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Leveraging Artificial Intelligence to Improve Digital Banking Services: The Case of MasterCard

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ABSTRACT

Digital banking has gained global prominence in recent years, yet insufficient research remains on the interaction between artificial intelligence (AI) and the banking system. This study aims to fill this gap by exploring how AI's capabilities and complex systems can fulfil the digital technology requirements of the banking sector and support its development. It examines a case study of Mastercard, a global leader in digital payments, which has strategically utilised AI. The findings demonstrate that Mastercard's AI implementation has played a crucial role in its digital transformation, enhancing services such as consumer protection, digital consultancy, early detection systems and biometric authentication. Moreover, advancing digital banking services with AI requires learning from the experiences and expertise of leading nations in this field.

1. Introduction

Recent advancements in AI have transformed various industries, notably the banking sector, opening up new avenues to improve customer experiences. AI-driven digitalisation of banking operations has simplified and streamlined transactions. Integrating AI into digital banking can optimise processes, enhance decision-making, and bolster security. By leveraging AI algorithms to analyse data patterns and customer behaviours, banks can uncover valuable insights to craft targeted marketing strategies and offer personalised financial solutions tailored to individual needs (Svoboda, 2023).

Financial institutions like Mastercard leverage AI to stay competitive and meet the growing demand for seamless and personalised digital banking services. Mastercard utilises AI to process a staggering 75 billion transactions annually across 45 million global locations. By employing real-time data streams and self-learning algorithms, Mastercard's AI systems make accurate decisions on transaction approvals, cutting false declines by 50%. Mastercard enhances operational efficiency through AI and advanced analytics, uncovers new revenue streams, and elevates customer experiences. Their AI-driven strategies prioritise data intelligence, fraud prevention, and cybersecurity, safeguarding 125 billion transactions annually (Mastercard Services, 2024).

In early 2017, Mastercard adopted Decision Intelligence, an AI-based technology designed to enhance payment authorisation accuracy, as illustrated in the key points of the infographic depicted in Figure 1.

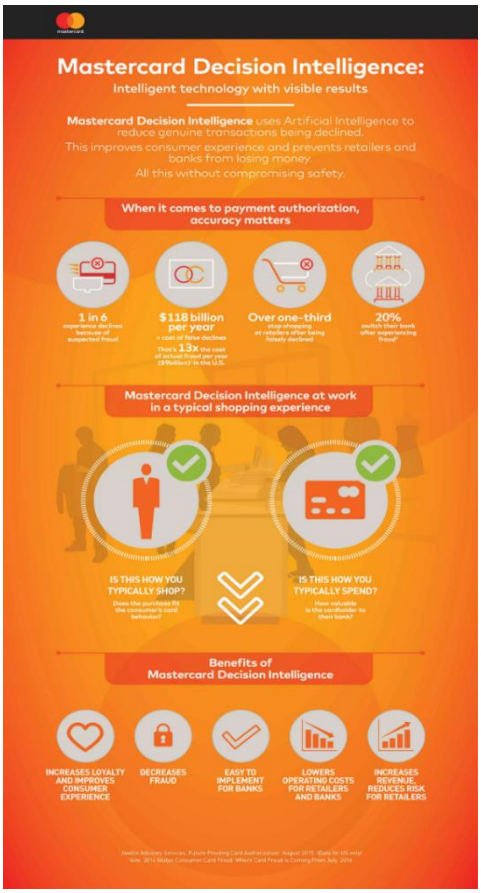

Figure 1. Mastercard Decision Intelligence of Artificial Intelligence at Mastercard.
Source: (Mejia, 2019)

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One in six transactions is declined due to suspected fraud. False declines cost $118 billion annually, 13 times the cost of actual fraud in the United States. More than a third of consumers stop shopping at a retailer after a false decline, and 20% change banks.

Decision Intelligence increases customer loyalty, enhances the consumer experience, reduces fraud, simplifies implementation for banks, and lowers operating costs and risks for retailers and banks.

According to previous research, more attention needs to be paid to this issue. Therefore, this study explores the importance of AI in transforming the digital banking landscape, focusing on Mastercard's innovative approaches and strategies for implementing AI solutions. To address this topic, we pose the following research question:

To what extent has artificial intelligence contributed to improving the digital transformation of banking services?

To answer this question, we have broken it down into the following sub-questions:

- ✧ What AI techniques have been adopted for digital banking?
- ✧ Is there notable development in digital banking services through the application of AI?
- ✧ What are the obstacles to developing digital banking services through AI?
- ✧ How has Mastercard used AI to improve its digital services?

To address these questions, a set of hypotheses was established to test their validity throughout the study:

- ✧ AI is the sole contributor to the digital transformation of banking services.
- ✧ There is sufficient awareness of the need for digital transformation in the banking sector and serious efforts to achieve it.
- ✧ AI enables access to a broader segment of individuals who avoid dealing with banks due to complexity and procedural hurdles.
- ✧ The digital transformation of financial institutions plays a vital role in commercialising banking services and reducing their costs.

The key objectives of this research paper are:

- ✧ Providing an overview of AI technologies and the motivations for their adoption.
- ✧ Understanding the forms of digital transformation in banking services.
- ✧ Assessing how Mastercard is leveraging AI to improve its digital services.

After the introduction, the paper is organised as follows: **The second section** presents Related Research. **The third section** presents Methodology. **The fourth section** offers an overview of artificial intelligence, detailing its various levels and technologies. **The fifth section** discusses digital banking services, highlighting their advantages and the role of AI in their implementation. **The sixth section** examines Mastercard's experience with AI in enhancing digital banking services. **The seventh section** explores Mastercard's AI-Powered Support for Small Business Success. **The eighth section** concludes the paper and provides some perspectives.

2. Related Research

Integrating AI into digital banking has transformed the financial services industry, allowing banks and financial institutions to improve customer experiences, streamline operations, and enhance security protocols. AI technologies, such as machine learning, predictive analytics, and robotic process automation, have been pivotal in reshaping traditional banking practices by offering personalised services, automating routine activities, and enhancing fraud detection. Specifically, AI has significantly improved customer satisfaction by providing superior service and more personalised financial solutions. Several research works have been introduced in this domain. This section addresses the key areas in which AI has impacted digital banking, including customer service, risk management, and operational efficiency, while addressing the challenges and opportunities associated with the adoption of AI in the financial industry through the following studies:

2.1 The Intelligent Digital Banking Technology and Architecture: A Systematic Literature Review (Indriasari et al., 2022)

This systematic review explores emerging technologies in digital banking, such as AI, blockchain, big data, biometrics, and cloud computing. It provides a detailed analysis of how these technologies are transforming digital banking platforms by enhancing customer experience and reducing the need for human interaction. The study also proposes an integrated architecture for developing intelligent digital banking platforms (Indriasari et al., 2022).

2.2 The Use of Artificial Intelligence in the Banking Industry (Mehndiratta et al., 2023).

This paper comprehensively analyses how AI is applied across various areas of the banking industry, including fraud detection, personalised financial advisory services, and automated customer support. It discusses AI's role in risk assessment, credit approval, investment management, and wealth management. The

study also highlights AI's potential to improve decision-making, reduce fraud risks, and enhance the customer experience through automation and data-driven insights (Mehndiratta et al., 2023).

2.3 Perceived Challenges and Benefits of AI Implementation in Customer Relationship Management Systems (Mazingue,2023)

This study focuses on implementing AI in Customer Relationship Management (CRM). It examines how AI enhances customer service through automation, personalisation, and improved decision-making. The research highlights the challenges and benefits of integrating AI into CRM systems to improve customer satisfaction and operational efficiency (Mazingue,2023).

2.4 Analysing the Digital Transformation and Evolution of Financial Technology (Fintech) Across Various Industries (Babu et al., 2024)

This paper examines the broader impact of Fintech on financial services, emphasising AI's role in driving digital transformation across industries. It discusses how Fintech innovations such as mobile payments, peer-to-peer lending, and blockchain disrupt traditional banking systems while enhancing accessibility and efficiency (Babu et al., 2024).

Table 1 provides a comparison that summarises the key findings, the impact of AI on digital banking, and the focus areas of the studies above, along with the conclusions and gaps identified:

Table 1. Comparative Analysis of AI's Impact on Digital Banking: Key Findings and Focus Areas from Recent Studies

Ref study	Key Findings	Impact of AI on Banking	Focus Areas
(Indriasari et al., 2022)	Explores technologies transforming digital banking, reducing human interaction, and enhancing customer experience.	Enhances customer experience and operational efficiency.	Various emerging technologies in digital banking.
(Mehndiratta et al., 2023).	AI applied in various banking areas enhances fraud detection, decision-making, and customer experience.	Improves decision-making and customer experience.	Fraud detection, advisory services, customer support.
(Mazingue,2023)	Focuses on AI in CRM systems, highlighting automationand personalisation for improved customer satisfaction.	Enhances customer service and operational efficiency.	AI in CRM systems.
(Babu et al., 2024)	Discusses Fintech innovations disrupting traditional banking systems while enhancing efficiency and accessibility.	Drives digital transformation and improves accessibility.	Fintech innovations in financial services.

Source: Prepared by the researchers based on the references listed in the table.

The studies mentioned above collectively confirm the transformative impact of AI in digital banking, highlighting its role in improving customer experience, streamlining operations, and enhancing risk management. AI is pivotal in personalising services and enhancing customer satisfaction by automating processes and offering customised solutions. Integrating AI technologies enhances operational efficiency, reducing the need for human intervention in routine tasks. AI applications in fraud detection play a crucial role in mitigating risks and enhancing security protocols within the banking sector. Emerging technologies like blockchain and big data converge with AI to create innovative digital banking solutions. There is a notable focus on customer relationship management (CRM) systems as a key area where AI can improve service delivery and customer satisfaction.

2.5 Identified Gaps:

There are still gaps worthy of attention due to the lack of research on the integration of AI into digital banking. The literature focuses little on the impact of AI adoption on customer relationships and loyalty, two key components of a bank's competitive advantage in the ever-changing digital banking environment. Furthermore, strengthening the ethical frameworks surrounding the use of AI requires greater attention to applicable data privacy and ethics policies. The lack of empirical research analysing the practical application of AI-based solutions to enhance operational efficiency and improve customer satisfaction leads to significant

gaps in understanding the actual impact of these technologies. Furthermore, the use of AI to promote financial inclusion for the unbanked remains unexplored, along with the obstacles banks and Small and Medium-sized Enterprises (SMEs) face when adopting these technologies. The aim is to fill these gaps, and the lack of previous detailed studies provides an opportunity to approach the topics differently and address all the issues that have been uncovered.

2.6 Addressing Key Gaps in AI-Driven Digital Banking: A Mastercard Case Study

Our study addresses several important gaps in the existing research. Based on the analysis of related works, the following are the main contributions and gaps that our study fills:

2.6.1 Focus on Mastercard's AI Adoption

This study presents an illustrative case study of how Mastercard strategically integrates AI technologies into its digital banking services, along with some significant innovations. Mastercard uses AI systems to manage approximately 75 billion transactions annually, achieving a 50% reduction in false declines and 125 billion secure transactions annually, improving the reliability of its payment ecosystem. AI enhances the accuracy of payment authorisations through Decision Intelligence, reducing the risk of fraud and strengthening customer loyalty through reliable transactions. AI supports biometric authentication systems, enhancing security. This, coupled with ease of user navigation, highlights Mastercard's innovative leadership in digital banking.

2.6.2 Examination of AI's Role in Digital Transformation

This study explores how AI has been instrumental in Mastercard's digital transformation. It explains that AI optimises processes, improves decision-making, and strengthens security in digital banking. Using real-time data streams and self-learning algorithms, Mastercard has enhanced operational efficiency, identified new revenue opportunities, and improved customer experiences.

2.6.3 Broader Implications for Digital Banking

Beyond the case study of Mastercard, this study addresses the wider impact of AI on digital banking. It emphasises that AI technologies such as machine learning and predictive analytics transform traditional banking by automating routine tasks, delivering personalised services, and improving fraud detection. The article also discusses the challenges and opportunities associated with adopting AI in the financial sector.

2.6.4 Contribution to Academic Literature on AI in Financial Services

This study seeks to explore the role of AI in helping the banking sector keep pace with rapid technological changes, filling a significant gap in existing academic studies. AI is a key driver of digital transformation in this sector in multiple ways, warranting an in-depth study of its impact. For example, Mastercard has adopted specific strategies to enhance its services using AI, highlighting the technology's potential to improve banking performance. The study also examines the barriers to expanding the use of AI in the banking sector, offering practical and thoughtful insights by approaching the topic from multiple perspectives. In doing so, this study explains how AI is reshaping financial services, focusing on its potential future impacts in this field.

2.6.5 Practical Guidance for Financial Institutions

The findings of this study provide valuable practical advice for other financial institutions seeking to adopt AI technologies. Mastercard's successes in implementing these technologies serve as a benchmark for banks and financial institutions to leverage to improve customer satisfaction, enhance security measures, and streamline operational processes. Furthermore, the study makes a significant contribution by detailing Mastercard's innovative use of AI, providing broad insights into how AI is revolutionising digital banking across the industry and contributing to a deeper understanding of this evolving field.

3. Methodology

To establish a robust theoretical foundation and provide a clear understanding of contemporary practices in the field of artificial intelligence, digital banking services, and financial technology, this study undertook a comprehensive and systematic review of relevant scholarly literature. Data were meticulously gathered from a variety of sources, including peer-reviewed journals, authoritative industry reports, and official publications from Mastercard, with a focus on AI methodologies, innovations in digital banking, and Mastercard's AI-driven initiatives. These data were subjected to rigorous analytical scrutiny to distil key applications of artificial intelligence, evaluate its transformative impact on digital banking services, and explore the challenges associated with these advancements. The study seeks to offer an in-depth analysis that addresses the intelligent techniques employed within digital banking systems, while critically assessing the role of AI in enhancing Mastercard's digital service offerings. Furthermore, it aims to formulate evidence-based recommendations to guide financial institutions in optimising the integration of AI into their operations.

Through this endeavour, the study aspires to enrich the academic discourse by contributing novel insights and empirical evidence that illuminate the transformative potential of AI within the realm of digital banking services.

4. Artificial intelligence

AI explores the capabilities of information and communication technology (ICT) by imitating human problem-solving skills, which include thinking, learning, and self-correction. AI can be applied across various industries, with the banking sector being one of the most significant. In this field, systems employ complex algorithms capable of handling large amounts of data and making autonomous decisions.

4.1 Definition of Artificial Intelligence

AI is defined as the capability of machines or software to perform tasks that typically require human intelligence, such as visual perception, decision-making, and language translation. AI systems utilise algorithms and machine learning techniques to acquire knowledge from data and gradually improve their performance, The term AI refers to the concept and development of computer systems capable of executing tasks traditionally dependent on human intelligence. It encompasses two primary components: machine learning, which enables computers to learn autonomously without explicit programming, and deep learning, a subfield of machine learning that relies on algorithms structured in a manner that mimics the logical processes of the human brain, commonly known as artificial neural networks. It is equally important to clarify what AI is not,to avoid common misconceptions. AI is not a substitute for human intelligence or expertise, and it is not without flaws; without meticulous design, systematic testing, and continuous supervision, AI systems may produce errors or biased outcomes. While AI excels in performing specific tasks with high precision and efficiency, it lacks essential human qualities such as creativity, intuition, and empathy traits that are fundamental to learning and human communication (Jose & Jose, 2024).

The Arab Monetary Fund defines AI as imitating human behaviours using intelligent robots or machines equipped with systems that allow them to think similarly to humans. These systems can perform problem-solving, decision-making, speech recognition, translation, and more tasks. AI is an advanced computer system capable of simulating human skills using rules and data (Nasrallah, 2021).

John McCarthy, often regarded as the father of AI due to his groundbreaking contributions, coined the term in the 1950s. He defined it as the science and engineering of creating intelligent machines. His motivation stemmed from his belief that humans would better understand their intelligence through this endeavour. Today, there are numerous definitions of AI; however, defining it precisely is challenging due to the field's rapid evolution. Behaviours once considered intelligent may no longer be noteworthy. A simplified way to define AI is the science of creating machines that operate intelligently and exhibit human-like behaviour to complete tasks requiring human intelligence. AI can also be seen as a cognitive potential for problem-solving and finding solutions. In summary, it is intelligence shaped by humans and exhibited by machines—a human-made tool that mimics the cognitive functions of the human brain. This distinction highlights how AI differs from other technological concepts, such as the Internet of Things (IoT) and big data. AI utilises IoT devices and sensors to collect data for analysis and processing (Cedersund, 2023).

Based on previous definitions, AI can be defined as the science that enables machines to behave in a way that mimics human intelligence by developing computer programs that think like humans. AI is characterised by its ability to make various inferences and learn from mistakes, allowing machines to perform tasks with exceptional speed and skill.

4.2 Characteristics of AI

AI has a set of key characteristics that make it an effective tool in developing digital banking services. Foremost among these characteristics is the ability of intelligent systems to mimic human cognitive processes. Machines can mimic cognitive functions such as thinking, learning, and problem-solving, like the human mind. Furthermore, these systems can collect external data and adapt to changes in environments or inputs, allowing them to handle dynamic conditions with flexibility. AI systems can also learn from available data, enabling them to improve their performance over time without the need for explicit reprogramming. In the context of decision-making, these systems enable informed decisions and logical conclusions, mimicking human thought processes. Furthermore, AI can manage and operate specific systems, contributing to enhanced efficiency and accuracy in operations. Finally, AI is characterised by its ability to predict future developments based on current data trends, supporting proactive planning and strategic decision-making that enhances the effectiveness of financial institutions in facing challenges (Nedelko, 2024).

4.3 Levels of Development of AI

AI varies in complexity and operation and is categorised into three levels: weak to super-intelligent, as outlined below (Tai, 2020):

4.3.1 Narrow AI (ANI) or Weak AI

This type focuses on performing specific tasks within limited domains, such as facial recognition, voice recognition, or autonomous driving. They are also known as Applied AI (AAI), which mimics human intelligence for designated tasks to create commercially viable smart applications. While narrow AI enhances human quality of life, it also poses risks if malfunctions occur, such as disrupting electrical grids or damaging nuclear facilities.

4.3.2 General AI (AGI)

This represents a more advanced form of narrow AI capable of independent thought and problem-solving for tasks not pre-programmed. AGI can learn and understand any intelligent task with its reflective intelligence, potentially matching or exceeding human performance in those areas.

4.3.3 Super-intelligent AI (ASI)

This is the third generation of AI, sometimes called true AI due to its ability to solve problems instantly across various domains and outperform humans in all tasks. For instance, it could simultaneously solve complex mathematical equations or write a bestselling book instantly with minimal errors. This type of AI currently exists only in science fiction, where it significantly surpasses human knowledge and capabilities.

The distinctions among these levels of AI development are summarised in Table 2.

Table 2. The variation between stages of AI development.

Narrow AI (ANI)	General AI (AGI)	Super-intelligent AI (ASI)
- Weak AI , below human level. - Application of AI in a limited field of work. - Lack of independence and inability to solve problems outside the scope of human intervention. - Partially equals or exceeds human intervention in specific, limited areas.	- AI equivalent to human-level. - application of AI across many domains. - Ability to independently solve problems in multiple areas. - Excessds and equals humans in many domains.	-Self-aware and conscious, surpassing human level. - Application of AI in all fields. - Ability to solve problems instantly across all domains. -Outperforms humans in all areas.

Source: (Kaplan and Haenlein, 2019)

4.4 Techniques of Artificial Intelligence

AI encompasses various technologies and methodologies to create intelligent systems that perform tasks usually requiring human intelligence. Some of the key technologies used in AI are shown in Figure 2 (Hussain, 2018).

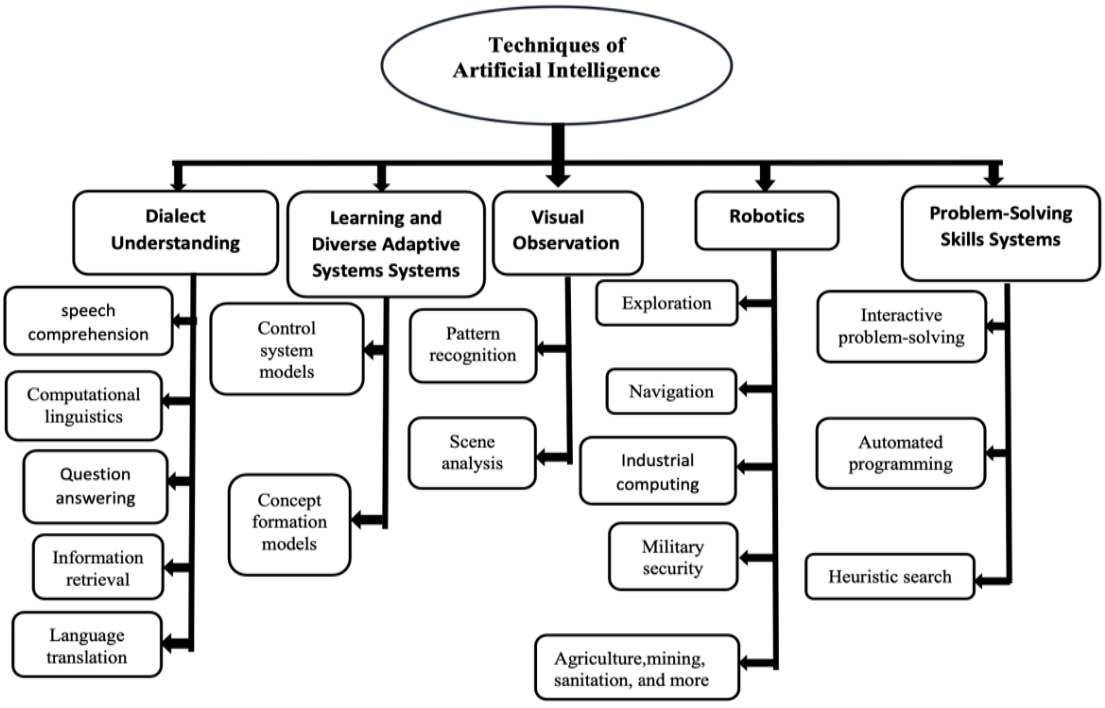

Figure 2. Classification of AI Techniques

Source: Prepared by the researchers based on (Hussain, 2018).

AI technologies comprise a range of interconnected subfields, the most prominent of which is dialect understanding. This field focuses on understanding spoken language and analysing it in written form, with the ability to interpret diverse dialects. This requires developing a systematic framework for recognising different dialects and navigating between the most common ones while adhering to dialogue standards. This field has seen significant progress in speech understanding, computational linguistics, question answering, information retrieval, and language translation. Variable learning and adaptive systems aim to enable systems to modify their behaviour based on previous experiences and extract general rules from those experiences, leading to the development of models such as control system models and concept formation models. Concerning visual perception, this technology enables systems to analyse spatial situations by linking them to an internal model representing "human information" about perceived objects. This includes pattern recognition and scene analysis. Problem-solving skills focus on appropriately representing dilemmas and drawing conclusions related to them, while determining when and how additional information is needed to solve them. These skills include interactive problem-solving, automated programming, and heuristic search. Finally, robots combine most or all of these capabilities, enabling them to move through different environments and manipulate objects through tasks such as exploration, navigation, industrial computing, military security, as well as domestic, agricultural, mining, sanitation, and other applications.

4.5 AI and Computing Activities

As the OECD AI Expert Group explains, an AI system is a machine-based system capable of generating predictions, recommendations, or decisions that influence real or virtual environments to achieve a specific set of human objectives. This system uses machine and human input to perceive environments, summarise perceptions into models automatically or manually, and use model-based reasoning to formulate information or action options. These systems operate with varying levels of autonomy. A knee-jerk reaction to the issues surrounding AI applications in the financial sector might be to limit them to this inherently fragile sector. However, the study demonstrates that this is a mistake if the issues are properly understood and addressed. Given the financial sector's strict regulation, and for good reason, the study discusses how AI interacts with existing rules and how "horizontal" AI regulations could impact the financial sector (OECD, 2021).

Figure 3 presents various AI-based computing activities used in global economic practices that require synchronisation, real-time processing, speed, accuracy, data security, and transaction security in today's global economy.

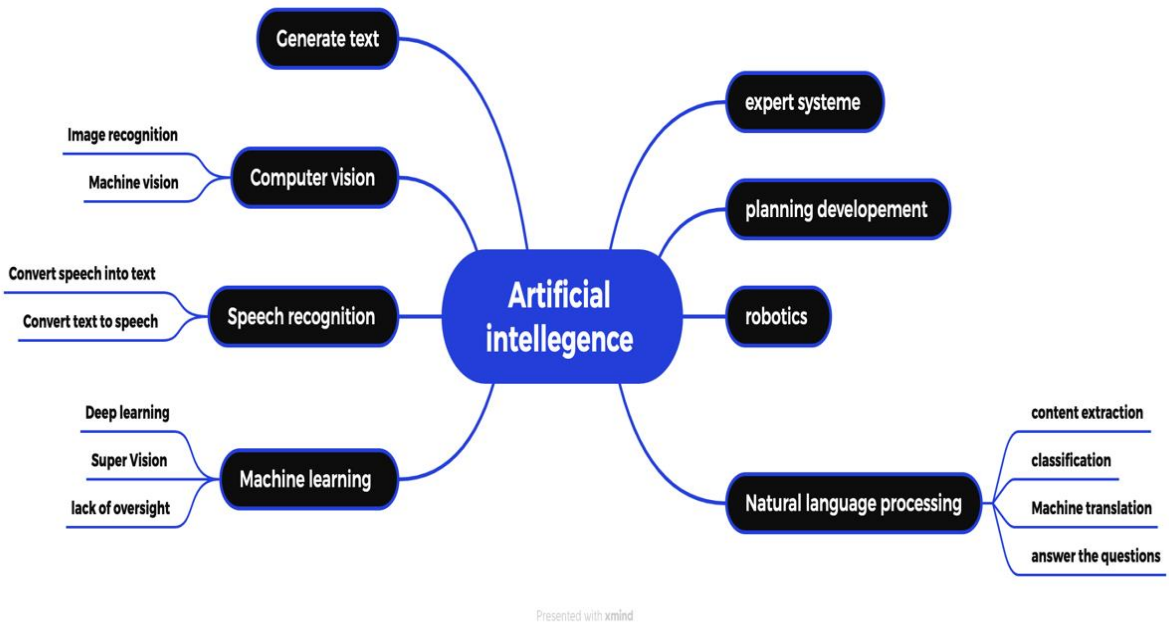

Figure 3. AI-Based Computing Activities.

Source: (Sugiharto et al.,2023)

4.6 The Returns from the Contribution of AI Technologies Worldwide

AI technologies are expected to generate significant economic returns by 2030, with China and North America set to benefit the most. AI is expected to contribute $7 trillion to China's GDP and $3.7 trillion to North America's, representing 26.1% and 14.5% of their economies, respectively. Europe will also see significant benefits, with the economic impact in Northern and Southern Europe expected to reach $2.5 trillion, while

developed Asia will see gains estimated at $0.9 trillion. In contrast, gains in Latin America, the combined regions of Africa, Oceania, and other Asian markets will be more modest, reflecting differences in adoption levels and economic capabilities between global regions (PWC,2017), as shown in Figure 4.

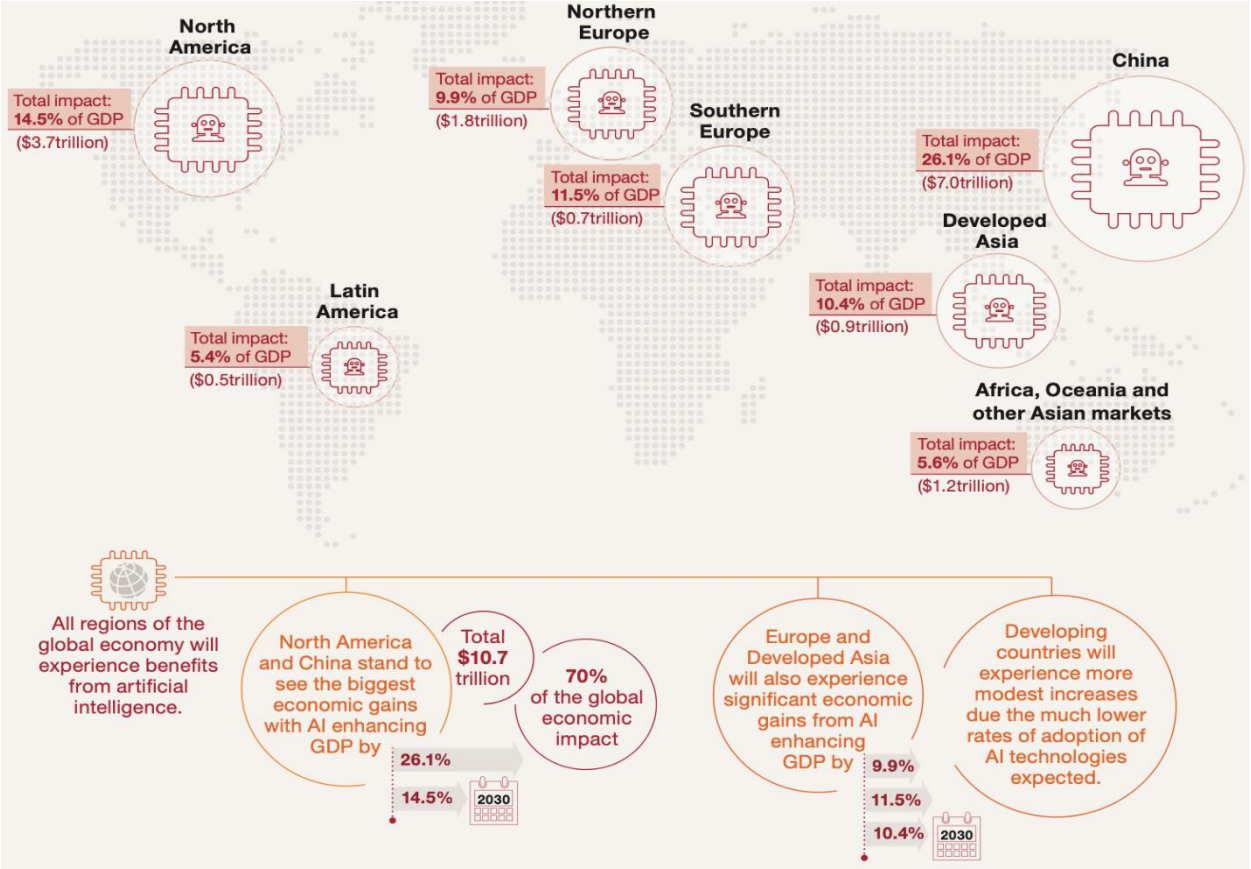

Figure 4. Projected Economic Impact of AI Technologies by Region Worldwide

Source: (PWC,2017)

Figure 4 shows that AI technologies will have a significant economic impact on the globe by 2030. Although the effects are not uniformly distributed across regions, this calls for examining regional differences in AI-driven economic growth and exploring the drivers behind such differences. China and North America are the two regions that stand to benefit most from the implementation of AI, as China is predicted to witness an economic boost of 26.1% of its GDP (which is $7 trillion) and North America is predicted to see a 14.5% GDP boost (which is $3.7 trillion), making them the front runners in the AI-powered global economy. By contrast, Southern Europe (11.5% of GDP, or $0.7 trillion), Northern Europe (9.9% of GDP, or $1.8 trillion), and developed Asia (10.4% of GDP, or $0.9 trillion) constitute a second tier of gainers. These regions can expect to experience large economic gains, though ones that are considerably less than China's and North America's. Developing and emerging economies, such as Latin America (5.4% of GDP, or $0.5 trillion) and the combined Africa, Oceania, and other Asian markets (5.6% of GDP, or $1.2 trillion), can expect milder impacts, primarily because AI is less prevalent in these countries. Worldwide, AI is anticipated to create an economic value of $10.7 trillion, and 70% of this value is centred in the examined areas, which implies that worldwide financial disparity will rise if AI is adopted further. Digital banking services have a growing part to play in this environment, based on the infusion of digital technology in banking, and customers can carry out financial activities and access online bank services. These services have been significantly influenced by forces like user experience, technological adoption, and AI utilisation that drive their continuous change.

5.1 Definition of Digital Banking Services

Digital banking services refer to the digitalisation of all traditional banking activities and services previously only accessible to customers through in-person visits to bank branches. These services allow customers to manage accounts, carry out transactions, and access financial services online, typically via mobile applications or websites. This process employs advanced technologies to improve user experience and operational efficiency. Below are key definitions and concepts related to digital banking services based on recent research:

5.1.1 Digital Banking Services in Terms of Technological Integration

Digital banking services involve the transition from traditional banking methods to online and mobile banking platforms. This evolution is driven by mobile applications, biometric authentication, artificial intelligence (AI), machine learning (ML), and blockchain technology, which together enhance banking operations and customer experiences (Shaimerdenova et al., 2023).

5.1.2 Digital Services in Terms of Information Considerations

With the advent of digital services, challenges arise concerning cybersecurity and organisational structures. The frameworks within which these networks operate must address numerous risks to ensure the secure provision of digital services. Additionally, new technologies must be integrated with consumer trust requirements (Shaimerdenova et al., 2023).

5.1.3 Digital Banking in Terms of Financial Technologies

The integration of financial technologies into digital banking services facilitates the generation and storage of vast amounts of data, enabling banks to offer personalised services and improve decision-making processes related to investments and credit. AI and blockchain play a crucial role in enhancing information security and operational efficiency within digital banking (Melnychenko et al., 2020).

5.1.4 Digital Banking from a Customer-Centric Perspective

Customer-focused experiences are tailored according to individual preferences and behaviours. These services are adopted for clear advantages and ease of use, particularly among younger demographics who prioritise convenience and efficiency in their banking experiences (Nurahmasari, 2023).

Based on the above definitions, digital banking can radically transform the financial landscape by providing more convenient and efficient banking solutions. It enables the use of advanced technologies, enhances the focus on personalisation to meet customer needs, and requires a robust regulatory framework to address security challenges and ensure compliance with legal standards.

5.2 Content of Digital Banking Services

Digital banking services primarily encompass online and mobile banking. Online banking allows customers to access banking services from a computer via the bank's website. Through this platform, customers can log into their accounts to check balances, pay utility bills, and apply for loans or credit cards at various banks using the online banking portal. This service enables customers to manage their financial tasks remotely while seated at their computers.

Mobile banking, on the other hand, involves using an application to access similar banking features through mobile devices such as smartphones and tablets. Banks develop and provide these applications where customers hold their accounts, typically using the same login credentials as the online banking portal. Mobile banking applications are often designed with user-friendly interfaces, incorporating frequently used banking features such as mobile cheque deposits, money transfers, and bill payments. They may also include convenient options like peer-to-peer payments through platforms such as the CPA mobile app from the Algerian Popular Credit Bank. Additionally, banks can use their mobile apps to send customers alerts regarding fraud detection and low account balances.

In summary, the equation that encapsulates digital banking is: Online Banking + Mobile Banking = Digital Banking (Napoletano, 2024).

5.3 Advantages of Digital Banking Services

Digital transformation in banking applications offers numerous advantages that contribute to improving banking services. These can be summarised as enhancing competition by increasing the competitiveness of digital banking services, especially with the continuous improvements in quantity and quality of services aligned with the Fourth Industrial Revolution. This is in addition to supporting technological progress through the rapid development of communications technology and computer software. It also facilitates communication through advanced technological networks that enable interaction between internal and external parties, overcoming geographical and time barriers to complete banking, commercial, and financial transactions remotely without the need for a direct physical presence between the parties involved in the banking relationship. This enables the provision of cross-border services without geographical restrictions. Furthermore, it contributes to reducing congestion in bank branches by enabling customers to manage their accounts remotely via personal computers or mobile devices, enabling transfers, payments, and other transactions. Digital transformation expands customer access, allowing access to a wider customer base without restrictions related to location or time, as services can be requested at any time, providing convenience, ensuring the confidentiality of transactions, and enhancing customer confidence (Qarziz et al., 2022).

5.4 Applications of AI in Digital Banking Services

AI technologies have become integral to everyday life, prompting banks to deploy them to digitise their services. The applications of these technologies can be summarised according to the taxonomy depicted in Figure 5 (Geetha, 2021).

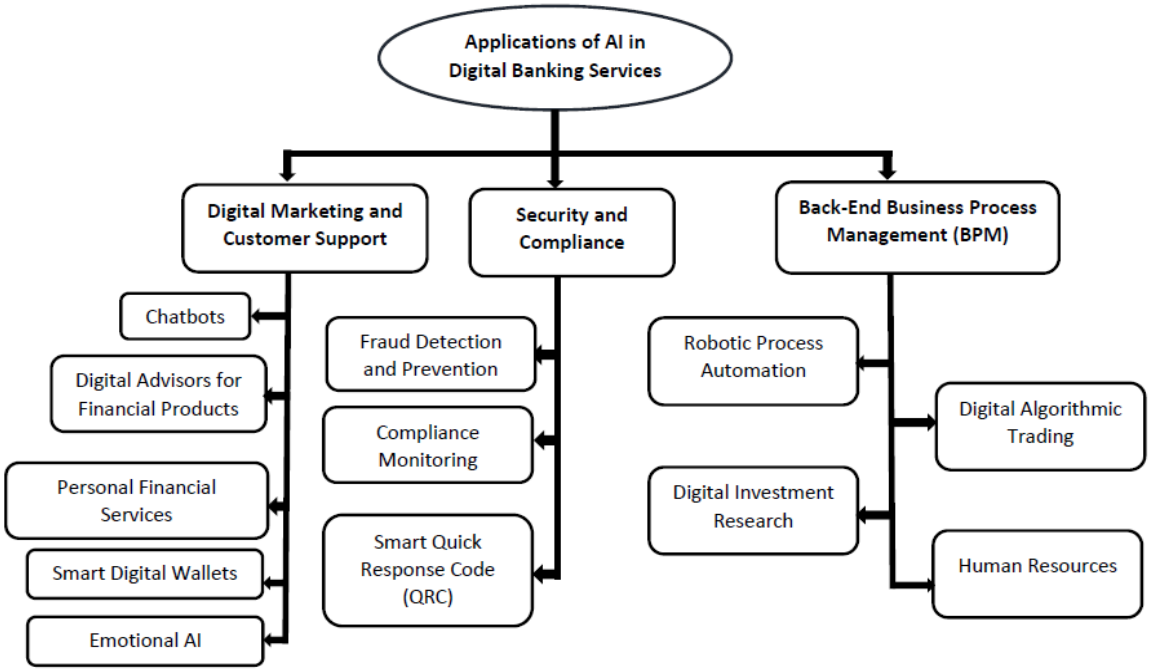

Figure 5. Taxonomy of AI Applications in Digital Banking Services.
Source: Prepared by the researchers based on (Geetha, 2021)

5.4.1 Digital Marketing and Customer Support

AI applications are a pivotal element in enhancing digital marketing and customer support in the banking sector. Chatbots are self-learning programs designed to engage in intelligent conversations with humans via chat or voice. They are available 24/7, easy to use, and able to respond to customer inquiries at any time. Digital financial advice platforms, powered by advanced algorithms, provide financial advice, reinvest profits, and automatically create and rebalance investment portfolios with limited human intervention, enhancing the financial services provided. In contrast, personalised financial services, through robo-advisors, focus on monitoring clients' goals and suggesting buys or sells of stocks and bonds, offering personalised attention tailored to the client's preferred risk level. Smart digital wallets, powered by AI, enable the management of various digital services, including chat, booking buses, taxis, events, and movie tickets, and paying utility bills, enhancing the customer experience. Finally, emotional AI, as a branch of AI, plays a vital role by enabling machines to detect human emotions using advanced facial and voice recognition techniques, which greatly supports the process of identifying customers and understanding their needs.

5.4.2 Security and Compliance

AI technologies are a critical tool in enhancing security and compliance in the banking sector. Machine learning-based fraud detection and prevention platforms are used to automate processes, reducing the need to continually expand workforces to detect fraud and counter security attacks. AI also contributes to compliance monitoring by scanning lengthy documents and flagging potential issues within seconds, tasks that would otherwise take several hours. Meanwhile, the Quick Response Code (QRC), a new AI-powered tool, is emerging to help companies stay compliant by ensuring no documents are overlooked when filing, while reducing risk by monitoring customer behaviour based on empirical data.

5.4.3 Back-End Business Process Management (BPM)

AI is increasingly transforming how banks manage their back-end operations, introducing advanced tools that enhance both efficiency and accuracy. One of the most prominent of these tools is robotic process automation (RPA), where software robots are used to handle large amounts of routine administrative tasks, saving time and improving operational accuracy. In algorithmic trading, AI processes data from multiple financial markets in real time to make immediate investment decisions. Global trading is estimated to be driven by algorithms at over 70%. AI is also reshaping digital investment research by helping investors make more informed decisions when selecting stocks. It enables broader coverage of companies listed on global stock

exchanges, conducts in-depth analysis, and supports effective portfolio management. Furthermore, AI is having a significant impact in human resources by streamlining recruitment processes. It facilitates onboarding, screens candidates through social media, conducts initial assessments through chatbots, and even predicts employee turnover, saving valuable time for HR teams.

5.5 Obstacles to Using AI in Digital Banking

Despite its vast potential, several external factors could hinder the adoption of AI in the banking sector. The General Data Protection Regulation (GDPR) of the European Union, which came into effect in 2018, includes protective clauses regarding automated decision-making. This regulation affects not only the financial industry but all sectors in general. Article 22 of the GDPR states: "The data subject shall have the right not to be subject to a decision based solely on automated processing." This presents a challenge for AI tools that inherently make decisions automatically. To comply with Article 22, human intervention may be required at some point in the process so that the final decision in the AI chain is made by humans.

Additionally, Article 13 of the GDPR includes disclosure provisions. For example, if an AI tool denies a bank account or loan application, the customer has the right to know the reason for this decision. While this does not necessarily require revealing the source code, the AI algorithm must be disclosed in detail after reviewing some input information. Compliance with these processes and other data privacy rules may require human programmers' involvement, potentially reducing the efficiency gains expected from AI (Kaya, 2019).

6. MasterCard's Experience with Artificial Intelligence in Enhancing Digital Banking Services

6.1 Overview of MasterCard

MasterCard is a leading technology company in the global digital payments industry, connecting consumers, financial institutions, merchants, companies, digital partners, and other organisations worldwide. It facilitates using electronic payment methods as an alternative to cash and cheques. The Interbank Card Association (ICA) was founded in August 1966 by a group of Greek individuals to establish a framework for credit card payment systems (Master Charge). The association was governed by consensus among member banks, which set card licensing, clearing, and settlement guidelines. Within two years, the system was launched internationally. Innovations included the creation of a computer network to replace telephone authorisations in 1973, the introduction of the magnetic stripe on cards in 1974, and the automation of card vouchers in 1975, replacing the need for mailing. In 1979, Master Charge was rebranded as MasterCard.

Further automation improved global licensing during the 1980s after acquiring Cirrus, the largest ATM network worldwide. By the 1990s, MasterCard holders could withdraw cash at over 50,000 locations globally. In 1991, MasterCard introduced the Maestro debit system, enabling cardholders at participating banks to pay for transactions directly from their accounts. As of 2021, MasterCard employed approximately 21,000 people worldwide and reported net revenues of $15.301 billion, a decrease of 8% from 2019 due to the impact of the COVID-19 pandemic (Mastercard, 2024).

MasterCard was created to enable payments and clear transactions through digital payments. Banks issued MasterCard-branded cards to their customers to facilitate purchases, while retailers agreed to accept these cards for transactions. MasterCard's technology digitally transmits the information to the bank for payment approval when a purchase is made. The data is immediately transferred through the system to authorise payment and transfer funds from the issuing bank to the acquiring bank. Notably, MasterCard only knows the card number initiating the transaction; all other personal customer data, such as names, contact details, and purchase history, is retained by the issuing bank (Isik & Simone, 2022).

6.2 AI at MasterCard

MasterCard's vision was to establish itself as a leading hub for AI, enhancing its digital services and solutions while improving operational efficiency and effectiveness. The company recognised AI as a powerful tool to support innovation and cybersecurity, including efforts to combat money laundering. Researching AI algorithms involves defining the problem (what is being solved or the desired outcome), preparing data (organising and cleaning it, checking for inconsistencies, and labelling if necessary), and selecting solutions and training algorithms with the data. Rohit Chauhan, who led MasterCard's AI Garage, established in 2018, explained that AI differs from traditional computing by relying on training AI models in general systems that are not based on AI. In AI systems, data is provided to train the model until it can generate its requirements to achieve the desired outputs. MasterCard identified that one potential issue in deploying AI could be biases inherent in the database. The company developed its requirements to address these biases, prioritising transparency and interpretability to enable AI to replicate the same logic with new input chains. Another concern was the unconscious biases of those creating algorithms, as AI developers may introduce perspectives influenced by their education and life experiences, including gender, religious views, and cultural backgrounds. MasterCard sought to govern AI through a governance framework to optimise AI use, integrating AI into its

operations systematically (Isik & Simone, 2022). To make the best use of AI, the company has strived to govern it through the AI governance framework represented in Figure 6.

Figure 6. Industrial Engineering Framework
Source: (Isik & Simone, 2023)

Mastercard's AI governance procedure is set on a sequence of steps to encourage the responsible and effective use. The process begins with goal assessment, where the intended use case is assessed for alignment with Mastercard's fundamental values and if it brings value in enhanced operational efficiency. This is then followed by a careful review of the data to make sure that the most appropriate and quality data are used to generate the required outcomes. Then, the use case is walked through with the data model design to make sure that both the data and the model are fit for purpose. This step also encompasses identifying and dealing with any biases that are present. Upon developing and piloting the model in the real world, the model's logic and performance are evaluated for ongoing effectiveness and productivity. Importantly, the model does not end with deployment but includes ongoing monitoring and auditing for tracking the AI tool's long-term performance and ensuring sustained compliance with relevant standards. Finally, a risk assessment model is used to determine whether any residual risks remain. Where medium or high risks are identified, consultations with the relevant stakeholders are initiated to make informed decisions on the release or adaptation of the AI system (Işık, 2023).

6.3 Mastercard's adoption of AI in the development of digital banking services

When discussing Mastercard's adoption of AI in the development of digital banking services, several key elements can be highlighted to provide a comprehensive understanding of how the company leverages AI to enhance its operations and services:

6.3.1 Strengthening Consumer Protection with Generative AI

As technology-savvy fraudsters increasingly target banks and customers, Mastercard is deploying cutting-edge generative AI technologies. These AI systems, which sit between specialised narrow AI and more advanced general AI, are being utilised to strengthen security measures that safeguard consumers and the entire payment network. Mastercard's Decision Intelligence (DI)solution, unveiled at the Mastercard Global Risk Leadership Forum on 20-21 March 2017 in Dubai, helps banks securely process and approve 143 billion transactions annually. This innovative generative AI technology analyses an unprecedented trillion data points to predict the authenticity of a transaction. If a transaction's score falls below a customer's predetermined threshold, it is declined. This ensures that a transaction is only rejected when the software identifies significant discrepancies in the data. The next-generation DI Pro technology enhances Mastercard's existing capabilities by evaluating the relationships between various entities involved in a transaction to assess its risk, improving the overall DI score in under 50 milliseconds. Initial models suggest that these AI enhancements increase fraud detection rates by an average of 20% and, in some cases, up to 300%. With AI, Mastercard is transforming the speed and precision of its solutions, challenging traditional methods and diverting the attention of criminals and labour organisations. Kakai Agayla, Mastercard's Head of Cybersecurity Intelligence, asserts that the acceleration of algorithms will ultimately enhance the ability to predict events and build trust. By improving DI, banks find it easier to shield cardholders from significant fraudulent transactions while reducing false positives of legitimate transactions mistakenly identified as fraudulent. Ajay Bhalla, the President of

Mastercard's Cyber & Intelligence at Mastercard, highlighted that the solution's distinctiveness, validated through real-world partnerships and internal analysis, proves its effectiveness and has reduced false positives by over 85% over the past five years (Mastercard, 2024).

Mastercard has invested over $7 billion in cybersecurity and AI technologies. Implementing DI technology in 2017 had a major impact on Mastercard's revenue and growth by strengthening customer protection and trust. The data shows that Mastercard's revenue grew from $12,497 million in 2017 to $15,301 million in 2020, a notable increase from $10,776 million in 2016. This upward trend underscores the positive influence of AI on the company's financial success over time. (Gupta & Arya, 2024), as shown in Figure 7.

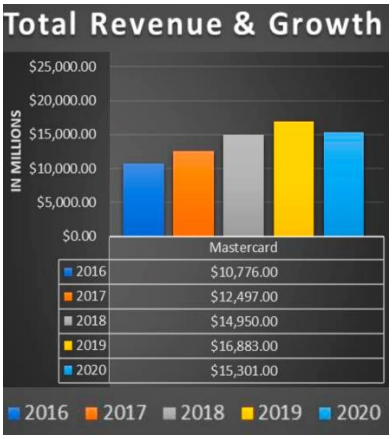

Figure 7. Total income and growth of MasterCard

Source: (Gupta and Arya,2024)

6.3.2 Digital AI Consulting Services at Mastercard

After implementing the DI solution, Mastercard acquired AI developer Brighterion and launched an AI technology service called AI Express, where companies can build digital models by offering digital consulting services using Mastercard's own AI algorithms. Taking advantage of Brighterion's strengths, Mastercard fosters rapid assimilation of AI technologies in the digital payment sector by opening up its code to more companies so that it may be utilised to develop machine-learning models aimed at curbing money laundering, forecasting credit risks, enhancing cybersecurity, and reducing fraud risks. On 2 October 2017, Mastercard rolled out the Mastercard Early Detection System, a machine-learning-based AI model that customers of AI Express can use to create their models; this system applies predictive analytics to assess whether a card is at risk for fraud identity and informs the card issuer if the risk is over a threshold set by the issuer (Erenhouse, 2018). Additional details on the features and advantages of this solution are illustrated in Figure 8.

Figure 8 MasterCard Early Detection System

Source: (Walker,2017)

Before Mastercard introduced the Early Detection System, the company had experienced a 400% increase in infections affecting mobile networks and Internet of Things (Iot) devices (Nokia Threat Intelligence Laboratories, 2016). In 2016, there were 4,149 breaches, exposing more than 4.2 billion records, nearly 3.2 billion more than the 2013 record (Risk Based Security, 2017). Identity thieves are searching for any consumer credentials they can obtain, and it takes only nine minutes for them to access user data. They publish this data on websites that hackers and others use for exchanging stolen credentials (Lazarus, 2017).

The primary tools employed by Mastercard to combat user data fraud include several key measures. In some cases, up to 40% of consumers use an alternative card less frequently after a breach (Walker, 2017). When a potential Account Data Compromise (ADC) event is detected, the assigned team must quickly assemble and conduct a risk assessment to determine whether an event has occurred, its nature, and its extent. The Incident Response Plan (IRP) should include promptly reporting any event or potential event to Mastercard within 24 hours and adhering to the guidelines outlined in the Account Data Compromise User Guide to assess the severity of an ADC event. This approach has enabled Mastercard to reduce account data breaches by 95% to 97% (Mastercard, 2019). Recognising that speed is crucial in combating fraud, Mastercard introduced its AI-driven Early Detection System, which replaces many traditional tools used for fraud detection. This innovative service offers issuers an early warning for cards and accounts at heightened risk of fraudulent activity due to exposure to security incidents or data breaches. By leveraging Mastercard's network insights, predictive capabilities, and a variety of internal and external data sources, the Early Detection System assesses whether a card or account has been compromised and sends an alert to the issuer, providing a quantified risk level (Nokia Threat Intelligence Laboratories, 2016).

6.3.3 Biometric Authentication for Purchases and Account Access

Mastercard offers an identity verification service called Mastercard Identity Check, which uses AI and machine vision to authenticate customers through digital data to approve transactions and access accounts. Biometric information, such as a customer's fingerprint, facial recognition, or even an eye blink, can be used to verify payments with Mastercard Identity Check. The company indicates that this solution applies to various financial services requiring authentication and is available to merchants interested in securing digital payments or e-commerce transactions. Merchants using Mastercard Identity Check can view biometric data approvals for each customer during the payment process. EMVCo's Three-Domain Secure (3DS) protocol supports this identity verification solution, which enables customers to verify their identity for card-not-present e-commerce transactions. The protocol adds a layer of security across three key financial domains involved in transactions: the merchant, the issuer, and the payment systems that transfer funds from the customer's bank or issuer to the merchant. The customer's biometric authentication results are shared as transactions move through these domains, helping merchants avoid fraudulent charges and potential chargebacks. It also assists issuers in ensuring that only fraudulent payments are declined, reducing the need for customers to cancel their cards due to fraud (Mejia, 2019).

7. Mastercard's AI-Powered Support for Small Business Success

Christen Nino De Guzman has established herself as a pivotal figure within the creator economy, drawing upon her extensive experience at leading platforms such as Pinterest, Instagram, and TikTok to broker partnerships between brands and digital content creators. Concurrently, she has developed a robust personal brand centred on providing career guidance, with her content amassing millions of views.

Leveraging her insider perspective, Nino De Guzman underscores the transformative influence of platforms like TikTok in democratising the creator economy. In the industry's earlier stages, success was often predicated on access to professional equipment and support teams. However, the current landscape increasingly prioritises authenticity, enabling individuals from varied professional backgrounds, such as dental hygienists, bartenders, and students, to achieve significant digital prominence. Nevertheless, this democratisation has not consistently resulted in equitable financial rewards.

Through her involvement in numerous brand campaigns, Nino De Guzman observed substantial disparities in remuneration, with influencers of comparable audience size and content quality receiving payments that differed by as much as tenfold. She attributes these discrepancies, in part, to the absence of standardised compensation frameworks in this emerging industry, noting that many creators lack the expertise or confidence to negotiate fair rates.

In response, she launched Clara for Creators in 2022, a digital platform designed to enhance pay transparency and promote equitable compensation practices within the creator economy. To date, over 34,000 creators utilise the platform to exchange experiences and access crowd-sourced mentorship.

In alignment with her commitment to empowering creators, Nino De Guzman collaborated with Mastercard to support the development of Mastercard Small Business AI, a generative AI-powered chatbot

tailored to deliver personalised mentorship to small business owners. According to a 2024 U.S. Small Business Administration survey, while over 90% of small and medium-sized enterprise owners recognise the value of mentorship, only 25% have access to a mentor. This tool addresses this gap by offering customised guidance across a spectrum of entrepreneurial needs, including business ideation, copyright navigation, financing, marketing, recruitment, and franchising opportunities.

The tool, informed by anonymised compensation data from Clara for Creators and Nino De Guzman's expertise, was developed in partnership with Create Labs Ventures, a social enterprise dedicated to broadening technology access in underserved communities. Additionally, Mastercard collaborated with media organisations, including Blavity, Group Black, Newsweek, and Televisa Univision, to ensure the AI's training content is inclusive and representative.

Currently undergoing pilot testing via Mastercard.com in the United States, the AI tool forms part of Mastercard's broader commitment to fostering small business growth, which includes a recently fulfilled pledge to integrate 50 million small enterprises into the digital economy. The company has also introduced Mastercard Biz360, a centralised platform consolidating essential tools for small and medium-sized enterprises. Reflecting on these advancements, Nino De Guzman emphasises the significance of scalable solutions: "Creators and small business owners frequently lack extensive support teams. Tools like this AI can deliver immediate answers, reduce reliance on outsourcing, and facilitate knowledge-sharing on a wider scale, rendering them invaluable assets in today's digital economy" (Hyman,2024).

8. Conclusions

Mastercard's integration of AI technology has revolutionised the financial industry, harnessing the power of machine learning and natural language processing to optimise operations, strengthen fraud detection, and personalise customer experiences like never before. AI has significantly improved the efficiency and accuracy of transaction processing, enabling Mastercard to offer tailored digital financial solutions that meet customers' unique needs. As AI continues to evolve and become more sophisticated, Mastercard is well-positioned to remain at the forefront of digital banking innovation, setting a new benchmark for the industry and redefining the future of financial services.

8.1 Study Findings

The study arrived at several conclusions, including the following:

- ✧ AI offers distinct features compared to human intelligence, which are the main reasons for investing in it.
- ✧ Implementing AI in the banking sector aids in advancing digital marketing, supporting customer service, and reducing fraud, money laundering, and common errors.
- ✧ Various factors are motivating Mastercard to adopt AI technologies to boost the digital transformation of its banking services through digital AI consulting, biometric authentication, and enhanced consumer protection.

8.2 Recommendations

- ✧ The African financial sector, particularly in Algeria, should prioritise adopting AI solutions and provide training to staff in these technologies, given their significant role in improving the banking system.
- ✧ It is crucial to formulate strategies for integrating AI technologies to digitise and enhance banking services securely and efficiently, ensuring the protection of users.
- ✧ Establishing AI governance in the banking sector is essential. This can be achieved by implementing key regulations and laws through the country's central bank.
- ✧ Enhancing digital banking services through AI should be informed by the experiences of fintech companies and should leverage their expertise in this area.

8.3 Future Scope for Research

In collaboration with IT engineers, we plan to implement an advanced AI-based framework to identify and prevent fraudulent activities, as well as enhance credit card security measures within the digital banking sector in Algeria. This proposed work is illustrated in Figure 9.

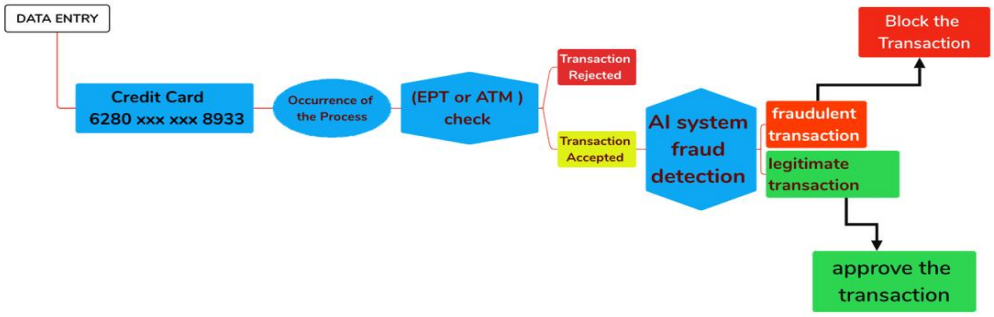

Figure 9. Proposed work on AI-powered fraud detection systems for credit card transactions

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