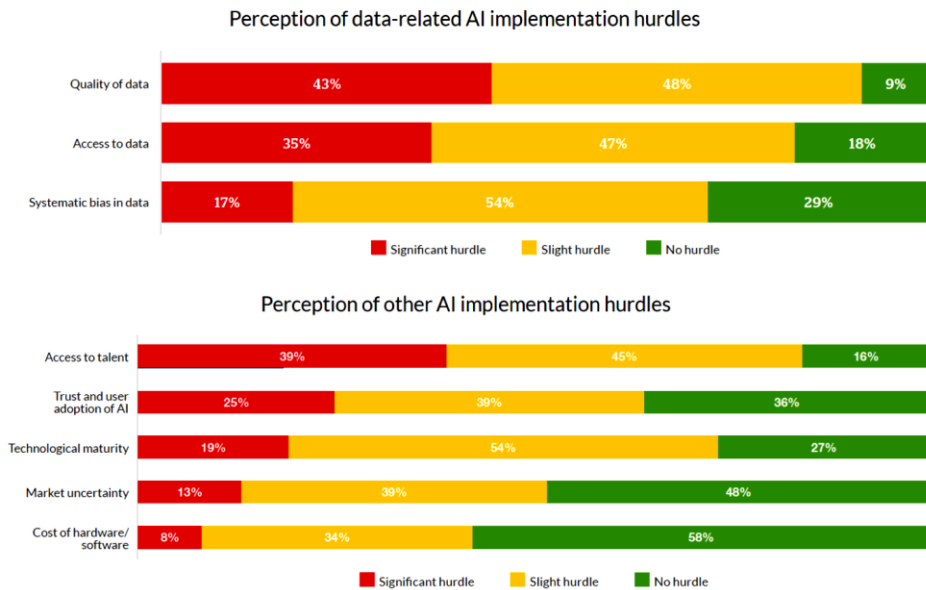

Figure 7 Obstacles to the implementation of AI *(WEF, 2020)*.

The impact of AI implementation on jobs in the case of incumbents and fintechs is presented in Fig 8.
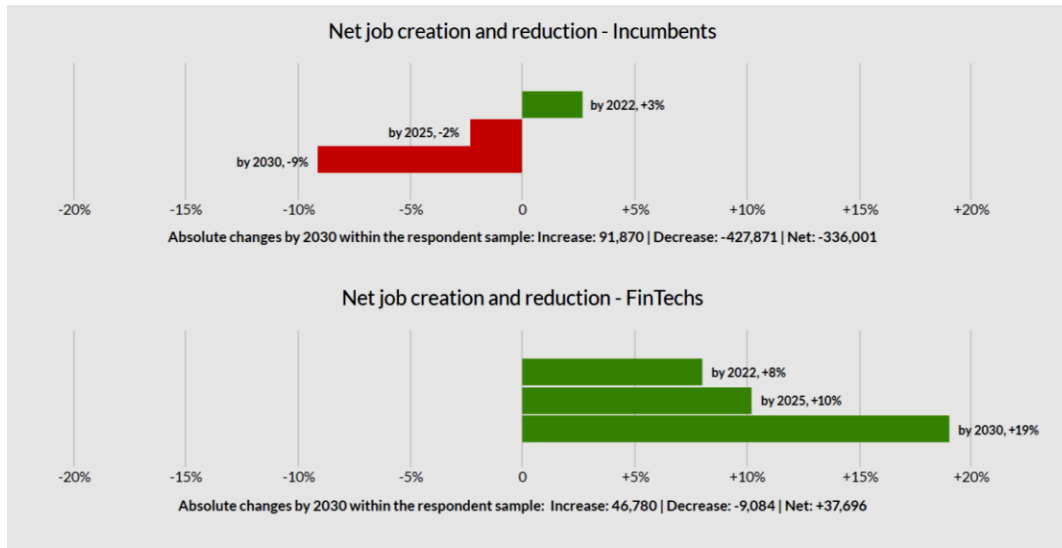

Figure 8 Impact of AI implementation on jobs in incumbents and fintechs *(WEF, 2020).*

By 2030, an 8% reduction in jobs is estimated for incumbents, and a 19% increase is calculated for fintechs.

The relative extent of market-wide and firm-specific risks by AI adoption varied with the type of risk, competitive impact of AI adoption and organisation-specific factors. The risks are privacy breaches, cyberattacks, exacerbating biases and discrimination, systemic risks, market-wide concentration risks, market uncertainty and geographical region. Firms perceived methods of risk management in different ways. AI implementation for risk management was one method for about one-third of the firms.

While 47% of incumbents perceived regulation as a hindrance to AI implementation, only 36% of fintechs perceived so. By sector, only payment services were not hindered by regulations. Different regulatory frameworks have different levels of burdens and different AI maturity levels. There are regional differences in supporting regulations. EU, except the UK and China, consider it as a significant advantage. Incumbents perceived sharing information with law enforcement agencies more favourably than fintechs.

About 88% of participants used different methods of supervised learning, 54% unsupervised learning and 51% reinforced learning. Regarding hardware, fintechs preferred cloud computing, and incumbents preferred local GPUs.

Using a mixed approach of an online survey of 120 participants from financial firms and qualitative document analysis, El Hajj and Hammoud (2023) revealed the growing adoption of AI and ML applications in algorithmic trading, risk management, fraud detection, credit scoring,

and customer service. Qualitative analysis revealed challenges and barriers to adoption, the role of regulation, workforce transformation (job losses and gains), and ethical and social considerations (algorithmic bias, fairness and transparency). The challenges were high implementation costs, data and infrastructure deficits, privacy issues, and regulatory compliance requirements. A strategically inclined organisational culture and leadership are essential to overcome these challenges. Regulatory settings with clear guidelines and international collaborations to address cross-border issues were suggested.

A survey (Ahmadi, 2024) by revealed that the impact of AI and big data analytics was higher in the case of stock markets than in the case of banking and insurance sectors indicating the extent of AI adoption in these sectors. The paper does not say from where the participants were sampled and the number of participants responded to the survey.

What are the applications of AI and ML in finance?

AI in finance can be applied in five general areas: personalise services and products, create opportunities, manage risk and fraud, enable transparency and compliance, automate operations and reduce costs.

A bibliographical review by Lakhchini, et al. (2022) showed that AI and ML could be used for (1) Portfolio Management and Robo-Advisory, (2) Risk Management and Financial Distress (3), Financial Fraud Detection and Anti-money laundering, (4) Sentiment Analysis and Investor Behaviour, (5) Algorithmic Stock Market Prediction and High-frequency Trading, (6) Data Protection and Cybersecurity, (7) Big Data Analytics, Blockchain, FinTech.

In the finance industry, AI and ML facilitate more efficient information processing, assessment of credit quality, price and market insurance contracts, automate client interaction, market impacts of financial trading, optimising trading execution to maximise returns from investments by hedge funds and stock market brokers and for regulatory compliance, surveillance, data quality assessment, and fraud detection. Network effects and scalability may lead to dependence on third parties. Some unexpected interconnections between financial markets and institutions may happen (Financial Stability Board, 2017).

The CRS report by Tierno (2024) recognises financial intelligence, credit underwriting, chatbots for customer interactions, RegTech, capital market applications, asset management and trading applications of AI and ML in the financial sector.

A bibliometric analysis by Bahoo, et al. (2024) identified predictive/forecasting systems, classification detection/early warning systems, big data analytics/data mining/text mining, algorithmic trading/trading models, natural language processing/sentiment analysis, artificial neural networks, robo-advisory, modelling, digitalisation/digital technology as the AI applications in the finance sector.

What are the impacts/outcomes of using AI and ML in finance?

The impacts of AI and ML in finance are increased operational efficiency, evidence-based predictive analysis and decision-making, improved customer experience, and better risk management (Hidayat et al., 2024).

According to Kanaparthi (2024), the impacts of AI, ML and blockchain in finance are a reduction in accounting expenses, high precision, real-time financial reporting capabilities, increased speed of auditing processes, automation of repetitive financial accounting tasks, and optimising staff requirements to reduce costs. These positive impacts motivate financial firms to increasingly adopt AI, ML and blockchain technologies in their financial operations.

Analysis of 115 annual reports of 15 Jordanian banks by Shiyyab, et al. (2023) revealed that AI has a positive effect on accounting performance in terms of ROA and ROE and a negative impact on total expenses, thus improving revenue and reducing costs.

Using a literature review and case studies of some financial institutions, Adeyeri (2024) identified positive economic impacts of increased productivity, cost savings, enhanced accuracy, and better customer service and negative impacts of job displacement, security and privacy concerns, and economic inequality.

Based on a literature review, Zakaria, et al. (2023) observed that AI can improve accuracy and efficiency to reduce costs and provide fresh insights into financial markets and investments. It can impact risk management. AI algorithms can analyse vast amounts of data and detect patterns and anomalies to significantly impact financial forecasting. It can predict future market movements and investment opportunities by analysing historical data, market trends, and other relevant factors.

A review and meta-analysis of 150 papers by Berdiyeva, et al. (2021) showed the positive effects of AI in accounting and finance processes. AI applications can positively impact the accounting and finance process. AI can function as an expert system and as an intelligent agent by reducing errors, increasing the efficiency of the audit process, cost-saving, and time-saving by training inexperienced accounting staff. Demand factors like requirements of financial regulation, competition with other firms, and profitability and supply factors like access to the infrastructure and the data sector and technical advances motivate the adoption and implementation of AI in financial sectors.

AI acts as a moderator to increase socially responsible investments (SRI) and a mediator to incentivise corporate social responsibility (CSR). Legal and ethical provisions are involved in the AI systems. They could act as catalysts for corporate governance reform towards sustainability (McBride, et al., 2022).

According to Jain, et al. (2024) the impacts of AI and ML in fintechs are fraud detection, credit scoring, customer service, and investment management.

AI impacts the financial sector by improving efficacy, accuracy, and inclusivity in the financial and economic landscape. In economic and financial analysis, it impacts wealth management and precise prediction of consumer behaviour. AI enables more accurate economic forecasting, improves market trend understanding, and drives data-driven decision-making. Using AI, financial institutions are better positioned to address unmet needs, like expanding credit availability and enhancing risk assessment methodologies using AI algorithms (Abu Jamie, et al., 2024).

The impacts of AI in finance include customer experiences, security protocols, risk management, operational efficiency, return on investment, and regulatory compliance. In customer-centric operations, AI-driven chatbots and virtual assistants enhance interactions with personalised and anticipatory services. To improve security, AI acts as the guardian and strengthens trust through real-time fraud detection and biometric authentication. A paradigm shift in risk management happens due to predictive analytics driving financial institutions toward strategic advantages in navigating dynamic markets. Operational excellence is achieved through automation, liberating human resources for strategic endeavours, and boosting a cost-conscious ethos. AI-driven automation tools and biometric authentication ensure transparency and accountability, as there is persistent regulatory scrutiny (Rahmani & Zohuri, 2023).

Using a review of the literature, Douglas (2024) identified the impact of AI in finance, including falling data storage costs, reduction, regulatory compliance, competitive advantage, risk management, customer experience, fraud detection and increased connectivity. It also enhances customer support, improves security through fraud detection algorithms, and enhances credit scoring accuracy through machine learning. The value creation potential of AI in banking includes building up $1 trillion of incremental value annually through personalised services, cost reduction via automation, and uncovering new opportunities.

Using a review of the literature, case studies and empirical data, Kotha and Puttewar (2023) identified the impact of AI in finance. The five case studies from India showed a 50% reduction in customer service response time, increased customer satisfaction, increased capability to handle higher numbers of customers, better credit choices, lower non-performing assets (NPAs), higher portfolio performance, fraud reduction, increase in customer trust, surpass market benchmarks, beat competition, provide better returns for clients, strengthening the platform's security, increased customer engagement, increased online selling chances and enhanced customer happiness. These impacts resulted from AI driving innovation, enhancing efficiency and improving client experiences. Some emerging trends in the fintech sector, as well as areas emerging as new norms in banking, have been presented in Fig 9. The items in Fig 7 are self-explanatory.

Figure 9 Some emerging trends as new norms in banking *(Kotha & Puttewar, 2023).*

What problems and challenges occur when AI and ML in finance?

The challenges identified by Hidayat, et al. (2024) are ethical issues, changes in regulatory requirements, and risks related to the adoption of AI and ML.

The challenges of AI and ML implementation in finance identified by Jain, et al. (2024) are related to regulatory compliance, data privacy, and ethical considerations.

Some challenges identified by Douglas (2024) are a lack of clear strategy, legacy systems, fragmented data assets, cyberattacks, voice cloning and fraud. The solutions may be the promotion of a growth mindset and responsible AI deployment.

Some challenges identified by Kotha and Puttewar (2023) were cultural aspects, existing regulations, data availability, talent acquisition, and regulatory frameworks.

Some opportunities and challenges and how they affect the financial stability of AI adoption in four areas of finance, financial intermediation, insurance, asset management and payments are given in Fig 10 from Aldasoro, et al. (2024).

		Financial Intermediation	Insurance	Asset management	Payments
Traditional analytics	Opportunities	Rule-based risk analysis, greater competition		Risk management, portfolio optimisation, automated and HF trading	Fraud detection
	Challenges	Rigid, requires human supervision, small number of parameters, threats to consumer privacy, emergence of data silos		Zero-sum arms races flash crashes	Technical vulnerabilities
	Financial Stability	Herding, cascade effects and flash crashes, such as the US stock market crash of 1987			
Machine Learning	Opportunities	Credit risk analysis, lower underwriting costs, financial inclusion	Insurance risk analysis, lower processing costs, fraud detection	Analysis of new data sources, high frequency trading	New liquidity management tools, fraud detection and AML
	Challenges	Black box mechanisms, algorithmic discrimination		Zero-sum arms races, model herding, algorithmic coordination	New liquidity crises, increased cyber risks
	Financial Stability	Herding, network interconnectedness, lack of explainability, single point of failure, concentrated dependence on third party providers			
Generative AI	Opportunities	Credit scoring (unstructured data), easier back-end processing, better customer support	Better risk analysis with newly legible data, easier compliance	Robo-advising, asset embedding, new products, virtual assistants	Enhanced KYC, AML processes
	Challenges	Hallucinations, increased market concentration, consumer privacy concerns, algorithmic collusion			
	Financial Stability	Herding, uniformity, incorrect decisions based on alternative data, macroeconomic effects of potential labour displacement			
AI Agents	Opportunities	Automated design, marketing and sale of new financial products without human intervention		Increase in speed of information processing	Faster payment flows, fraud prevention
	Challenges	New risks to consumer protection, cybersecurity, potential overreliance, fraud and unforeseen risks		Cybersecurity, fraud, unforeseen risk concentration with AI agent interactions	Sudden liquidity crises, fraud with deception and unforeseen risks
	Financial Stability	Misalignment risks, inherent unsuitability of AI agents for aspects of macroprudential policies			

Figure 10 Opportunities, challenges and financial stability in four areas of finance *(Aldasoro, et al., 2024)*.

Discussion

Many papers are available to answer the four research questions of this review. However, only 26 papers were used due to the consideration of the length of this paper. All research questions were answered satisfactorily by the papers discussed under the questions.

To what extent AI and ML have been adopted globally in finance?

Although both incumbents and fintech firms use AI and ML for similar purposes, the extent of use is higher in the case of fintech. Implementation of these technologies is only going to increase shortly as considerable business value is created by implementing them. The current use levels of AI methods are much higher than those considered to be used in the next two years. Only a small percentage of financial institutions use all AI and ML tools, and it may not be necessary to use all. Mass adoption can exaggerate market risks. There is little doubt that AI and ML implementations will lead to higher profitability for financial organisations if they care about addressing challenges. Obstacles and risks of various types at the organisational level, internet level or AI/ML technology levels can demotivate the adoption of AI and ML in finance. There are a lot of discrepancies in the methodology and estimation of the extent of AI and ML adoption, leading to widely differing values in different papers.

What are the applications of AI and ML in finance?

Many applications of AI and ML in finance have been identified. They can be divided into six categories: personalise services and products, create opportunities, manage risk and fraud, enable

transparency and compliance, automate operations and reduce costs. These categories were expanded and discussed by the papers cited in this section.

What are the impacts/outcomes of using AI and ML in finance?

Using AI and ML in different ways for different purposes leads to impacts/outcomes at the organisational or customer level. The impact of these technologies in the entire finance sector of a nation largely contributes to its economy. This focal theme has been expanded in the papers cited in this section.

What problems and challenges occur when AI and ML in finance?

Problems and challenges related to ethics, customer trust, cyberattacks, regulatory compliance, talent acquisition and even culture, in some cases, have been discussed in the cited papers. Similarly, many opportunities have also been discussed in these papers; of particular note is the table of challenges, opportunities and their net impact on the financial stability of the organisation presented by Aldasoro et al. (2024).

Conclusion

This review showed the extent of AI and ML adoption in finance is high and increasing rapidly. Fintech firms dominate over incumbents in all respects. Many new applications of AI and ML are being integrated into the financial services sector. The future is bright for AI and ML in finance.

The various applications of AI and ML in finance can be categorised into personalised services and products, creating opportunities, managing risk and fraud, enabling transparency and compliance, automating operations and reducing costs. These applications have different impacts/outcomes on the organisation, customers and the government.

The adoption and implementation of AI and ML in finance are subject to many challenges and problems. The main challenges are ethics, customer trust, cyberattacks, regulatory compliance, talent acquisition and culture. There are many opportunities also. To utilise the opportunities, challenges need to be addressed using appropriate methods.

Overall, the adoption and implementation of AI and ML in finance is an exciting development affecting the global population in various ways.

Limitations

Although many more papers are available, only 26 were used for this review owing to limitations on the length of the paper.

Google and Google Scholar were used to select papers rather than databases. This limited the scope of selection.

The research questions were used as search terms. This also limited the scope of the literature search.

A better method might have been a PRISMA-based procedure with a meta-analysis of the data in the papers. This can be a future research attempt.

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