Artificial Intelligence and Digital Financial Inclusion

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Abstract

Artificial intelligence (AI) is rapidly growing with new use cases emerging every day. AI has many applications in the financial sector. It has applications for risk management, fraud detection, efficiency, cost savings and improved customer experience. However, its applications for digital financial inclusion and development finance are yet to be explored in the literature. This study explores how artificial intelligence can be used to increase digital financial inclusion. Specifically, the study explores the potential for AI to streamline the operations of agents of digital financial inclusion; determine the communal areas in need of digital financial inclusion; automate the digital formal account opening process; offer customized experience for both banked and unbanked adults; ensure security and safety of customers' funds; determine the credit worthiness of unbanked adults who have recently become banked; give banked adults full control of their financial lives; deepen digital financial inclusion; and promote equity and diversity for digital financial inclusion. The study also identifies the challenges of AI for digital financial inclusion. It further presents some insights on the possible AI governance frameworks for digital financial inclusion. The insights offered in this study are useful to guide countries and policymakers that want to use AI to accelerate digital financial inclusion.

Keywords: Artificial intelligence, financial inclusion, digital financial inclusion, AI algorithm, digital technology, unbanked adults, machine learning.

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1. Introduction

In the last decade, the financial services industry has witnessed a rapid surge in the use of digital technologies in different segments of the industry. Digital technologies offer opportunities for financial service providers to enhance the delivery of financial services, and to offer personalize financial services for clients in the financial services industry. While the use of digital technologies is growing in the financial sector, there are on-going discussions about the prospect of using digital technologies to bring financially excluded people into the formal financial system (Malladi et al, 2021; Tay et al, 2022). By financially excluded people, I mean people who lack access to a formal account which could be a bank account or a mobile money account. Lack of ownership of a formal account means that they cannot access basic formal financial services. Presently, there are 2billion unbanked adults in the world who lack access to a formal account according to the World Bank's Global Findex 2023 data. Digital technologies can be used to bring many unbanked adults into the financial system to reduce the number of people who are unbanked globally.

Digital financial inclusion refers to the use of digital technologies and digital systems to bring unbanked people into the formal financial system (Khera et al, 2021). Put differently, digital financial inclusion refers to the use of digital technologies and digital systems to enable access and use of formal financial services by members of the population (Ozili, 2022). The digital technologies and systems that are used to accelerate digital financial inclusion can be anything ranging from a basic 'mobile phone' to 'unstructured supplementary service data (USSD', 'financial technology (Fintech)' or 'artificial intelligence systems'. This article focus on the latter. It explores how artificial intelligence systems can be used to accelerate digital financial inclusion.

Artificial intelligence (AI) is the use of computers or machines to perform tasks that are traditionally performed by humans (Fetzer and Fetzer, 1990; Boden, 1996). AI systems perform some tasks more efficiently than humans. As a result, AI systems are being used to replace human efforts in many industries. AI technologies are also used by leading financial service providers to offer financial services, but their applications for digital financial inclusion have not been explored in the literature. Understanding how AI can help to accelerate digital financial inclusion is important because it can offer insight into how AI can close the financial exclusion gap and accelerate the attainment of sustainable development goal one (SDG1) which is "no poverty" because AI-assisted digital financial inclusion would enable people to

access and use affordable financial services much faster to improve their welfare and rise above poverty.

The intersection between AI and digital financial inclusion is important because of the ability of artificial intelligence systems to assist unbanked and underserved adults in accessing and using digital financial services at any time of the day. As a result, it has the potential to make digital financial services available and accessible to banked customers, save cost for digital financial service providers, reduce human error, and deliver seamless financial services. Despite these benefits, the literature has not examined how AI can increase digital financial inclusion. This study fills this gap in the literature by exploring how AI can increase digital financial inclusion.

This study contributes to the artificial intelligence literature that examines the widespread applications of AI across industries and disciplines (Zhang and Lu, 2021; Chowdhary, 2020; Minh et al, 2022). The present study contributes to this literature by exploring the applications of AI for digital financial inclusion. The study also contributes to the literature that examines the emerging enablers of digital financial inclusion (Thomas and Hedrick-Wong, 2019; Risman et al, 2021; Ozili, 2018). The present study contributes to this literature by showing that AI can potentially support ongoing efforts aimed at increasing the level of digital financial inclusion in society. The study further contributes to the broad financial inclusion literature which examines how digital technologies can be used to accelerate financial inclusion (Demirgüç-Kunt and Klapper, 2012; Wang and Guan, 2017; Ozili, 2021). The present study contributes to this burgeoning literature by showing that AI is an advanced digital technology system that can support policy efforts to increase the level of financial inclusion in countries.

The chapter is arranged in the following order. Section 2 presents a review of theory and the literature. Section 3 presents the global interest in AI and digital financial inclusion information. Section 4 presents some strategies on how AI can increase digital financial inclusion. Section 5 presents some challenges of AI for digital financial inclusion. Section 6 discusses AI governance for digital financial inclusion. Section 7 presents the conclusion of the study.

2. Theory and literature review

2.1. Theory

In the theoretical literature, the technology acceptance model is commonly used to explain the acceptance and use of technology in society (Davis et al, 1989; Lu et al, 2003; Legris et al, 2003; Ghazizadeh et al, 2012). The technology acceptance model can also explain the acceptance and use of artificial intelligence to accelerate digital financial inclusion. The technology acceptance model argues that the willingness of individuals to use a technology depends on the perceived usefulness of the technology and the perceived ease of use of the technology (Davis et al, 1989). In the context of this study, the implication of the technology acceptance model is that the willingness of financial service providers to use artificial intelligence systems (i.e., technology) to accelerate digital financial inclusion depends on the perceived usefulness of artificial intelligence systems for digital financial inclusion and the perceived ease of use of artificial intelligence systems for digital financial inclusion. Other theoretical frameworks such as the digital agency theory of financial inclusion (see Ozili, 2024) which argues that digital agents can deploy artificial intelligence technologies to accelerate digital financial inclusion on behalf of the financial inclusion principal.

2.2. Literature review

The literature documents several applications of artificial intelligence in the financial services industry. Fares et al (2023), in a systematic review of literature, examined the use of AI in the banking sector and found that majority of the studies that were reviewed showed that AI was commonly used in the formulation of bank strategy, banking processes, and in customer service. Umamaheswari and Valarmathi (2023), also examined some roles of AI in banks. They showed that banks use AI-based virtual assistants to harmonise processes and they also use AI applications to automate their processes, enhance profitability, reduce human dependency, and enhance the overall performance of banks.

Rahman et al (2023) also examined the importance and challenges of using artificial intelligence in the banking industry focusing on Malaysia. They also examined the determinants of the intention to adopt AI. They used interviews to elicit responses from 302 bank customers in Malaysia. They found that AI was more important for fraud detection and risk prevention. The study also identified some challenges of AI for the banking sector. They are the absence of unclear regulations, risk of data privacy and security breaches, lack of

relevant AI-related skills and lack of relevant information communication infrastructure. They also found that the determinants of customers intention to adopt AI were attitude towards AI, perceived usefulness, perceived risk, perceived trust, and subjective norms.

Ho and Chow (2024) assessed the effect of retail banks' AI marketing efforts on the brand preference of customers in Hong Kong. They argued that artificial intelligence can improve the consumer–brand relationship. Using questionnaire survey collected from 300 Gen Z respondents, the authors found that AI marketing efforts significantly affected brand experience, brand preference, and the repurchase intention of customers. It was also found that brand experience moderated the relationship between AI marketing efforts and brand preference. Manrai and Gupta (2023) examined the perception of investors toward artificial intelligence and robo advisory services. They also examined the factors influencing investors intention to adopt artificial intelligence and robo advisory services. Using responses obtained from the convenience sampling of 252 investors from Delhi NCR between January and February 2020, the results showed that trust, perceived usefulness, perceived ease of use, and attitudes had a significant influence on AI-based investment.

Rane (2023) examined the role and challenges of generative AI technologies in the financial and accounting sectors. They showed that, in the financial sector, generative AI models help to streamline customer interactions, offer personalized financial advice, aid investment decision-making, facilitate real-time market analysis, enhance algorithmic trading, reduce risk management, and mitigate fraud detection. Meanwhile, in the accounting sector, generative AI models help to automate accounting data entry, automate financial report generation, reduce human errors, reduce operational costs, assist in compliance tasks, ensure adherence to regulations, and enhance forensic accounting methods. They also identified some challenges of generative AI in the finance and accounting sectors such as the ethical dilemma relating to data privacy, security, biased decision-making algorithms, data integrity, and the accountability of AI-driven financial decisions.

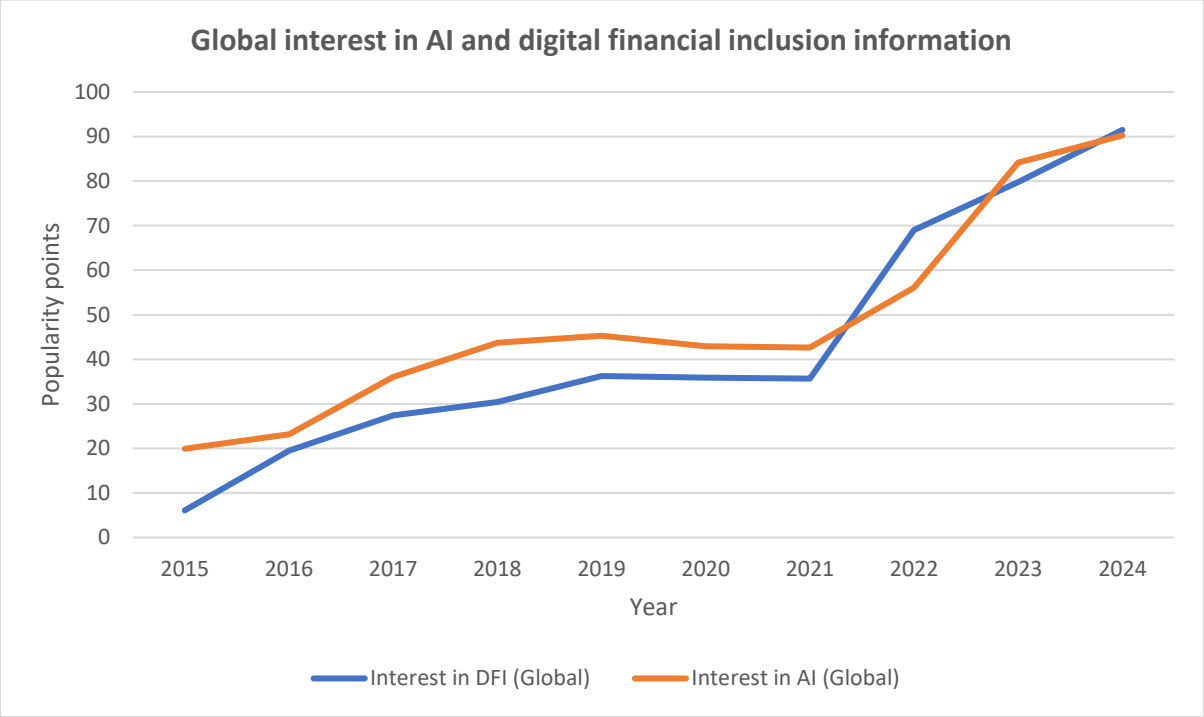
Arora et al (2023) examined the factors influencing customers' perceptions of AI-based FinTech services using survey questionnaires from 970 respondents from four Indian cities namely Mumbai, Delhi, Kolkata and Chennai. The factors used in the survey were service quality, trust commitment, personalization, perceived convenience, relationship commitment, perceived sacrifice, subjective norms, perceived usefulness, attitude, and vulnerability. It was found that service quality, perceived usefulness and perceived convenience were significant

factors impacting customers' experience with AI-enabled FinTech services. In a related study, Estep et al (2023) examined how financial executives feel about the use of artificial intelligence in financial reporting and auditing. They found that financial executives are not averse to using AI in their companies, but they feel uncertain about how auditors would use AI and they expressed concern that auditors may use AI in a way that would not benefit their companies. The above studies show several applications of artificial intelligence in the financial services industry, but these studies do not examine the effect of artificial intelligence on digital financial inclusion.

3. Global interest in AI and digital financial inclusion information

This section assesses the global interest in information about AI and digital financial inclusion. Monthly data of people's search for the term 'artificial intelligence' and 'digital financial inclusion' on Google were collected from Google Trends database for the 2015 to 2024 period. The monthly data were annualized by taking their annual average. The data are reported in figure 1. It shows that people increasingly searched the internet for information about artificial intelligence and digital financial inclusion during the period. However, people searched for more information about artificial intelligence than information about digital financial inclusion between 2015 to 2021. Interestingly, people's interest in information about digital financial inclusion exceeded their interest in information about artificial intelligence in 2022. Overall, the data indicates that people were very interested in both artificial intelligence information and digital financial inclusion information.

Figure 1. Global interest in AI and digital financial inclusion



Source: Google Trends

4. The ways in which AI can increase digital financial inclusion

This section explores the diverse ways in which AI can accelerate digital financial inclusion for unbanked and banked adults.

4.1. Using AI to streamline the operations of agents of digital financial inclusion

The agents responsible for accelerating digital financial inclusion can use AI systems to streamline their operations and enable efficient delivery of seamless financial services to both unbanked and underserved people. They can also use AI systems to offer financial services using AI-assisted digital apps, monitor customer engagement with AI-assisted digital apps, gain insight from customer usage data, and use the data to offer a variety of digital financial services to unbanked and banked customers.

4.2. Using AI-assisted geospatial intelligence to determine the communal areas in need of digital financial inclusion

Geospatial intelligence, also known as AI-assisted geospatial technology systems, can be used to survey rural areas to identify the most remote locations where people live and to determine whether digital financial services exist in those remote locations. Financial institutions and fintech operators often refuse to go to remote locations if there are no enabling information and communications technology (ICT) infrastructure, Internet infrastructure and other physical infrastructure in those locations. AI-assisted geospatial technologies can be used to conduct aerial geospatial survey to identify the most remote communities where financial institutions have refused to go because the remote communities lack the enabling road, electricity, internet, and ICT infrastructure. The authorities can then use the data generated from the AI-assisted geospatial technology to gain insight into the infrastructure deficit in these areas and provide the necessary Internet and ICT infrastructure so that fintech operators can rely on the infrastructure to offer digital financial services to people living in those remote locations, thereby increasing digital financial inclusion.

4.3. AI enables full automation of the formal account opening process

AI allows digital financial service providers to fully automate the account opening process for unbanked adults who are first-time users of digital financial services. The AI system can be designed to onboard unbanked customers as quickly as possible and with minimum documentation requirements so that they can quickly own a mobile money account or any other type of formal account and begin to make financial transactions that improve their welfare. The benefit of this to unbanked customers is the time savings and convenience it offers. The benefit of this to digital financial service providers is that it allows them to automate all routine account opening processes, it reduces the workload on the customer service staff, it saves cost, it improves efficiency, and it reduces human errors in the delivery of digital financial services.

4.4. Using AI to offer customized experience for both banked and unbanked adults

The agents responsible for accelerating digital financial inclusion can use AI technologies to deliver highly customized digital financial products and services that meet the unique needs and preferences of different customers. The agents responsible for advancing digital financial inclusion can use deep learning natural language processing techniques to analyze customer profile information (e.g., age, gender, location, etc.) and their transaction pattern (e.g., highest transaction amount, lowest transaction amount, frequency of financial transactions, etc.). The

AI systems can use this information to match specific digital financial services to customers with different profiles and different preferences. This will ensure that only relevant digital financial services are offered to banked and underserved customers. Where necessary, AI chatbots and robo-advisors can be used to solicit information from underserved customers and the collected information can be used to suggest the financial services that is right for each underserved customer.

4.5. AI can be used to ensure security and safety of customers' funds

Unbanked adults who bring their money into the financial system and access their money through bank apps and fintech apps will benefit from the deep learning cybersecurity AI algorithms embedded in bank apps and fintech apps. The cybersecurity AI algorithms embedded in bank apps and fintech apps can be used to (i) detect unusual attempts to access customers' bank account, (ii) detect any unusual transactions that were initiated, and (iii) disallow unauthorized transactions until the customer validates and approves the transaction. This is aimed at preventing fraudulent and unauthorized activity in the account of customers. This will make customers feel safe and prevent loss of customer's money. AI-assisted cybersecurity systems can alert a customer's bank about an attempt by a third-party to gain unauthorized access to a customer's account so that the bank can audit the third-party and take remedial actions against the third-party.

4.6. Using AI systems to determine the credit worthiness of unbanked adults

After bringing unbanked adults into the formal financial system using digital devices or digital apps, unbanked adults may seek to obtain loans from their digital financial service providers. The challenge they face is that they lack credit history and valuable collateral to post against the loans they take. AI can be useful in generating a credit score for newly banked adults who were previously unbanked. Digital financial service providers can embed AI-based credit scoring APIs into their digital lending platforms to generate a credit score for newly banked customers based on their 7-days or 30-days formal account activity and assign a loan threshold to customers based on their formal account activity. For example, newly banked customers that have performed more than 20 transactions in their account within a 30-day period should have a higher credit score and may be entitled to a maximum loan of $500 while newly banked customers that have performed only two transactions in their formal account within a 20-day period may be entitled to a lower loan amount of $100. The main point here is that AI systems can be used to generate credit scores for newly banked customers to enable them access formal

loans. Such easy access to loan can attract other unbanked adults to join the formal financial system through their digital bank apps and fintech apps in order to access formal loans, thereby promoting digital financial inclusion.

4.7. AI makes it much easier for banked adults to take full control of their financial lives

After unbanked adults have joined the formal financial system using digital apps or their mobile devices, they will be able to undertake financial planning through the AI algorithm installed in the digital apps or bank apps. They will be able to save money on the app from the comfort of their homes. The AI algorithms will be able to provide personalized savings, investment, and spending recommendations to the customer. The AI algorithm can also be programmed to help customers to achieve their financial goals by placing limits on daily spending via digital apps. Deep learning AI algorithms can also suggest areas for savings, budgeting, and financial discipline to the customer.

4.8. AI can promote equity and diversity for digital financial inclusion

Racial inequalities, ethnic discrimination and other forms of discrimination can prevent people from accessing formal financial services (Natile, 2020; Kofman and Payne, 2021). The authorities can create an AI-equity framework or policy that require digital financial service providers to use artificial intelligence tools that (i) offer the same opportunities to everyone, and (ii) offer the same level of access to digital financial services to people of all race and ethnic groups irrespective of gender, age, sexual orientation, physical abilities, and income status. Digital financial service providers should also be required to use AI algorithms that do not utilize customers' racial information and socioeconomic status as a basis to deliver certain types of digital financial services to customers. This will foster equity and inclusion. Also, customers from different backgrounds should be able to communicate their diverse financial needs to digital financial service providers who will develop AI algorithms that can assist customers in meeting those varied financial needs through their mobile phones or digital apps.

4.9. Use AI to deepen digital financial inclusion

Digital financial inclusion deepening refers to the use of digital technologies to increase the frequency of the use of formal financial services in the financial system (Kang, 2018). Digital financial service providers can use the AI algorithms embedded in fintech apps or bank apps to screen all customers and identify those customers who use formal financial services less frequently. Once they have been identified, the digital financial service providers can channel

their effort to know the reasons for the infrequent use of digital financial services, identify and remove any structural barriers that may be responsible for the infrequent use of digital financial services, and introduce incentives that could increase the frequency at which customers use their digital apps or fintech apps to undertake digital financial transactions such as to make digital payments, savings, deposits, investment, remittances and payment of goods purchased from oversees.

5. Challenges of AI for digital financial inclusion

Although AI presents an opportunity to increase digital financial inclusion, its use poses some challenges for digital financial inclusion.

5.1. Increase in transaction cost

Although AI algorithms can be incorporated into fintech and bank apps and can be used to offer easy-to-access digital financial services that can attract unbanked adults to use the fintech or bank apps, it must be acknowledged that AI algorithms are not cheap. The cost of deploying AI algorithms into fintech and bank apps to offer digital financial services is usually incorporated into the transaction fees charged to customers using fintech or bank apps. The challenge is that the transaction fees may become too expensive for newly banked poor adults who have little money in their formal account (Ahmad et al, 2020; Mader, 2018). The high transaction cost could be a setback for digital financial inclusion.

5.2. High risk of bias

Another challenge of using AI to accelerate digital financial inclusion is the potential for AI algorithms to have embedded bias that are discriminatory in nature. The embedded bias may arise from historical data or may be introduced by the people who developed the AI algorithms. Such embedded bias may lead to discriminatory digital financial services recommendations to newly banked customers, or the generation of discriminatory credit score for newly banked customers who are from certain ethnic groups or race. Bias in AI algorithms could also lead to discrimination based on income by offering high-income newly banked customers greater access to a wide variety of savings, deposit, credit, investment, and mortgage products, while poor unbanked adults will be granted limited access to digital financial services such as only savings and deposit products.

5.3. Digital literacy, financial literacy and language barriers can hinder digital financial inclusion

Newly banked adults who were previously unbanked will often be introduced to digital apps and fintech applications that have embedded AI algorithms. After customers have logged into the apps, the AI algorithms may offer recommendations and suggestions which customers do not understand because they are financial illiterate. Some newly banked adults may be digital illiterate. They need to be taught how to use digital apps and how to understand the recommendations and suggestions of the AI algorithms embedded in those apps. Sometimes, the difficulty may arise from language barriers especially if newly banked adults are non-English-speaking natives while the instructions on the digital apps are in English. In sum, the language barrier as well as digital illiteracy and financial illiteracy can hinder digital financial inclusion.

5.4. Cybersecurity risks

Just like every technology, AI can be used for good and bad purposes (Yudkowsky, 2008; Lombardo, 2021). The potential for AI to be used for bad purposes increases if cyber-attackers can exploit both the visible and hidden vulnerabilities in the AI algorithms used to accelerate digital financial inclusion. Cyber-attackers may launch an automated malware attack on newly banked customers to steal their personally identifiable information and to steal their money. Cyber-attackers can also create malicious codes that bypass existing security protections and launch a severe automated malware attack on the digital apps or fintech apps used to accelerate digital financial inclusion.

5.5. AI privacy risks

Data privacy risk may arise when AI is used to accelerate digital financial inclusion (Curzon et al, 2021). This risk may arise when digital apps use customers' historical transaction information to make customized payment and savings recommendations to customers even when customers did not give consent for their historical data to be used to offer payment recommendations and suggestions to them. Certain customers may be displeased with such pre-emptive recommendations because it indicates that their transaction history are being used without their consent or authorization. Furthermore, digital financial service providers may analyze customers historical transaction data to determine the add-on financial services that could be offered to specific customers, but such analysis may be done without obtaining customer's consent and it poses data privacy risk.

6. AI governance in digital financial inclusion

As AI becomes increasingly used to increase digital financial inclusion, ethical issues will arise. There will certainly be concerns that the data used to train AI models have embedded bias (Ntoutsi et al, 2020). Other concerns that may arise include lack of transparency, safety issues, liability issues and data privacy concerns (Wischmeyer, 2020; Falco et al, 2021). These concerns will lead to the need to establish ethical and regulatory governance frameworks to guide digital financial service providers when using AI-assisted digital technologies to bring unbanked adults to the formal financial system and when offering financial services to existing bank customers. There is a need for regulators and digital financial service providers to collaborate in developing AI governance frameworks that clearly identify the ethical challenges to using AI for digital financial inclusion, identify the risks, and outline some consensus principles to ensure that AI works for the benefit of newly banked customers. Such governance frameworks should have mechanisms that foster trust and innovation while mitigating privacy infringement and misuse of AI by digital financial service providers (Königstorfer and Thalmann, 2020). It should also have mechanisms that ensure that AI algorithms are constantly updated, monitored, and evaluated to ensure that AI algorithms do not lead unbanked adults to make bad financial decisions that diminish their welfare. Such frameworks will ensure that AI systems do not drift from their intended purpose and ensure that they serve customers meaningfully while addressing ethical concerns. Finally, the regulatory authorities should ensure that digital financial service providers comply with established policies, frameworks or practices that ensure the responsible use of AI technologies for advancing digital financial inclusion. The AI algorithms which they use to bring unbanked adults into the formal financial system should be guided by the principles of fairness, empathy, accountability, transparency, bias control, equity, privacy protection, innovation, and consumer protection (Wischmeyer, 2020; Falco et al, 2021; Königstorfer and Thalmann, 2020).

7. Conclusion

This study explored the role of AI in increasing digital financial inclusion. It highlighted the ways in which AI could be used to increase digital financial inclusion. The potential of artificial intelligence to increase digital financial inclusion is promising. AI offers many benefits for digital financial inclusion. For instance, AI can be used to streamline the operations of agents of digital financial inclusion. It can also be used to offer customized experience for both banked

and unbanked adults and to ensure security and safety of customers' funds. Geospatial AI can be used to determine the communal areas in need of digital financial inclusion. AI can also be used to automate the digital formal account opening process and to determine the credit worthiness of unbanked adults who have recently become banked. AI can also be used to give banked adults full control of their financial lives while also deepening digital financial inclusion and promoting equity and diversity for digital financial inclusion. AI also poses some challenges for digital financial inclusion which are the increase in transaction cost, high risk of bias, lack of digital and financial literacy, cybersecurity risks and AI privacy risks.

The exploration of the connection between AI and digital financial inclusion serves as a significant step in improving the level of financial inclusion using digital technologies. The insights offered in this study will assist policymakers in ensuring that AI works for the good of all users of digital financial services. Policymakers who are seeking to use AI to increase financial inclusion in their countries should collaborate with the private sector, financial institutions, and technology companies to find the right balance between AI-driven efficiency and the responsible use of AI for digital financial inclusion. Policymakers should also ensure that banked customers understand how AI algorithms interact with their data. Finally, the journey to increase the level of financial inclusion is not easy but AI-assisted digital technologies can hasten the process and make it much easier. AI can help digital financial service providers to improve efficiency while helping countries to increase their levels of financial inclusion after ethical concerns have been addressed.

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