BCT Journal

Journal of Business, Communication & Technology

Challenges and Opportunities of the Financial Service Industry in the Wake of the Fourth Industrial Revolution: A Systematic Review

Bronson Mutanda[1]*, Bomi Cyril Nomlala[2]

[1]Manicaland State University of Applied Sciences, Zimbabwe, [2]University of KwaZulu-Natal, South Africa

Abstract The rapid integration of fourth industrial technologies to meet the demands of the evolving financial landscape and customer needs is fundamentally transforming the financial services industry, creating both significant opportunities for innovation and substantial challenges. In light of this background, this study investigates challenges and opportunities realized by financial sector companies in the wake of the fourth industrial revolution. To achieve the objectives, a systematic literature review was conducted, with PRISMA used for document screening. The study examined 51 research articles published between 2015 and 2025 inclusive. NVivo 12 was used to identify and present key themes from the analyzed documents. A literature survey conducted revealed eight challenges brought out by digital transformation in the context of the fourth industrial revolution. Literature also revealed 12 opportunities that came as a result of the integration of fourth industrial revolution technologies into the financial sector. In light of these findings, it is prudent for the financial service industry to collaborate with training institutions and facilitate the introduction of new curricula that take note of changes in technology. In addition, firms in the financial sector need to invest in acquiring digital infrastructure as a strategy for surviving the competition brought out by the fourth industrial revolution.

Keywords: *Fourth industrial revolution, Financial sector, Blockchain, Artificial intelligence, Cryptocurrencies*

***Corresponding Author:**
Bronson Mutanda
valemutanda@gmail.com

Received: September 25, 2025
Revised: November 22, 2025
Accepted: December 15, 2025
First Published: December 27, 2025

1. Introduction

The financial sector has seen the emergence of new technologies, sparking a rapid transformation that is redefining traditional industries globally (Machkour & Abriane, 2020). This digital shift is known as the fourth industrial revolution or Industry 4.0, building on previous technological advancements like Industry 3.0, 2.0, and 1.0 (Cannavacciuolo et al., 2023). The fourth industrial revolution is characterized by technological advancements that catalyze societal and industry-wide change, aiming to integrate physical assets into linked digital and physical processes, creating intelligent manufacturing environments and smart factories (Aghimien et al.,

2020). This revolution is marked by the virtualization and networking of intelligent industrial devices, driving a profound global shift . The goal of the fourth industrial revolution is to maximize mobility, exchanges, and communication among all information systems as well as production capacities. With the power of digital automation, the fourth industrial revolution, also referred to as the transition from a time when people worked with computers to a time when computers work without humans, is digitally revolutionizing a number of industries (Machkour & Abriane, 2020).

As the global economy becomes increasingly digital, consumer preferences are constantly changing, forcing businesses globally to adjust their strategies to remain relevant and avoid becoming obsolete. The majority of consumers across all sectors of the global economy have drastically shifted to digital services as a way of accessing fast and efficient services (Reinartz et al., 2019; Schweidel et al., 2022; Torkington, 2021). The financial sector is not an exception, as the majority of consumers, especially in developing and emerging countries, are going for digital financial services. Most tech-savvy financial services consumers now prefer accessing financial services from home, rather than visiting physical bank branches (Valenti & Alderman, 2021). Among the technologies that the global financial sector is utilizing in the aftermath of the fourth industrial revolution are fintech innovations, digital banking, and blockchain technology. In addition, artificial intelligence (AI), cloud computing, internet of things, and application programming interfaces have also become more prevalent in the financial sector of the economy (Ridzuan et al., 2024). With these technologies, personalization of banking has increased dramatically since 2015 and is now almost expected by the majority of customers. Customers in the financial sector are increasingly looking for banks that utilize AI to offer individualized services and guidance, like classified breakdowns of their outgoings, investment advice, and safe spending strategies (Peirce, 2025).

The financial sector's digital transformation is accelerating, with global FinTech investments reaching $164 billion in 2022, driving growth in areas like AI-powered risk management and blockchain (Ally et al., 2025). The integration of the fourth industrial revolution in the financial sector has sparked a debate among scholars and practitioners, with some viewing these technologies as beneficial and others highlighting their drawbacks. As these technologies are now an integral part of the financial sector, it is crucial for the banking sector to understand the opportunities and challenges they present. This study aims to synthesize existing literature and examine the opportunities and challenges associated with adopting fourth industrial revolution technologies in the financial services sector, addressing the following research questions (RQ):

RQ1: What are the opportunities presented by fourth industrial revolution technologies to the financial sector?
RQ2: What are the challenges presented by fourth industrial revolution technologies to the financial sector?

Understanding the opportunities presented by fourth industrial revolution technologies (RQ1) is essential for financial institutions to capitalize on the benefits of digitalization. On the other hand, recognizing the challenges posed by fourth industrial revolution technologies (RQ2) is vital for financial institutions to mitigate potential risks and address vulnerabilities. Addressing these research questions will provide financial institutions, policymakers, and regulators with a comprehensive understanding of the impact of fourth industrial revolution technologies on the financial sector. This knowledge will inform the development of effective strategies, policies, and regulations, enabling stakeholders to harness the benefits of fourth industrial revolution technologies while minimizing the risks.

2. Methodology

2.1. Search Strategy

The Preferred Articles for Systematic Review and Meta-Analysis (PRISMA) was used to search, retrieve, and choose documents for the study. This systematic review of the literature took into consideration all research articles published between 2015 and 2025. It is widely accepted that technologies of the fourth industrial revolution gained wide acceptance into the business landscape after 2011 (Philbeck & Davis, 2018). This explains why researchers decided to access documents published

between 2015 and 2025 inclusive. Articles for this study were gathered from the Scopus database through the use of a combination of search Boolean Operators AND/OR. The search terms used for the study are: *("fourth industrial revolution" OR 4IR OR "emerging technologies" OR blockchain OR "artificial intelligence" OR AI OR "cloud computing" OR "internet of things" OR IoT) AND (challenges OR opportunities) AND ("banking sector" OR "banking industry" OR "Financial sector")*. The terms were used because they are part of the fourth industrial revolution technologies.

2.2. Document Inclusion and Exclusion Criteria

Document inclusion criteria took many steps, with documents published between 2015 and 2025 inclusive being considered for the study. The initial search from the Scopus database retrieved 1047 documents. The researchers utilized the Scopus database system, which enables filtering of documents based on specific criteria, to narrow down the search results. A range of filtering criteria was applied to refine the document selection. All retrieved documents were screened using the year of publication, subject, document type, stage of publication, and language of publication. This process led to the elimination of 810 documents, and 237 documents remained. The filtering strategy involved considering papers from specific fields, including Computer Science, Business, Management and Accounting, Economics, Econometrics, and Finance. Additionally, researchers applied a document type filter, limiting the selection to research articles only, which further narrowed down the pool of relevant documents. This deliberate selection of research articles was made to gather empirical evidence on the opportunities and challenges faced by the banking sector in the context of the fourth industrial revolution, ensuring that the study's findings are grounded in concrete data and real-world experiences. The language of publication was also used for screening, with documents published in English being considered. The search string, as copied from the Scopus database, is shown below:

TITLE-ABS-KEY ((("fourth industrial revolution" OR 4ir OR "emerging technologies" OR blockchain OR "artificial intelligence" OR ai OR "cloud computing" OR "internet of things" OR IOT) AND (challenges OR opportunities) AND ("banking sector" OR "banking industry" OR "Financial sector"))) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))

2.3. Document Extraction and Screening

Documents that passed the first screening and filtering stage were exported to a Microsoft Excel Sheet via CSV for further screening through reading of the abstracts. The final screening stage involved a thorough review of abstracts to assess alignment with the current study's research questions. Studies were eligible for inclusion in this research if they specifically examined the opportunities and challenges presented by fourth industrial revolution technologies within the financial sector. All documents that did not speak to the opportunities and challenges in the financial sector were not considered. A coding system was employed, where relevant papers were marked "1", irrelevant papers "0", and those requiring further review "2". This process allowed researchers to identify documents that would be used for the study.

2.4. Data Reliability and Data Quality

Data reliability refers to the completeness and accuracy of data as a measure of how well it can be counted on to be consistent and free from errors across time and sources (Reynolds et al., 2021). To ensure the reliability of document screening, researchers worked independently during the process. This rigorous process ultimately led to the selection of 51 research papers for this study. After the whole process of screening the documents, a Cohen's Kappa coefficient was calculated to ensure inter-rater reliability, yielding a high agreement score of 0.925. The Scopus database was selected for its credibility and comprehensive indexing of high-impact journals, ensuring the inclusion of reliable and trustworthy sources in the research.

2.5. Data Analysis

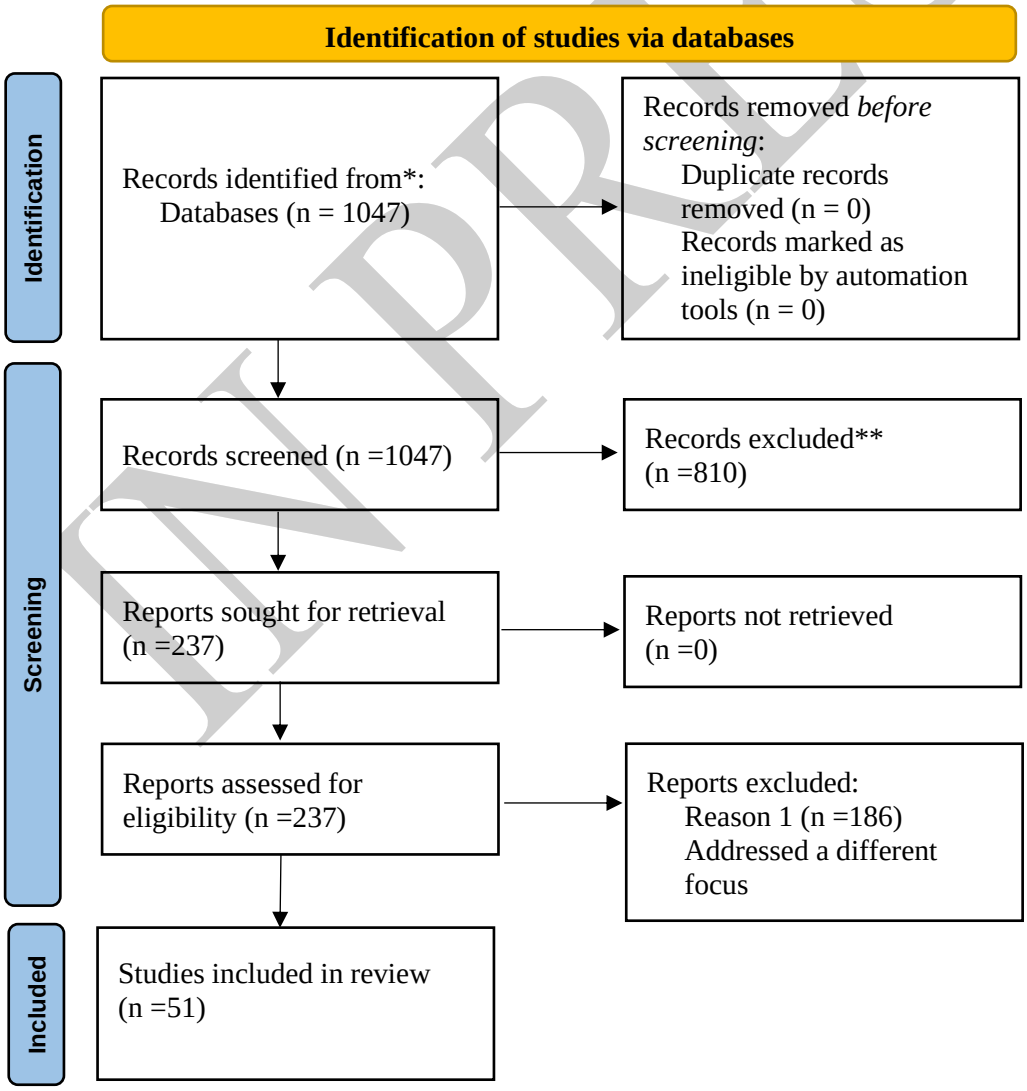
The data analysis process involved a thorough review of the abstracts from the selected documents to identify recurring themes. To allow an analysis using NVivo 12, all the abstracts of the accepted documents were copied into a single document. After this process, the document with all the abstracts was imported into NVivo 12. The researcher read each abstract in full and created memos and annotations to capture initial impressions and analytic notes. Using NVivo 12, the researcher conducted open coding by highlighting meaningful units of text and assigning them to Nodes. Codes were created inductively, directly from the data, rather than from a predetermined framework. Codes were compared and refined within NVivo 12. Similar codes were merged, and broader conceptual categories (parent nodes) were created to cluster related codes. In order to present the themes that were later approved as final themes, NVivo's Mind Map tool supported the visualization and refinement of these emerging thematic structures. The resulting themes were used to create a thematic map (shown in Figure 5) through NVivo 12, facilitating data visualization and further analysis.

2.6. Document Retrieval, Screening, and Inclusion Process

Figure 1 is a flowchart indicating how documents for this study were gathered and how filtering was done to retain the required documents.

Figure 1

The PRISMA Process Adopted in Screening Literature for Analysis



Following the search, 1047 articles were retrieved, and a rigorous filtering process was applied, resulting in the elimination of 990 documents. The whole process of screening and filtering of the research paper eliminated 990 documents, leaving 51 documents for this research paper.

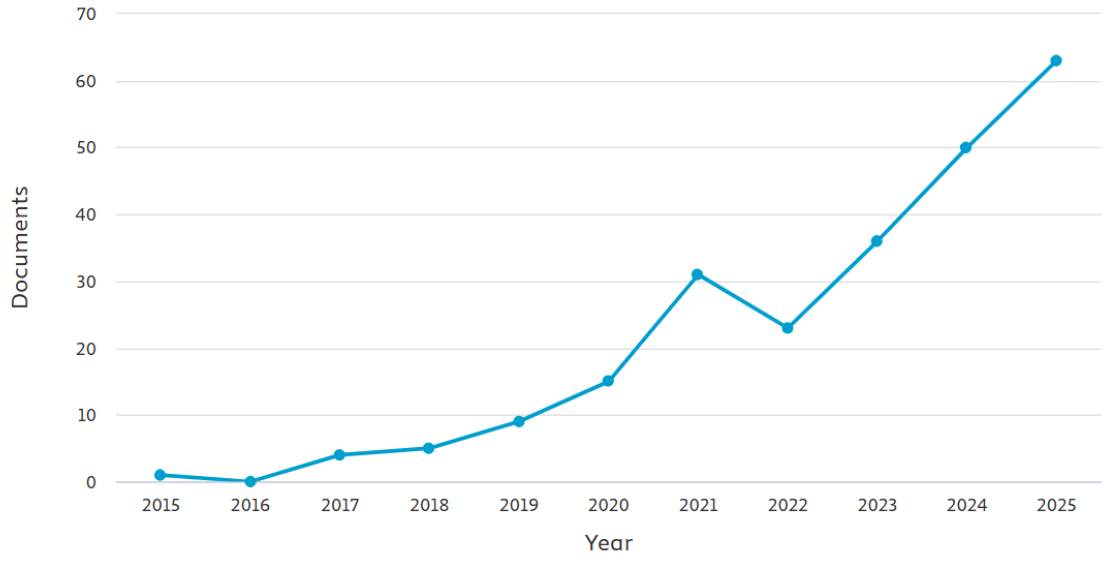
3. Results

As illustrated in Figure 2, there has been a steady increase in the number of articles published on the challenges and opportunities facing the financial sector as it navigates the fourth industrial revolution.

3.1. Publications by Year

The publication trend shows a slow start, with only one article in 2015, followed by a gap in 2016. However, a significant surge in publications occurred from 2019 onwards, coinciding with the COVID-19 pandemic. This uptick is hardly surprising, given the pandemic's role in accelerating digital transformation across industries, including financial services. The steady increase in publications since 2019 reflects the growing attention from scholars and the financial industry, highlighting the sector's recognition of these technologies' potential. As lockdowns forced clients to go digital, the need for technological integration became pressing, driving interest in fourth industrial revolution technologies. The dip in publications in 2021 likely reflects a shift in focus as lockdowns eased, with businesses balancing physical and digital services. However, the rebound in 2022 suggests emerging technologies gained renewed attention, with both the financial sector and academia intensifying their focus on these innovations, acknowledging their lasting impact. This trend generally means that the COVID-19 pandemic accelerated the adoption and use of fourth industrial revolution technologies, and this triggered an interest among scholars to carry out studies on their impact on the financial sector.

Figure 2
Publications by Year



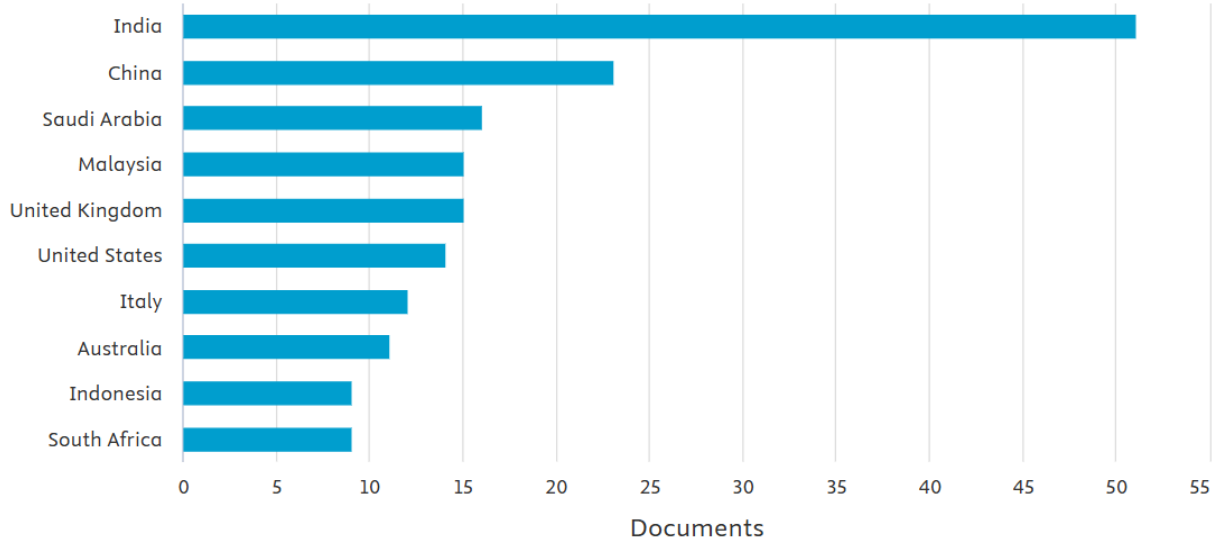
3.2. Country or Territory of Publication

Figure 3 highlights the global scope of research on the challenges and opportunities of the fourth industrial revolution, with studies conducted in diverse countries such as India, China, Australia, France, Saudi Arabia, the United Kingdom, Malaysia, South Africa, Indonesia, the United Arab Emirates, and Morocco. India's high number of publications on emerging technologies can be attributed to its position as a global leader in adoption, not just in Asia but worldwide. A Deloitte survey (2024) reveals India is a frontrunner in Generative AI use and adoption among 13 countries in Asia. This is further supported by Singh (2025), who notes India's adoption rate is around 33%, surpassing the global average of 29%. This widespread adoption likely contributes to India's significant research output on the topic, exceeding that of other countries. China, Indonesia, Malaysia, and Saudi Arabia's notable

research output on emerging technologies likely stems from their status as emerging economies with rapidly growing economies. Their economic prospects position them favorably for adopting these technologies, driving interest and research in the field, and resulting in a substantial number of publications. The United Kingdom, the United States of America, and Italy, being developed countries with robust economies and advanced financial systems, are likely to drive a notable research output on emerging technologies. As leaders in technological innovation, they are probably fueling a notable volume of research on emerging technologies in the financial sector. Notably, the presence of both developed and developing countries (South Africa) in this list underscores the universal relevance of this issue, affecting banking sectors worldwide. The fourth industrial revolution is an undeniable reality that requires attention and adaptation from the global financial system, driving the surge in research efforts across the globe.

Figure 3

Publications by Territory or Country



3.3. Data Extraction Instrument

The data extraction instrument, as outlined in Table 1, lists the papers used in this study, capturing essential details such as author names, publication date, study purpose, citation count, and key findings. This comprehensive approach enabled a thorough assessment of each paper's relevance to the study's objectives. The inclusion of citation count is particularly noteworthy, as it serves as a proxy for the paper's impact and influence within the academic community, lending credibility to the study's findings.

Table 1

Data Extraction Instrument

No	Author, date	Title of article	Aims/purpose	Citations	Key findings
1	Rahim (2025)	Revolutionizing the Shariah secretariat function through artificial intelligence: Prospects and challenges for Malaysia's Islamic banking sector	To examine the potential and challenges of integrating AI in revolutionising the Shariah Secretariat function in Malaysia's Islamic banking sector.	0	AI provides an opportunity for automating tasks and regulatory reporting, which improves efficiency and compliance. Challenges include the high cost of implementation, addressing ethical issues, and the need for clear legal and regulatory frameworks for AI in Islamic banking.

2	Damaris et al. (2025)	Data governance for artificial intelligence implementation in the financial sector: An Indonesian perspective	To explore the need for Indonesia to establish a comprehensive and forward-thinking data governance framework tailored to AI implementation in the financial sector.	1	While AI presents immense opportunities for innovation and efficiency, it also poses complex challenges in data governance.
3	Gaviyau & Godi (2025)	Banking sector transformation: Disruptions, challenges and opportunities	To trace the evolution of banking and examine associated disruptions, opportunities, and challenges.	1	Challenges include regulations, skills shortages, legacy systems, and cybersecurity that must be addressed.
4	Abdallah-Ou-Moussa et al. (2025)	Blockchain, cryptocurrencies, and decentralized finance: A case study of financial inclusion in Morocco	To examine the potential role of cryptocurrencies and DeFi in enhancing financial inclusion in Morocco	1	Cryptocurrencies offer cost-efficient financial transactions and improved accessibility, but their adoption may be constrained by regulatory uncertainty, security risks, and technological limitations.
5	Patil et al. (2025)	Securing financial systems through data sovereignty: A systematic review of approaches and regulations	To investigate existing approaches for securing financial systems through machine learning, legal frameworks, and regulations.	1	AI and machine learning technologies offer significant potential for enhancing financial security.
6	Chand et al. (2025)	The impact of financial technology (Fintech) on bank risk-taking and profitability in small developing Island States: A study of Fiji	To examine the impact of FinTech on bank risk-taking and profitability in the small island economy of Fiji	1	FinTech development significantly reduces bank risk-taking and enhances profitability.
7	Kariuki et al. (2025)	Internet of things on banking processes in south africa: A systematic reflection on innovations, opportunities and challenges	To examine IoT's influence on banking processes in South Africa.	2	Most banks have enhanced their customer experiences through IoT innovations, enhanced their security systems, and enhanced their data access ecosystem to improve their operational efficiency.
8	Manta et al. (2025)	Banking transformation through FinTech and the integration of artificial intelligence in payments	To explore the transformative impact of FinTech and AI on the banking sector	5	Integrating AI boosts efficiency, improves customer experience, strengthens fraud detection, and enables personalized services.'
9	Poluyan et al. (2025)	Opportunities for applying artificial intelligence by	To determine the opportunities for using AI by	0	The use of AI algorithms increased protection

		commercial organizations in data security and cyber threat monitoring	commercial organizations in the field of data protection and cyber threat monitoring.		against cyber threats by 54%,
10	Xu & Cho (2025)	Factors affecting human–AI collaboration performances in the financial sector: Sustainable service development perspective	To examine how employee skills, data reliability, trusted systems, and effective management jointly influence innovation capability and managerial performance	0	Financial services firms should upskill employees and strengthen data reliability through robust governance.
11	Sayari et al. (2025)	Artificial intelligence and machine learning adoption in the financial sector: A holistic review	To examine the potential for AI and machine learning in enhancing financial stability and productivity.	3	Challenges, including regulatory and ethical concerns, cybersecurity risks, data issues, and skill gaps
12	Awad & Ghonim (2025)	Data-driven marketing in banks: The role of artificial intelligence in enhancing marketing efficiency and business performance	To examine the role of AI in transforming marketing strategies in the banking sector	0	AI improves marketing efficiency, customer engagement, and business performance.
13	Nefla & Jellouli (2025)	Emerging technologies in finance: Challenges for sustainable finance	To map the evolving nexus between emerging technologies and finance.	4	While they enhance financial efficiency, transparency, and inclusion, and offer significant opportunities to advance sustainable finance, they also introduce risks such as cybersecurity threats, algorithmic bias, regulatory challenges, and critical barriers to long-term sustainability.
14	Khalegi et al. (2024)	Blockchain and sustainable finance: Enhancing transparency and efficiency in green investments	To analyse the possibilities of using blockchain technology to increase transparency and efficiency in sustainable finance.	13	Blockchain improves international transfer processes, increases the transparency of financial transactions, and simplifies the management of smart contracts, addressing existing challenges such as scalability and legal issues.
15	Vucinic & Luburic (2024)	Artificial intelligence, Fintech and challenges to central banks	to examine challenges posed by financial technological development and AI to central banks, as they have to adapt to	5	Opportunities of AI include enhancing financial stability and fostering economic growth. Challenges include risks like algorithmic bias,

			the novel times dominated by electronic financial services and AI tools		cybersecurity, and potential market instability.
16	Coetzee (2018)	Strategic implications of Fintech on South African retail banks	To identify the strategic implications of Fintech on South African retail banks.	55	New competitors are entering the fray and offering competitive digital-only solutions
17	Liu et al. (2024)	AI-driven financial analysis: Exploring ChatGPT's capabilities and challenges	To investigate ChatGPT's applications in financial reasoning and analysis	7	While Chat GPT plays a significant role in financial reasoning, it struggles with deep analytical and critical thinking tasks, especially in specialized finance areas.
18	Lytvyn et al. (2024)	Integration of digital means in the financial sphere: The potential of cloud computing, blockchain, big data, and AI	To conduct an in-depth analysis of the potential of cloud computing, blockchain, big data, and AI technologies in the context of their impact on the financial sphere.	9	AI enables banks to increase efficiency, reduce costs, and improve customer service. Challenges of implementing new technologies in the financial sector include the absence of a unified regulatory framework, high costs associated with transitioning to digital platforms, and resistance from traditional players.
19	Kayani & Hasan (2024)	Unveiling cryptocurrency impact on financial markets and traditional banking systems: Lessons for sustainable blockchain and interdisciplinary collaborations	To understand the nuanced dynamics, repercussions, and potential future paths of this shifting financial environment in the UK and the USA.	51	The advent of DeFi, smart contracts, and asset tokenization offers new prospects to improve financial transactions, increase transparency, and broaden participation in the investment market.
20	Jáuregui-Velarde et al. (2024)	Financial revolution: A systemic analysis of artificial intelligence and machine learning in the banking sector	To investigate advances, challenges, and approaches of AI and machine learning in the banking sector.	10	Emerging technologies are used in the banking sector for customer segmentation, credit risk analysis, recommendation, and fraud detection.
21	Naser et al. (2024)	The impact of Fintech innovation on bank's performance: Evidence from the Kingdom of Bahrain	To investigate the impact of bank-level Financial Technology (Fintech) innovations on banks' performance in the Kingdom of Bahrain	7	FinTech innovations increase banks' performance.

22	Al-Dosari et al. (2024)	Artificial intelligence and cyber defense system for banking industry: A qualitative study of AI applications and challenges	To explore the impacts of AI on the cybersecurity of banks in Qatar	58	AI is a major tool for enhancing the cybersecurity of banks in Qatar; (2) banks face challenges in using AI for improving cybersecurity.
23	Chang et al. (2020)	How blockchain can impact financial services – The overview, challenges, and recommendations from expert interviewees	To present three critical challenges as well as three ethical issues about using Blockchain technology.	437	Blockchain technology can significantly benefit financial services by improving efficiency, security, and reducing costs through streamlining processes and automation. Challenges, notably in regulatory compliance, technical integration with existing systems, scalability, and privacy concerns.'
24	Anwar et al. (2024)	Understanding AI's role in the banking industry: A conceptual review	To study the shifting role of AI within the banking industry	2	AI improves operational efficiency and customer service. However, its implementation faces hurdles such as regulatory ambiguity, ethical concerns, data privacy issues, and the need for skilled personnel.
25	Hasan et al. (2023)	Big data-driven banking operations: Opportunities, challenges, and data security perspectives	To assess the role of emerging technologies in the finance sector	12	Banks need to respond to external and internal cyberattacks and manage vulnerabilities.
26	Loan (2023)	Industry 4.0 and its impact on the development of vietnamese commercial banks	To evaluate and forecast the transformation of the banking industry globally and in Vietnam.	0	Improved performance, Enhanced products and services, Increased efficiency, and Greater integration. Challenges include increased investment in technology and the need for banks to invest in employee training and talent development.
27	Yan (2023)	Research on financial field integrating artificial intelligence: Application basis, case analysis, and SVR model-based overnight	To investigate the expanding role of AI in the financial sector, focusing on its applications and impact across financial products, channels, and service methodologies.	7	Challenges include data privacy, algorithmic bias, and the need for standardized implementation frameworks. The study confirmed the benefits of AI in financial applications, such as improved risk management, fraud detection, and

					personalized customer services, driven by the need for more detailed data analysis than traditional methods can provide
28	Farooq & Waseem (2021)	Application of blockchain in e-banking transactions	To develop a model for the use of blockchain in e-banking	0	Blockchain in e-banking indicates that its use can improve security, transparency, and efficiency in transactions while reducing costs. However, significant challenges remain, including regulatory hurdles, scalability issues, interoperability with existing systems, and concerns about data privacy.
29	Ghandour (2021)	Opportunities and challenges of artificial intelligence in banking: Systematic literature review	To identify, assess, and synthesize the extant evidence about the opportunities and challenges concerning the use of AI in the banking sector.	43	Opportunities include the following: Personalized services, smart wallets, decision-making and problem-solving, customer satisfaction and loyalty, process automation, transactional security and cybersecurity improvements, and promotion of digital financial inclusion.
30	Arjun & Suprabha (2020)	Innovation and challenges of blockchain in banking: A scientometric view	To assess the effect of blockchain technologies on the banking industry	30	Blockchain enables faster transactions, reduced costs, and improved security and record-keeping, but its adoption faces challenges like implementation hurdles, the need for significant infrastructure investment, a lack of trained personnel, and regulatory uncertainties.
31	Jantoń-Drozdowska & Mikołajewicz-WoźNiak (2017)	Equilibrium	To determine the potential impact that the DLT transfer to the banking sector may have on the functioning of the Single Euro Payments Area in the future.	5	Digital technologies help in the implementation of new financial products.
32	Siminica et al. (2025)	FinTech, artificial intelligence, and European Union banks: A double-edged sword for performance?	To examine the extent to which FinTech and AI integration influences financial performance across	0	The adoption of FinTech and AI is associated with significant improvements in performance metrics.

			banks in all 27 EU member states.		
33	Banerjee & Chandani (2025)	Challenges of blockchain application in the financial sector: A qualitative study	To understand the challenges of adopting blockchain technology in the financial sector	6	Challenges include vulnerability to financial crimes and glitches, privacy issues, and geopolitical tensions due to cross-border transactions.
34	Moharrak & Mogaji (2025)	Generative AI in banking: Empirical insights on integration, challenges, and opportunities in a regulated industry	To explore managerial preparedness, regulatory compliance, and data privacy challenges in implementing generative AI	16	There is a need to balance innovation with regulatory compliance and ethical considerations.
35	Choi et al. (2025)	Enhancing fairness in financial AI models through constraint-based bias mitigation	To address the challenge of mitigating bias in loan-approval models by applying fairness-aware machine learning techniques.	1	Fairness-constrained models achieve a superior balance between fairness and accuracy.
36	Qureshi et al. (2025)	Analysis of security challenges in cloud computing adoption for the banking sector	Evaluation of the banking sector's privacy, security, and trust issues in cloud computing.	0	Challenges include data privacy, third-party risks, and regulatory compliance.
37	Wang et al. (2024)	Data privacy and cybersecurity challenges in the digital transformation of the banking sector	To investigate the challenges banks have in maintaining data privacy and cybersecurity while implementing new technologies	46	Challenges include integrating legacy systems, evolving compliance management, managing vendor risks, maintaining customer confidence, and mitigating emerging risks.
38	Sharma & Choubey (2024)	Impact of information technology on the Indian banking sector	To explore the impact of IT on the Indian banking sector	5	Rise in the level of knowledge and awareness amongst consumers post-pandemic, effectiveness of data management, security, safety, and improvement in the service quality
39	Tigges et al. (2024)	Who gets the money? A qualitative analysis of fintech lending and credit scoring through the adoption of AI and alternative data	To examine the use of AI and alternative data in fintech lending	25	AI enhances predictive proficiency, risk management, decreases default rates, enhances financial inclusion, and provides real-time creditworthiness assessment.
40	Saxena et al. 2017)	Big data and Internet of Things (IoT) technologies in	To assess opportunities and challenges of	22	Challenges in tapping these technologies include: Security,

		Omani banks: A case study	invoking Big Data and Internet of Things (IoT) technologies in Omani Banks.		infrastructure, and regulatory norms.'
41	Swathi & Pahuja (2024)	FinTech frontiers: Cloud computing and artificial intelligence applications for intelligent finance investment and blockchain in the financial sector	To analyse the use of cloud computing, AI, and blockchain technologies in transforming finance	5	Cloud computing for cost-effectiveness for financial organizations. blockchain technology enhances financial system security and transparency.
42	Rahman et al. (2023)	Adoption of artificial intelligence in banking services: An empirical analysis	to understand the importance and challenges of adopting AI in the banking industry in Malaysia	164	AI is an essential tool for fraud detection and risk prevention. The absence of regulatory requirements, data privacy and security, and the lack of relevant skills and IT infrastructure are significant challenges to AI adoption.
43	Khanna & Haldar (2023)	Will adoption of blockchain technology be challenging: Evidence from Indian banking industry	To understand the challenges likely to be faced by the Indian banking industry while adopting blockchain technology.	17	Adoption challenges include cost, skill gaps, infrastructure, and a lack of a clear strategy.
44	Pahari et al. (2023)	Adoption of AI in the banking industry: A case study on Indian banks	To investigate the adoption of and role played by AI in Indian Banks	17	Indian banks are utilizing AI-powered technologies to automate labor-intensive operations, reduce operational costs, and increase revenue growth potential.
45	Mishra & Kaushik (2023)	Application of blockchain in dealing with sustainability issues and challenges in financial sector	To investigate the issues faced in the financial sector by means of applying blockchain technology.	61	Blockchain technology is cost-effective, transparent, and more effective.
46	Ji & Tia (2022)	The effect of blockchain on the business intelligence efficiency of banks	To investigate whether blockchain can affect the business intelligence efficiency of banks.	31	Accountability, transparency, security, fraud reduction, and privacy are the opportunities offered by blockchain technology.
47	Costa et al. (2022)	Artificial intelligence and its adoption in financial services	To understand the perceptions of AI and its impact on the financial sector.	4	AI adoption led to efficiency, better risk management, and financial services personalization. Challenges include cyber risks and governance issues.
48	Cucari et al. (2022)	The impact of blockchain in	To shed light on the new challenges	48	Use of blockchain improved operational

		banking processes: The Interbank Spunta case study	faced by bankers in the face of technological advancement		efficiency, transparency, and process standardization.
49	Osmani et al. (2022)	Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis	To outline blockchain's benefits, opportunities, costs, risks, as well as challenges of the technology in the context of banking and finance services.	122	Blockchain offers significant benefits in efficiency, security, transparency, and cost reduction, but its adoption is hindered by substantial technical and regulatory risks.
50	Rahman & Abedin (2021)	The fourth industrial revolution and private commercial banks: The good, bad and ugly	To assess how new and emerging technologies can contribute to achieving the financial goals of the private commercial banking sector in Bangladesh.	19	Fourth industrial revolution technologies are changing the nature of work and shifting business models.
51	Dinesh Kumar et al. (2019)	Blockchain technologies in financial sectors and industries	To assess how the integration of IoT and smart contracts would benefit the financial sectors	9	Blockchain boosts efficiency, security, transparency, and inclusion, but faces hurdles like scalability, regulation, privacy, and integration costs.

3.4. Opportunities and Challenges Brought by the Fourth Industrial Revolution to the Financial Sector

Figure 5 shows the thematic map showing the themes that emerged from the analysis of the documents that were considered for this study. The data analysis section in the methodology section details how the themes were identified and the coding procedure that was followed. These themes show opportunities and challenges brought forward by the coming of the fourth industrial revolution to the banking sector.

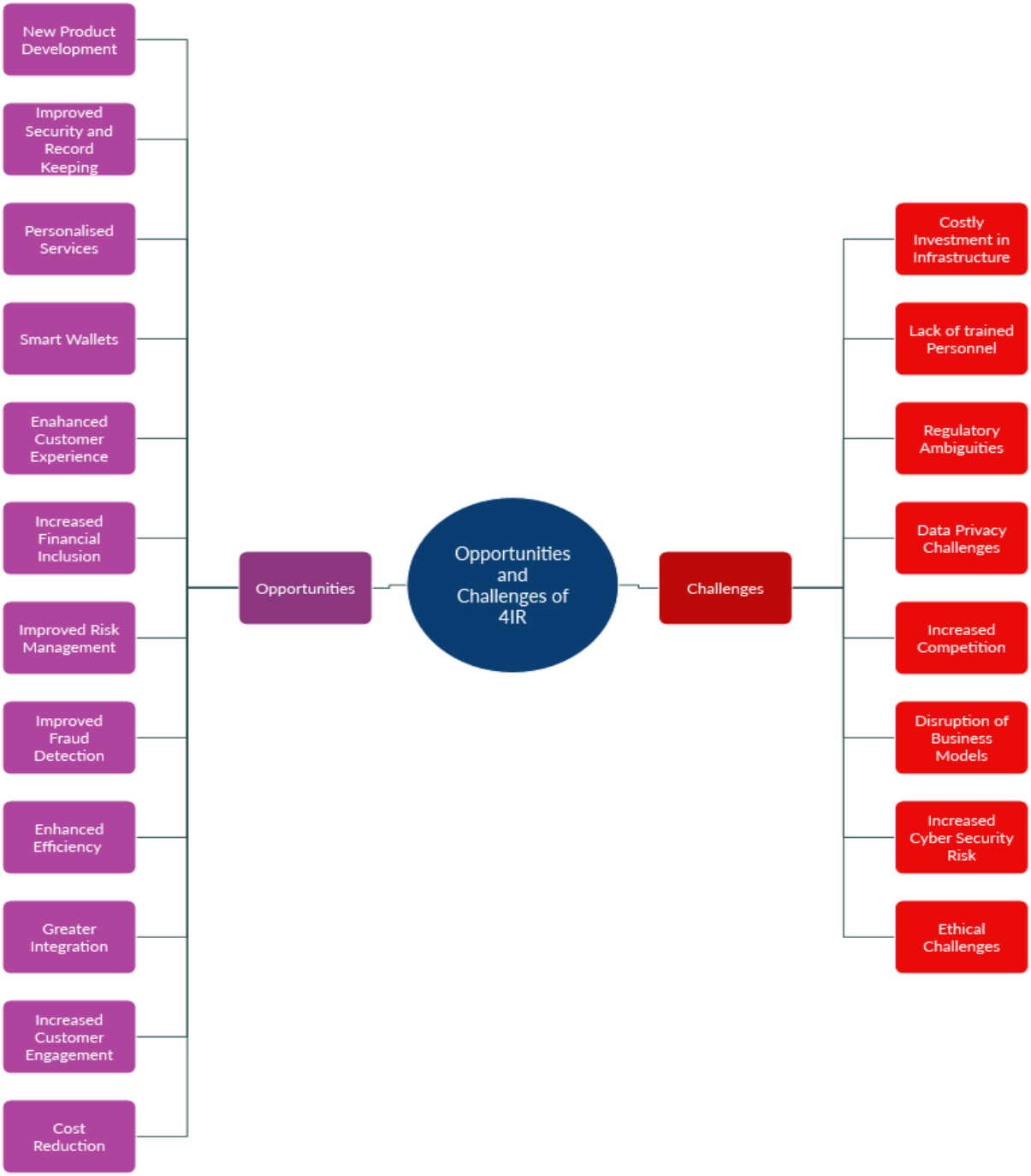
The study's findings indicate that the fourth industrial revolution has created opportunities for innovation in the banking sector, particularly in new product development (Jantoń-Drozdowska & Mikołajewicz-WoźNiak, 2017). Real-time payments and instant transfers, digital wallets, robo-advisors, Peer-to-peer (P2P) lending, digital assets, RegTech, credit scoring and personalized financial products and mobile banking are some of the products that were created courtesy of the fourth industrial revolution technologies. Studies by Arjun and Suprabha (2020), Ghandour (2021), and Farooq and Waseem (2021) also found that the integration of Industry 4.0 technologies has improved security, record keeping, and management in the financial sector. With the increasing use of financial information globally, these technologies play a crucial role in managing the resulting big data. A review of existing literature also highlights the role of the fourth industrial revolution in enabling personalized financial services, with AI-powered technologies allowing banks to offer tailored services (Ghandour, 2021). Furthermore, Industry 4.0 technologies are enhancing customer experiences, contributing to a more efficient and customer-centric financial sector.

The literature review also reveals that the fourth industrial revolution has transformed the banking sector in various ways. Loan (2023) notes that the adoption of Industry 4.0 technologies has led to increased

customer satisfaction and enhanced customer experience, as clients can perform transactions quickly and efficiently without relying on traditional brick-and-mortar banks.

Figure 5

Thematic Map Showing Opportunities and Challenges Brought by the Fourth Industrial Revolution in the Banking Sector



The review also highlights the potential of fourth industrial revolution technologies to improve financial inclusion, with digital technologies enabling excluded population groups to access financial services remotely (Nefla & Jellouli, 2025). More people can store money, send or receive payments, and transact safely without needing a formal bank account or in-person paperwork. Additionally, these technologies are enhancing risk management in the banking sector, allowing banks to identify, quantify, predict, and analyze risks more effectively. For instance, Jáuregui-Velarde et al. (2024) found that Industry 4.0

technologies improve credit risk analysis, reducing exposure to credit risks. Yan (2023) also notes that these technologies have improved fraud detection in the financial sector. Furthermore, the literature review indicates that the Fourth Industrial Revolution has created opportunities for increasing efficiency within the banking sector. Studies by Rahim (2025), Damaris et al. (2025), Kariuki et al. (2025), Manta et al. (2025), Awad and Ghonim (2025), Lytvyn et al. (2024), Chang et al. (2020), Anwar et al. (2024), and Farooq and Waseem (2021) all suggest that AI and other Industry 4.0 technologies are significantly improving operational efficiency, helping financial institutions reduce their operational costs.

The adoption of fourth industrial revolution technologies in the banking sector is not without its challenges. Research by Arjun and Suprabha (2020), Loan (2023), and Rahim (2025) highlights the high initial costs associated with implementing these technologies, which can be a significant barrier to adoption. Despite these costs, banks are compelled to adopt these technologies to remain competitive. Skills gaps also pose a significant challenge, with many banks lacking the skilled personnel needed to effectively utilize fourth industrial revolution. This shortage of skilled workers may hinder the banking sector's ability to fully realize the benefits of these technologies. Regulatory challenges are another obstacle to the adoption of Fourth Industrial Revolution technologies. Studies by Farooq and Waseem (2021), Anwar et al. (2024), Lytvyn et al. (2024), and Khalegi et al. (2024) note that regulatory ambiguities can create legal uncertainty, increase investment risk, hinder standardization, and complicate the establishment of accountability, ultimately affecting the use of these technologies.

It also emerged from the literature survey conducted that data privacy issues and ethical issues are the new challenges that came as a result of the emergence of fourth industrial revolution technologies. Farooq and Waseem (2021), Anwar et al. (2024), Chang et al. (2020), Sayari et al. (2025), and Xu and Cho (2025) found that 4IR technologies rely heavily on extensive data collection and analysis, raising significant concerns about data privacy and security. The absence of standardized and harmonized data protection regulations across different jurisdictions makes it difficult for organizations to comply with evolving rules and raises fears of privacy breaches among the public. Furthermore, the coming in of the fourth industrial revolution led to the entrance of fintech firms into the banking sector, and this led to the disruption of business models as well as increasing completion. Coetzee (2018) noted that the entrance of fintechs and other new products is increasing completion in the banking sector, and this is likely going to affect financial stability if there is no regulation. In addition, some scholars indicated that fourth industrial revolution technologies increased vulnerability to cyber risks in the banking sector. For instance, Hasan et al. (2023), Nefla and Jellouli (2025), and Sayari et al. (2025) noted that cyber fraudsters are leveraging upon fourth industrial revolution technologies to commit wholesale types of cybercrimes.

4. Discussion

The purpose of this study was to investigate opportunities and challenges realised by the banking sector in the face of the fourth industrial revolution. The fourth industrial revolution brought with it a number of digital technologies, and these technologies are finding their way into the financial sector. Because of the digital transformation of the business landscape, banks are also forced to adapt to these technologies. Given these developments, it is of utmost importance for a study to be carried out in order to determine the opportunities and the challenges brought forward by Industry 4.0 technologies to the banking sector.

Findings of the study reveal that Industry 4.0 technologies are enhancing customer experiences in the banking sector. Kariuki et al. (2025) argued that most banks have enhanced their customer experiences through Internet of Things (IoT) innovations, enhanced their security systems, and enhanced their data access ecosystem to improve their operational efficiency. Similar observations were also made by Manta et al. (2025), who argued that the fourth industrial revolution has altered how financial institutions communicate and interact with their clients. As financial services consumers transition to digital services, they are experiencing increased satisfaction, no longer needing to visit physical branches. Financial services consumers are enjoying fast, secure transactions, boosting satisfaction levels. Fourth industrial revolution technologies enhance customer experience by enabling personalized

services. AI-driven chatbots and virtual assistants provide instant support, giving customers immediate assistance and direction, ultimately elevating their overall experience.

It also emerged from the literature survey that Industry 4.0 technologies can handle large data. Scholars such as Saxena et al. (2017) and Hasan et al. (2023) argued that big data gives businesses deeper insights than ever before into the behaviour, preferences, dislikes, and wants of their customers. Financial institutions can now collect data from a variety of sources, including ATMs, smartphone apps, and online banking platforms, with the use of cutting-edge technologies like sensors and IoT devices. This information plays a critical role in evidence-based decision-making in the financial sector. Findings of the current study also revealed that Industry 4.0 technologies increase the security of financial transactions in the financial sector as a whole. Patil et al. (2025) argued that AI and machine learning technologies offer significant potential for enhancing financial security. Similarly, Kariuki et al. (2025) and Farooq and Waseem (2021) argued that the majority of banks have enhanced their security systems and enhanced their data access ecosystem for the fourth industrial revolution technologies. Contrary to the findings of Kariuki et al. (2025) and Farooq and Waseem (2021), scholars such as Nefla and Jellouli (2025) and Vucinic and Luburic (2024) argued that fourth industrial revolution technologies are introducing new risks in the form of cybersecurity risk. This highlights that while emerging technologies offer benefits, they also create vulnerabilities, making financial institutions prime targets for cyber-attacks. As such, financial sector players must prioritize robust cybersecurity measures to protect themselves. It also emerged from the current study that fourth industrial revolution technologies are enhancing the financial inclusion of the excluded population groups. Abdallah-Ou-Moussa et al. (2025) argued that blockchain has the potential to increase financial inclusion by giving the unbanked and underbanked communities more access to financial services. Similarly, Ghandour (2021) argued that AI and other digital technologies opened an opportunity for financial inclusion of the excluded population groups. Similar findings also came from Tigges et al. (2024), who argued that positive contributions, such as increased access to financial services, came as a result of the fourth industrial revolution, and they all contribute to the achievement of the Sustainable Development Goals. The digitalization of the global economy is enabling previously excluded groups to access financial services online, eliminating the need for physical branch visits. This shift allows the banking sector to expand its market reach and serve underserved populations, leveraging fourth industrial revolution technologies to bridge the gap.

The current study also established that the coming of the fourth industrial revolution has led to the disruption of business models in the banking sector. Rahman and Abedin (2021) argued that the banking and finance industries have experienced an acceleration and enhanced spread of digitalization, which has led to the disruption of traditional business models. According to Gaviyau and Godi (2025), the banking industry's rising digitisation as a result of technology use has put pressure on the already competitive banking sector. Coetzee (2018) posited that the financial services sector is unavoidably becoming more competitive as a result of the fourth industrial revolution and the faster advancement of digital technologies. As a result of this competition, banks are compelled by the growing usage of technology to reevaluate their business models, shift to a customer-centric strategy focused on resolving client issues, and launch new products for both existing and potential customers. Given that new players are entering the financial sector in the form of fintechs, traditional financial sector companies will need to change from being static financial institutions to dynamic digital platforms that, based on customer data analysis, offer competitive goods and services and a seamless user experience. It also emerged from the current study that the more frequent use of technology as a result of the fourth industrial revolution increases the potential of cyberattacks against businesses. Similarly, Chang et al. (2020) claim that serious privacy and security concerns are impeding the use of blockchain and AI in financial processes. In support of the issue of privacy and security concerns, Farooq and Waseem (2021) argued that while blockchain adoption in the banking sector offers built-in security features like cryptographic hashing and encryption, its transparent and immutable ledger design poses new privacy challenges. Similar claims were made by Patil et al. (2025), who suggested that the pseudonymity of blockchain transactions may make privacy and secrecy more challenging, particularly in sensitive financial transactions where anonymity may be crucial. Despite the potential of blockchain technologies to transform financial services and transactions in the financial sector, challenges of data privacy remain

a primary concern. Without proper handling of customer data, the risks could outweigh the benefits, undermining the technology's promise. The findings of the current study also revealed that the full implementation of the fourth industrial revolution technologies is marred by a lack of competencies and skills in the banking sector. These findings resonate with the results of Gaviyau and Godi (2025), who argued that there is an increasing need for highly qualified individuals as the finance sector becomes more automated. Xu and Cho (2025) argued that before implementing the digital strategy, employees in different company divisions must receive priority training and development and upskilling. Similarly, Rahman et al. (2023), both hard and soft skills are critical for success in the present financial environment as well as for the future. In addition, Rahman et al. argued that professionals in the financial sector need to possess both hard and soft skills. Upskilling and reskilling financial professionals can help unlock the benefits of 4IR technologies, while also mitigating emerging risks. By training workers, the sector can better navigate the challenges that come with integration, maximizing the potential of these innovations. Findings of the current study also revealed that regulatory challenges are the new challenges associated with the implementation of the fourth industrial revolution technologies. Fourth industrial revolution technologies entered the financial landscape when all regulators least expected them, explaining why they are struggling to exercise oversight over these technologies. Gaviyau and Godi (2025) argued that the entrance of emerging technologies created some regulatory challenges for the financial services industry. Similarly, Abdallah-Ou-Moussa et al. (2025) also argued that the decentralized and pseudonymous features of blockchain technology may complicate governmental oversight. Central banks and other centralized organizations are set up to keep an eye on a country's monetary flows and policies. However, as Sayari et al. (2025) pointed out, there is no central authority, regulatory organization, or set of regulations for cryptocurrencies, which makes it challenging for governments to control them. Abdallah-Ou-Moussa et al. (2025) further argued that regulation of cryptocurrencies continues to be a challenge for governments and that there seems to be no simple solution. They stated that while successfully trying to supervise blockchain-based applications and AI-driven financial services, regulators must strike a careful balance between encouraging innovation and guaranteeing consumer safety. The conclusion drawn from this study is that the fourth industrial revolution is changing business models and also bringing in a lot of benefits. The study concludes that the financial sector needs to keep pace with change in technology so as to remain relevant in a changing world. The traditional way of banking is slowly disappearing and being replaced by digital technology. The new business models brought about by financial technology are prompting banks and various industry players to develop new business models that align with the demands of the fourth industrial revolution.

The findings of this study have far-reaching implications for policymakers, financial institutions, and clients alike, highlighting the need for a multifaceted approach to harness the benefits of the fourth industrial revolution. From a policy perspective, it is imperative that regulatory frameworks are established to provide clear guidelines for the implementation of emerging technologies like blockchain. The absence of such frameworks is likely to create chaos and financial instability, particularly in economies that are yet to introduce these technologies into their financial systems. Policymakers must also prioritize data privacy policies to protect financial services clients and develop strategic plans to capacitate financial sector employees. Without such initiatives, the benefits of leveraging fourth industrial revolution technologies will remain elusive. Developing and emerging economies can also promote the adoption of digital technologies by reducing taxes on digital infrastructure imports, enabling banks to remain relevant in a rapidly evolving financial landscape. Financial institutions must also take proactive steps to stay ahead of the curve. This includes swiftly adopting digital technologies and developing strategic plans that outline a clear roadmap for integrating digital infrastructure into their systems. Reskilling and upskilling financial sector professionals is also crucial to reap the benefits of these technologies. Moreover, the financial services sector must bolster its security measures to protect against online threats, investing in robust cybersecurity training, risk assessment, and incident response capabilities to safeguard blockchain and AI systems. Ultimately, clients also have a critical role to play in protecting themselves against cyber threats. They must receive training on cyber issues to stay alert and vigilant, recognizing the evolving nature of technology and the increasing sophistication of cyber fraudsters. Through working together, policymakers, financial

institutions, and clients can unlock the full potential of the fourth industrial revolution, creating a more secure, efficient, and inclusive financial ecosystem.

Whilst the current study provides a comprehensive and nuanced understanding of the challenges and opportunities presented by the fourth industrial revolution in the financial service industry, there are still several areas that warrant further exploration. Future studies should focus on investigating the skills gaps that have arisen from the adoption of digital technologies, as this will enable scholars to identify the specific skills required by banking sector professionals to efficiently work with fourth industrial revolution technologies. In particular, research should focus on identifying the key competencies and training needs of banking professionals, as well as developing effective strategies for upskilling and reskilling the workforce. This could involve exploring the role of education and training institutions in addressing the skills gap, as well as the potential for industry-led initiatives to support professional development. Furthermore, future research should also examine the role of fourth industrial revolution technologies in enhancing alignment with the Environmental, Social, and Governance (ESG) framework. This could involve investigating how these technologies can be leveraged to promote environmental sustainability, social responsibility, and good governance practices within the banking sector. For instance, studies could explore how technologies such as blockchain, AI, and IoT can be used to enhance ESG reporting, improve risk management, and support sustainable investment decisions. Some potential research questions that could be explored in this area include: What role can these technologies play in promoting financial inclusion and reducing inequality? How can banking sector professionals be equipped with the skills and knowledge needed to effectively integrate ESG considerations into their decision-making processes?

Disclosure Statement

The authors claim no conflict of interest.

Funding

The research did not receive any specific grants from funding agencies.

References

Abdallah-Ou-Moussa, S., Wynn, M., & Kharbouch, O. (2025). Blockchain, cryptocurrencies, and decentralized finance: A case study of financial inclusion in Morocco. *International Journal of Financial Studies*, *13*(3), Article 124. https://doi.org/10.3390/ijfs13030124

Aghimien, D., Aigbavboa, C., & Matabane, K. (2020). Impediments of the fourth industrial revolution in the South African construction industry. In S. M. Ahmed, P. Hampton, S. Azhar, & A. D. Saul (Eds.) *Collaboration and integration in construction, engineering, management and technology: Proceedings of the 11th International Conference on Construction in the 21st Century* (pp. 223-227). Springer International Publishing. https://doi.org/10.1007/978-3-030-48465-1_37

AL-Dosari, K., Fetais, N., & Kucukvar, M. (2024). Artificial intelligence and cyber defense system for banking industry: A qualitative study of AI applications and challenges. *Cybernetics and systems*, *55*(2), 302-330. https://doi.org/10.1080/01969722.2022.2112539

Ally, O., Kulindwa, Y., & Mataba, L. (2025). Bank efficiency in the digital age: The role of financial technology in Tanzanian banks. *Modern Finance*, *3*(1), 1–24. https://doi.org/10.61351/mf.v3i1.218

Anwar, D., Faizanuddin, Fatima, S., Raza, S., & Dayal, R. (2024). Understanding AI's role in the banking industry: A conceptual review. *LatIA*, *2*, Article 119.

Arjun, R., & Suprabha, K. R. (2020). Innovation and challenges of blockchain in banking: A scientometric view. *International Journal of Interactive Multimedia and Artificial Intelligence*, *6*(3), 7-14.

Awad, A., & Ghonim, A. (2025). Data-driven marketing in banks: The role of artificial intelligence in enhancing marketing efficiency and business performance. *International Review of Management and Marketing*, *15*(5), 422-431. https://doi.org/10.32479/irmm.19738

Banerjee, S. S., & Chandani, A. (2025). Challenges of blockchain application in the financial sector: A qualitative study. *Journal of Economic and Administrative Sciences*, *41*(2), 658-679. https://doi.org/10.1108/JEAS-10-2021-0200

Cannavacciuolo, L., Ferraro, G., Ponsiglione, C., Primario, S., & Quinto, I. (2023). Technological innovation-enabling industry 4.0 paradigm: A systematic literature review. *Technovation*, *124*, Article 102733. https://doi.org/10.1016/j.technovation.2023.102733

Chand, S. A., Singh, B., Narayan, K., & Chand, A. (2025). The impact of financial technology (FinTech) on bank risk-taking and profitability in small developing island states: A study of Fiji. *Journal of Risk and Financial Management*, *18*(7), Article 366. https://doi.org/10.3390/jrfm18070366

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). How blockchain can impact financial services–The overview, challenges and recommendations from expert interviewees. *Technological Forecasting and Social Change*, *158*, Article 120166. https://doi.org/10.1016/j.techfore.2020.120166

Choi, Y., Hong, J., Lee, E., Kim, J., & Kim, S. (2025). Enhancing fairness in financial AI models through constraint-based bias mitigation. *Journal of Information Processing Systems*, *21*(1), 89-101. https://doi.org/10.3745/JIPS.01.0111

Coetzee, J. (2018). Strategic implications of Fintech on South African retail banks. *South African Journal of Economic and Management Sciences*, *21*(1), 1-11.

Costa, R. L. D., Cruz, M., Gonçalves, R., Dias, Á., Silva, R. V. D., & Pereira, L. (2022). Artificial intelligence and its adoption in financial services. *International Journal of Services Operations and Informatics*, *12*(1), 70-86. https://doi.org/10.1504/IJSOI.2022.123569

Cucari, N., Lagasio, V., Lia, G., & Torriero, C. (2022). The impact of blockchain in banking processes: The Interbank Spunta case study. *Technology Analysis & Strategic Management*, *34*(2), 138-150. https://doi.org/10.1080/09537325.2021.1891217

Damaris, R., Rosadi, S. D., & Bratadana, I. M. D. (2025). Data governance for artificial intelligence implementation in the financial sector: An Indonesian perspective. *Journal of Central Banking Law and Institutions*, *4*(3), 445-472. https://doi.org/10.21098/jcli.v4i3.430

Deloitte. (2024, May 16). *India ranks first in adoption of Generative AI technology across Asia Pacific: Deloitte survey*. https://www.deloitte.com/in/en/about/press-room/india-ranks-first-in-adoption-of-generative-ai-technology-across-asia-pacific-deloitte-survey.html

Dinesh Kumar, K., Komathy, K., & Manoj Kumar, D. S. (2019). Blockchain technologies in financial sectors and industries. *International Journal of Scientific and Technology Research*, *8*(11), 942-946.

Farooq, M. S., & Waseem, H. (2021). Application of blockchain in e-banking transactions. *VFAST Transactions on Software Engineering*, *9*(4), 143-149. https://doi.org/10.21015/vtse.v9i4.944

Gaviyau, W., & Godi, J. (2025). Banking sector transformation: Disruptions, challenges and opportunities. *FinTech*, *4*(3), Article 48. https://doi.org/10.3390/fintech4030048

Ghandour, A. (2021). Opportunities and challenges of artificial intelligence in banking: Systematic literature review. *TEM Journal*, *10*(4), 1581-1587.

Hasan, M., Hoque, A., & Le, T. (2023). Big data-driven banking operations: Opportunities, challenges, and data security perspectives. *FinTech*, *2*(3), 484-509. https://doi.org/10.3390/fintech2030028

Jantoń-Drozdowska, E., & Mikołajewicz-Woźniak, A. (2017). The impact of the distributed ledger technology on the Single Euro Payments Area development. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *12*(3), 519-535.

Jáuregui-Velarde, R., Andrade-Arenas, L., Molina-Velarde, P., & Yactayo-Arias, C. (2024). Financial revolution: A systemic analysis of artificial intelligence and machine learning in the banking sector. *International Journal of Electrical & Computer Engineering*, *14*(1), 1079-1090.

Ji, F., & Tia, A. (2022). The effect of blockchain on business intelligence efficiency of banks. *Kybernetes*, *51*(8), 2652-2668. https://doi.org/10.1108/K-10-2020-0668

Kariuki, P., Ofusori, L. O., & Goyayi, M. L. J. (2025). Internet of things on banking processes in South Africa: A systematic reflection on innovations, opportunities and challenges. *Digital Business*, *5*(1), Article 100097. https://doi.org/10.1016/j.digbus.2024.100097

Kayani, U., & Hasan, F. (2024). Unveiling cryptocurrency impact on financial markets and traditional banking systems: Lessons for sustainable blockchain and interdisciplinary collaborations. *Journal of Risk and Financial Management*, *17*(2), Article 58. https://doi.org/10.3390/jrfm17020058

Khalegi, F., Kadyraliev, A., Tursunalieva, D., Orozbekov, A., & Bigali, A. (2024). Blockchain and sustainable finance: Enhancing transparency and efficiency in green investments. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, *3*(11), 125-137. https://doi.org/10.52566/msu-econ3.2024.125

Khan, F. (2023, August 14). *Blockchain's paradigm shift: How it is revolutionizing B2B cross-border payments and remittances*. LinkedIn. https://www.linkedin.com/pulse/blockchains-paradigm-shift-how-revolutionizing-b2b-payments-khan/

Khanna, P., & Haldar, A. (2023). Will adoption of blockchain technology be challenging: Evidence from Indian banking industry. *Qualitative Research in Financial Markets*, *15*(2), 361-384. https://doi.org/10.1108/QRFM-01-2022-0003

Liu, L. X., Sun, Z., Xu, K., & Chen, C. (2024). AI-driven financial analysis: Exploring ChatGPT's capabilities and challenges. *International Journal of Financial Studies*, *12*(3), Article 60. https://doi.org/10.3390/ijfs12030060

Loan, T. T. D. (2023). Industry 4.0 and its impact on the development of Vietnamese commercial banks. *Review of Business and Economics Studies*, *11*(4), 45-60.

Lytvyn, O., Kudin, V., Onyshchenko, A., Nikolaev, M., & Chaplynska, N. (2024). Integration of digital tools into the financial sphere: The potential of cloud computing, blockchain, big data and AI. *Financial and Credit Activity Problems of Theory and Practice*, *1*(54), 127–145. https://doi.org/10.55643/fcaptp.1.54.2024.4257

Machkour, B., & Abriane, A. (2020). Industry 4.0 and its implications for the financial sector. *Procedia Computer Science*, *177*, 496-502. https://doi.org/10.1016/j.procs.2020.10.068

Manta, O., Vasile, V., & Rusu, E. (2025). Banking transformation through FinTech and the integration of artificial intelligence in payments. *FinTech*, *4*(2), Article 13. https://doi.org/10.3390/fintech4020013

Mishra, L., & Kaushik, V. (2023). Application of blockchain in dealing with sustainability issues and challenges of financial sector. *Journal of Sustainable Finance & Investment*, *13*(3), 1318–1333. https://doi.org/10.1080/20430795.2021.1940805

Moharrak, M., & Mogaji, E. (2025). Generative AI in banking: Empirical insights on integration, challenges and opportunities in a regulated industry. *International Journal of Bank Marketing*, *43*(4), 871-896. https://doi.org/10.1108/IJBM-08-2024-0490

Naser, H., Sultanova, G., & Nahar, S. (2024). The impact of Fintech innovation on bank's performance: Evidence from the Kingdom of Bahrain. *International Journal of Economics and Financial Issues*, *14*(1), 136-143. https://doi.org/10.32479/ijefi.15512

Nefla, D., & Jellouli, S. (2025). Emerging technologies in finance: Challenges for a sustainable finance. *Cogent Business & Management*, *12*(1), Article 2495191. https://doi.org/10.1080/23311975.2025.2495191

Osmani, M., El-Haddadeh, R., Hindi, N., Janssen, M., & Weerakkody, V. (2021). Blockchain for next generation services in banking and finance: Cost, benefit, risk and opportunity analysis. *Journal of Enterprise Information Management*, *34*(3), 884-899. https://doi.org/10.1108/JEIM-02-2020-0044

Pahari, S., Polisetty, A., Sharma, S., Jha, R., & Chakraborty, D. (2023). Adoption of AI in the banking industry: A case study on Indian banks. *Indian Journal of Marketing*, *53*(3), 26-41. https://doi.org/10.17010/ijom/2023/v53/i3/172654

Patil, A., Mishra, B., Chockalingam, S., Misra, S., & Kvalvik, P. (2025). Securing financial systems through data sovereignty: A systematic review of approaches and regulations. *International Journal of Information Security*, *24*(4), Article 159. https://doi.org/10.1007/s10207-025-01074-4

Peirce, M. (2025, May 13). *What is the 4th industrial revolution?* Zahara. https://www.zaharasoftware.com/blog/the-4th-industrial-revolution-and-how-it-affects-finance/

Philbeck, T., & Davis, N. (2018). The fourth industrial revolution. *Journal of International Affairs*, *72*(1), 17-22.

Poluyan, A., Purchina, O., & Fugarov, D. (2025). Opportunities for applying artificial intelligence by commercial organizations in data security and cyber threat monitoring. *International Journal of Basic and Applied Sciences*, *14*(2), 281-287. https://doi.org/10.14419/bh5z5x68

Qureshi, K., Sadeq, S. H., & Manuel, P. (2024). Analysis of security challenges in cloud computing adoption for the banking sector. *International Journal for Computers & Their Applications*, *31*(4), 308-319.

Rahim, M. S. B. A. (2025). Revolutionising the Shariah secretariat function through artificial intelligence: Prospects and challenges for Malaysia's Islamic banking sector. *Journal of Central Banking Law and Institutions*, *4*(3), 567-594. https://doi.org/10.21098/jcli.v4i3.444

Rahman, A., & Abedin, M. J. (2021). The fourth industrial revolution and private commercial banks: The good, bad and ugly. *International Journal of Organizational Analysis*, *29*(5), 1287-1301. https://doi.org/10.1108/IJOA-05-2020-2218

Rahman, M., Ming, T. H., Baigh, T. A., & Sarker, M. (2023). Adoption of artificial intelligence in banking services: An empirical analysis. *International Journal of Emerging Markets*, *18*(10), 4270-4300. https://doi.org/10.1108/IJOEM-06-2020-0724

Reinartz, W., Wiegand, N., & Imschloss, M. (2019). The impact of digital transformation on the retailing value chain. *International Journal of Research in Marketing*, *36*(3), 350-366. https://doi.org/10.1016/j.ijresmar.2018.12.002

Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). *Mastering modern psychological testing*. Springer. https://doi.org/10.1007/978-3-030-59455-8_4

Ridzuan, N. N., Masri, M., Anshari, M., Fitriyani, N. L., & Syafrudin, M. (2024). AI in the financial sector: The line between innovation, regulation and ethical responsibility. *Information*, *15*(8), Article 432. https://doi.org/10.3390/info15080432

Saxena, S., & Ali Said Mansour Al-Tamimi, T. (2017). Big data and internet of things (IoT) technologies in Omani banks: A case study. *Foresight*, *19*(4), 409-420. https://doi.org/10.1108/FS-03-2017-0010

Sayari, K., Jannathl Firdouse, M. K., & Al Abri, F. (2025). Artificial intelligence and machine learning adoption in the financial sector: A holistic review. *IAES International Journal of Artificial Intelligence*, *14*(1), 1-19.

Schweidel, D. A., Bart, Y., Inman, J. J., Stephen, A. T., Libai, B., Andrews, M., Rosario, A. B., Chae, I., Chen, Z., Kupor, D., Longoni, C., & Thomaz, F. (2022). How consumer digital signals are reshaping the customer journey. *Journal of the Academy of Marketing Science*, *50*(6), 1257-1276. https://doi.org/10.1007/s11747-022-00839-w

Sharma, M., & Choubey, A. (2024). Impact of information technology on Indian banking sector. *Journal of Financial Services Marketing*, *29*(4), 1609-1622. https://doi.org/10.1057/s41264-024-00287-3

Siminica, M. I., Cîrciumaru, D., Manta, A. G., Cârstina, S., Badareu, G., & Gherțescu, C. (2025). FinTech, artificial intelligence, and European Union banks: A double-edged sword for performance? *Oeconomia Copernicana*, *16*(3), 1099-1176. https://doi.org/10.24136/oc.3798

Singh, P. (2025, December 8). *On-demand technology adoption in India is rising faster than global peers*. Dataquest. https://www.dqindia.com/interview/on-demand-technology-adoption-in-india-is-rising-faster-than-global-peers-10892063

Swathi, G., & Pahuja, A. (2024). FinTech frontiers: Cloud computing and artificial intelligence applications for intelligent finance investment and blockchain in the financial sector. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(4), 654-659.

Tigges, M., Mestwerdt, S., Tschirner, S., & Mauer, R. (2024). Who gets the money? A qualitative analysis of fintech lending and credit scoring through the adoption of AI and alternative data. *Technological Forecasting and Social Change*, *205*, Article 123491. https://doi.org/10.1016/j.techfore.2024.123491

Torkington, S. (2021, July 7). *The pandemic has changed consumer behaviour forever - and online shopping looks set to stay*. World Economic Forum. https://www.weforum.org/agenda/2021/07/global-consumer-behaviour-trends-online-shopping/

Valenti, J, & Alderman, R. (2021, September 7). *Building on the digital banking momentum: How banks could influence customer channel preferences*. Deloitte. https://www.deloitte.com/us/en/insights/industry/financial-services/digitalization-in-banking.html

Vucinic, M., & Luburić, R. (2024). Artificial intelligence, Fintech and challenges to central banks. *Journal of Central Banking Theory and Practice*, *13*(3), 5-42.

Wang, S., Asif, M., Shahzad, M. F., & Ashfaq, M. (2024). Data privacy and cybersecurity challenges in the digital transformation of the banking sector. *Computers & security*, *147*, Article 104051. https://doi.org/10.1016/j.cose.2024.104051

Xu, C., & Cho, S. E. (2025). Factors affecting human–AI collaboration performances in financial sector: Sustainable service development perspective. *Sustainability*, *17*(10), Article 4335. https://doi.org/10.3390/su17104335

Yan, X. (2023). Research on financial field integrating artificial intelligence: Application basis, case analysis, and SVR model-based overnight. *Applied Artificial Intelligence*, *37*(1), Article 2222258. https://doi.org/10.1080/08839514.2023.2222258