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AI-Driven Digital financial Services: Unlocking Financial Inclusion Pathways in Algeria

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Abstract:
This paper examines the interplay between financial inclusion strategies and digital transformation within the context of Algerian banks. The adoption of artificial intelligence (AI) and machine learning (ML) technologies is explored as a mechanism to enhance digital financial services and promote financial inclusion.
The study underscores that digital transformation in banking improved service delivery, financial product diversification, and accessibility, thereby integrating underserved populations into formal financial systems. By analyzing global and local frameworks, this paper identifies critical barriers, including infrastructural gaps, cultural resistance, and limited public trust, that hinder Algeria's progress in digital financial services. Additionally, it highlights the role of FinTech and AI in reshaping financial ecosystems, offering tools for risk management, enhanced decision-making, and operational efficiency.
Keywords: Digital Financial Services; Artificial Intelligence; Financial Inclusion; Algerian Banks.
Jel Classification: G21, O 16, O33.

1. Introduction:

The primary importance of the financial system lies in facilitating the allocation and distribution of economic resources across time and space in environments characterized by high levels of risk. This function ensures the smooth mediation of financial transactions, regulates global exchange rates, and enables the transfer of resources from savers to borrowers efficiently. It also reduces risks and uncertainties

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in areas such as insurance and diversifies financial products. These financial transactions, which appear simple and essential today, were far more complex in the 1940s. Financial system operations inherently involve costs, including labor, machinery, and capital, incurred by financial intermediaries (such as banks). However, these operations occur within a defined market framework, where participants accept a certain level of capital risk, which represents additional costs. This dynamic constitutes the ecosystem in which financial and banking institutions operate, requiring information and data to sustain their activities and mitigate uncertainties and risks in capital management.

The global financial system has undergone significant structural changes, particularly in response to successive transcontinental capitalist crises and their economic repercussions. Among the most critical transformations are those affecting the banking sector and technological advancements, (Lin., Saliba., Bubar., Gantz., & Simms., 2022) which have reshaped legal frameworks and consumer preferences. The adoption of digital and technological innovations across the banking sector has become essential to ensuring the sustainability of financial systems, enhancing their effectiveness, and contributing to increased financial inclusion worldwide. (Kimani, 2016)

Many contemporary researcher, including (Mugane & Ondigo, 2016);(Kimani, 2016) emphasize the importance of digital transformation in fostering financial inclusion and improving the competitiveness of financial and banking institutions. Financial inclusion strategies expand the customer base of banking institutions, leading to shifts in their financial needs and preferences. This need integrating technological tools into financial services to improve the quality of these services, ensure faster and more accessible delivery without requiring physical visits to banking institutions, also guarantee the security of information networks and financial transactions both locally and globally. Meanwhile, (Frame & White, 2009)argue that

digital transformation strategies often entail significant capital investment, especially when implemented within a relatively short timeframe. They also highlight failures of such initiatives, which may stem from the public's reluctance to quickly embrace modern technologies in financial transactions, occasional mistrust of financial institutions, or the lack of suitable and secure digital infrastructure. Additionally, financial and banking institutions may fail to adopt standardized strategies due to the unique nature of their digital approaches, influenced by the type of services offered and the financial market in which they operate.

The contributions of theorists vary depending on the perspectives they adopt, with some supporting and others opposing the adoption of financial inclusion strategies to enhance digital transformation within banking institutions. This paper aims to explore the mechanisms through which financial inclusion influences digital transformation strategies. It will present key modern technological and digital tools adopted by various Algerian banks. Furthermore, most studies linking digital transformation in banking to financial inclusion determinants are conducted by official entities, such as the Financial Inclusion (FI) index for African and Arab countries, or analyze data from developed nations like the United States and the United Kingdom. This discrepancy is primarily due to the lack of data on these variables in certain regions and the relatively recent focus on AI driven digital transformation and financial inclusion strategies in banking environments.

Benefits of artificial intelligence (AI) and machine learning(ML) in analyzing big data and regulation technology are the most discussed in several papers, who's developing models for implementing technology in the banking, financial services and insurance (BFSI) sector. Financial inclusion is the only way to stay connected into the financial system in a pandemic or crisis. (Fazal & Ahmed, 2023)

Studies investigated the impact of financial innovation on traditional banks. (Mhlanga, 2020);;(Pattnaik, Ray, & Raman, 2024) have discussed the impact of

Fintech as an AI trading model on investment efficiency and risks. They analyzed the effect of RegTech, governance, shadow banking on financial inclusion. (Bao & Huang, 2021)

Other researchers explore the role of AI and ML in the (BFSI) sector, enhancing service quality, trust and mitigating risks. (Oualid, Hansali, Balouki, & Moumoun, 2022)obtained findings from investigating chat-bots; robo-advisors; sentiment analysis and text mining that expand insights into customer behavior.

The application of neural networks and ML techniques in the (BFSI) sector has a significant impact on prediction of bank failures, creditworthiness accurately and determining credit scoring models (Pattnaik, Ray, & Raman, 2024) future studies must elaborate sensitivity and scenario analysis which can help in tackling financial system failure and crisis.

Recent topics are about the effects of deep learning and deep neural networks applications for financial stability and risk management. Fuzzy logic has been used to model the behavior of financial system allowing for the prediction of exchange rate dynamics and inflation; other genetic algorithms have used to optimize and reinsure policies allowing efficient risk management. (Pattnaik, Ray, & Raman, 2024) Furthermore, robust and accurate models addressing the ethical concerns with use of AI and ML in the financial sector.

1.2. Research Problem and Hypotheses

Based on the aforementioned context, we pose the following question:
-What role do artificial intelligence strategies play in advancing digital financial services in Algeria to achieve financial inclusion?

To answer this complex question, which involves analyzing various variables within the banking environment, we propose the following hypothesis:

-Digital transformation, through the adoption of artificial intelligence strategies, contributes to enhancing digital financial services and, in turn, promoting financial inclusion in Algerian banks.

2. Theoretical framework:

Financial innovation refers to any development that contributes to reducing costs and financial risks while improving the quality of financial products, services, and tools within the financial system. High levels of risk in the financial sector highlight the importance of financial innovation. (Levine, 1999) Consequently, the rise of technological advancements associated with the internet era, such as digital technologies, the Internet of Things, big data analytics, and platform algorithms, has facilitated the emergence of new business models.

These developments have prompted governments to adapt policies, regulatory frameworks, and legislation to align with the digital transformation. This shift has also paved the way for new economic systems, such as the digital platform economy and freelance work, leveraging social media and search engine data to benefit business plans for companies, government entities, and financial institutions, among others. (OECD, 2017)

One of the sectors most significantly impacted by this global digital transformation is the banking sector, which has transitioned from traditional operations to modernized practices. In Algeria, electronic payments are expected to become the standard for all financial transactions in the near future, driven by technological and digital advancements. This transformation is part of the FinTech era, which has expanded the user base of financial services both locally and globally. FinTech offers benefits such as enabling users to access financial products without the need for physical travel and allowing them to manage their accounts electronically. These advancements have extended the reach of financial inclusion, making it an

essential aspect of modern consumer interaction in an internet-connected world. (shahid & Razaq, 2017)

According to reports by the (OECD, 2017), every historical era witnesses a new technological revolution. Over the past 40 years, this was marked by the advent of information and communication technologies (ICT). However, the digital age goes beyond e-commerce, with financial inclusion strategies supporting digital transformation across societies. These strategies influence the behavior of financial service users, making digital financial services accessible to all segments of society. (Kabakova & Plaksenkov, 2018)

2.1. Financial Inclusion Measurement: A Strategy for Developing DFS

The World Bank defines financial inclusion in its 2014 financial development report as the proportion of individuals or institutions utilizing various financial. (World Bank, 2014) Similarly, the Arab Monetary Fund describes financial inclusion as the ability of individuals, regardless of income level, and institutions, regardless of size, to access and effectively use a broad range of high-quality financial services at reasonable and well-structured costs. These services include payments, financial transfers, savings, credit, insurance, and more, all within a responsible and sustainable framework supported by suitable legal and regulatory environments. (Arab Monetary Fund, 2017) The same report highlighted that approximately 70% of adults in the Arab world do not have bank accounts, attributing low financial inclusion rates to reliance on informal financial transactions.

The (OECD, Financial Inclusion and Consumer Empowerment in Southeast Asia, 2018)defines financial inclusion as the promotion of formal financial products and services at the right time and place, at affordable prices, and the expansion of their use by all societal segments. This is achieved by designing modern and innovative

strategies to enhance financial literacy and contribute to comprehensive economic and social development.

Based on the preceding definitions, it can be concluded that financial inclusion aims to expand the use of financial services by individuals to achieve sustainable economic development. The significance of financial inclusion lies in improving the quality of financial services provided to individuals, increasing demand for these services, and fostering competition among financial institutions. Furthermore, financial inclusion facilitates access to innovative financial products for startups and micro, small, and medium enterprises (MSMEs), integrating them into the financial sector and providing mechanisms suited to their size and financial conditions. Financial inclusion strategies also consider low-income groups by offering simplified mechanisms to assist and involve them in development processes, particularly vulnerable populations and women.

Additionally, financial inclusion helps integrate informal sector activities into the formal economy, thereby broadening the tax base by collecting small contributions from a large number of participants instead of collecting large contributions from a smaller group, such as traders and artisans.Over the past two decades, numerous efforts have been made to establish a global financial inclusion index, especially in African and Arab countries. Financial and governmental institutions have studied the determinants of financial inclusion to understand its measurement variables and its impact on economic development indicators worldwide. According to World Bank reports from 2011, 2014, and 2017, the Financial Inclusion Index (FIndex) consists of five key indicators (World Bank W. , 2017).

- **Bank Account Usage**: This measures the percentage of adults aged 18 and older who have financial accounts with formal institutions such as banks, post

offices, or financial companies. It categorizes users by income level (low, middle, or high), gender, and occupation.

- **Savings Rate**: This reflects the percentage of adults who saved money in the past year through formal or informal financial institutions, such as family members or acquaintances.
- **Borrowing Rate**: This measures the percentage of adults who borrowed money in the past year from formal or informal financial institutions, including loans from friends or relatives.
- **Payment Transactions**: This indicates the percentage of adults using formal financial accounts for receiving or sending wages or government payments in the past year. It also includes individuals who use electronic payment methods, such as ATMs or online platforms, for their transactions.
- **Insurance Rates**: This measures the percentage of adults who insure themselves or their assets, categorized by their activity type and income level.

Financial inclusion strategies contribute to increasing the funding available for various investment projects, particularly startups and MSMEs, thereby achieving higher levels of local economic development. The following figure illustrates the composition of the Financial Inclusion Index for startups, micro, and small enterprises.

2.2. Digital Transformation Ecosystem in Algerian Banks

The digital economy refers to the interaction between information and communication technologies (ICT); macroeconomic and international systems. This interaction aims to achieve transparency, speed, and access to economic indicators that support decision-making in economic, financial, and commercial activities over a specific period. Easier access to knowledge and information sources fosters greater integration of the local economy into the global economy, enhances trade opportunities, and provides access to key international markets. In 1993, P. Drucker

highlighted that knowledge would become the new basis for competition over the next 20 years, replacing traditional factors like capital, labor, and machinery. By 2020, P. Drucker described digitization, or what he called the "network economy," as the primary driver of development in the post-capitalist era. (Drucker, 2020)

Digital transformation in financial institutions requires accurate management of loan records, bank accounts, insurance policies, and investment management. It also necessitates robust data protection through efficient ICT management, programming systems, and electronic devices, alongside monitoring and safeguarding electronic data. Cloud servers are increasingly important for preventing data loss. Despite its competitive advantages, digital transformation presents significant costs and risks, necessitating skilled labor and leaving no room for error, particularly in decentralized banking administration and loan management.

Thedigital transformation ecosystem in Algerian banks has undergone the following phases:

2.2.1. Transformation of legal and regulatory framework

Digital transformation involves transitioning businesses to models that leverage digital technologies to innovate products, services, and revenue streams. In Algeria, the "E-Algeria Project" (2008–2013) marked the government’s vision for digital transformation, initially focusing on modernizing public administration and improving government services. This vision materialized through initiatives like issuing biometric passports, ID cards, and driver’s licenses. By late 2020, it expanded to include the electronic issuance of birth, death, and marriage certificates. However, Algeria ranked 120th globally on the E-Government Index (UN, 2020)reflecting delays in fully implementing this project.

In addition, **Law No. 18-05** (May 2018) established the first comprehensive legal framework for e-commerce in Algeria, defining general rules and standards for online trade (Joradp, 2018)

Digital transformation of banks involves shifting from traditional hierarchical organizational cultures to structures that enable delegation of authority and streamlined banking processes. This transition encourages collaboration between tech R&D teams and other banking divisions, enhancing digital literacy among employees, improving managerial skills, and embedding value-based management principles to ensure operational excellence. It also closes avenues for corruption and fraud. (Slaimi & Bouchi, 2019)

Algeria has introduced electronic payment cards (CIB, Eddahabia) and digital payment systems usable locally and internationally. However, gaps remain in the infrastructure for internet connectivity and payment platforms, which are critical to advancing digital banking services.

2.2.2. Government Support

The Algerian government has launched platforms for local electronic payment services, such as bill payments and balance inquiries, but has yet to establish reliable global e-payment platforms or adopt independent cloud computing services. Currently, Algeria remains largely isolated from international financial transactions, with no official foreign exchange offices. Consequently, individuals often resort to the informal currency market, where rates deviate significantly from official bank rates.

To adopt global Digital Financial Services (DFS) systems, Algeria must enact legal frameworks that safeguard financial rights and promote competition among banking institutions. This would boost demand for advanced services like electronic insurance and instant loans via mobile finance solutions (World Bank Group, 2020).

3. Digital Divide and Strategies to Enhance DFS in Algerian Banks

The digital divide between developed and developing countries influences priorities in digital and financial inclusion strategies. In Algeria, digital transformation in banking depends on the following:

1. Improving communication and information networkstailored to local needs.
2. Enhancing internet speed and affordability.
3. Encouraging private investment in telecommunications infrastructure to alleviate capital-intensive challenges.

A national digital strategy should ensure widespread access to ICT and financial services. The focus should start with key sectors like education, healthcare, and public administration to create a foundation for individual and corporate adoption of digital services. (Guendouz, 2013)

3.1. Building a FinTech Ecosystem in Algeria

The global financial and banking systems are undergoing significant transformations, particularly in developing countries. In Algeria, the FinTech ecosystem remains in its infancy, primarily focused on supporting financial inclusion through postal services rather than banking.

The Findex report noted an increase in Algerians with financial accounts, rising from 33% to 43% of the population.(Asli, Klapper, Singer, Ansar, & Hess, 2018)However, the banking sector has not seen comparable technological advancements. While postal financial services have introduced modern money transfer systems since 2019, banking innovations remain limited.

Algeria's **2015–2019 ICT action plan** included efforts to promote e-payment systems. In 2016, the government created the FIB (Banking Intermediary Unit) to

facilitate electronic transactions, involving 11 banks, 9 companies, and 930,000 clients by 2017. This network installed 16,000 point-of-sale (POS) terminals in large retailers, restaurants, and stores for use by customers with bank accounts.(OBG, 2017)

The adoption of DFS strategies, including biometric identification, began in 2018 under the Central Bank of Algeria (CBA). However, progress has been slow due to limited public awareness of electronic payments and cultural resistance to adopting such technologies (GSMA, 2019).

3.2. Toward a Unified Digital Financial Inclusion Standard

Global efforts to measure financial inclusion and address the digital divide include indices like Findex or the Financial Inclusion Survey(FAS). However, these tools often lack coverage in regions with insufficient data or underdeveloped infrastructure. For this study, data from the World Bank and Findex indices highlight Algeria's progress in digital banking adoption.

Table 1: Indicators of Banking Sector Digitization, Achieving Digital Penetration, and Financial Inclusion

Digitization of the Economy, Society, and Public Sector	Addressing the Requirements of Digital Financial Inclusion	Determinants for Encouraging Access to Formal Financial Services for the Wider Public
	Modernizing the Quality of Financial Services Provided	Including the quality of electronic contracts, e-payment contracts, and managing digital financial accounts.
	Equitable Access to Digital Financial Services	Digital service channels that rely on internet networks using various technological means such as mobile phones, digital tablets, computers, or

		ATMs with high speed and lower cost.
	Formalizing Relationships Between Digital Financial Service Providers and End-Users	Adjusting the business model for end-users to align with digital transformation technologies.

Source: Prepared by the researchersbased on **(Arab Monetary Fund, 2017)**; **(Asli, Klapper, Singer, Ansar, & Hess, 2018)**; **(World Bank Group, 2020)**

The analysis suggests that Algeria needs more targeted reforms to build trust, enhance digital infrastructure, and foster a culture of electronic financial transactions.

3.3. Applications of Artificial Intelligence in Supporting Digital Financial Transactions

The emergence of artificial intelligence (AI) applications dates back to the 1950s, when Alan Turing posed the question, “Can machines think?” during World War II. Later, in 1956, John McCarthy coined the term "artificial intelligence" during the Dartmouth Conference. By the 1980s, the training of neural networks and the development of backpropagation algorithms paved the way for AI applications. In the financial field, AI is defined as an innovation that enables machines to simulate human cognition and leverage previous experiences in handling payments and financial services.

The significant transformations in the communications field in developed countries have started to reach Algeria. The signs of digital transformation in Algeria began to emerge with the adoption of the "Electronic Algeria" project for the period 2008–2013. This initiative reflected Algeria's influence by the rapid global digital transformations on one hand, and on the other, demonstrated the Algerian legislator’s

aspiration to move towards the digital world. This step is considered a positive move towards establishing a knowledge-based society by utilizing electronic tools to carry out the work of administrations and organizations in key sectors, including:The Interior and Local Authorities sector;The economic sector;E-commerce;The financial sector (e-banking);The justice sector;The postal and telecommunications sector;The health sector;The education, higher education, and scientific research sectors.

The use of AI in financial services reduces operational costs, enhances institutional performance, and improves profitability. Consequently, many institutions are investing in FinTech tools and AI applications. Technologies such as cloud computing and AI is becoming industry norms. (Lin., Saliba., Bubar., Gantz., & Simms., 2022)FinTech represents one of the most prominent manifestations of AI, utilizing machine learning and cognitive computing to enhance financial inclusion. Global companies like Google, Microsoft, IBM, and Meta have made significant investments in AI and machine learning for commercial applications, making these technologies widely accessible (Mhlanga, 2020).

4. Conclusion and Findings

Findings suggest that while Algeria has initiated reforms to digitize banking services, structural challenges, including reliance on informal markets and underdeveloped infrastructure, impede full integration. The paper concludes that leveraging Artificial Intelligence strategies is essential for advancing digital financial services, achieving financial inclusion, and aligning Algeria's banking sector with global standards. This research contributes to the broader discourse on the digital economy, offering actionable insights for policymakers and financial institutions navigating the complexities of digital transformation in emerging markets.

The recurring financial crises that disrupt the global system, alongside shifts in globalization trends, highlight the urgent need for digital transformation. For

instance,thefinancial crisis**,** triggered by the subprime mortgage collapse, disrupted global trade and financial flows. More recent protectionist policies in the U.S., such as the imposition of tariffs, slowed global economic growth and affected economies worldwide, especially developing countries.AlsoCOVID-19 pandemic further exacerbated economic challenges by halting global economies due to border closures. However, while goods-based economies faced a downturn, data flows and related electronic transactions thrived, signaling a shift in globalization toward digital transformation in economic, financial, cultural, and educational sectors.

Digital transformation has become essential for simplifying transactions on both macro and micro levels. In Algeria, the government must reevaluate traditional transaction practices, including governmental, commercial, and banking transactions. This study confirms the hypothesis that digital transformation significantly contributes to enhancing digital financial transactions in Algerian banks.

While Algeria has implemented legislative frameworks to support digital transactions, the local business environment does not fully embrace these changes. Structural challenges persist, such as:

- Mismatch with global developments in financial systems.
- The informal currency market and structural imbalances in the official exchange rates.
- Consumer preferences for cash-based transactions, driven by inadequate infrastructure and the lack of robust financial inclusion strategies.
- Insufficient data security measures**,** raising concerns about the protection of digital transactions and electronic contracts.

For instance, it was not until late 2020 that Algeria introduced electronic civil documents, despite launching e-government initiatives in 2009. Similarly, official

cross-border money transfers remain opaque, limiting trust in Algeria's financial system and hampering efforts toward digital transformation.

Hence, artificial intelligence applications are increasingly central to digital financial transactions worldwide, offering enhanced security, efficiency, and speed. Algeria must prioritize the following:

- Invest in AI technologies: by integrating AI into the financial sector to bolster digital transformation and enhance financial inclusion.
- Strengthen tnfrastructure: by building robust infrastructure to support digital finance, including data protection mechanisms and cloud computing systems.
- Train human resources: to develop expertise in AI and digital technologies to create a workforce capable of handling modern financial systems.
- Foster trust: to improve consumer trust through clear legal frameworks and transparent systems, ensuring the security and reliability of digital transactions.
- Increase account ownership**:**just about 43% of Algerians have bank accounts, with 56% of account holders being men and 44% women.
- Digital payment adoption**:** only 20% of account holders use electronic payment cards, indicating limited cultural acceptance of e-payment.
- Cash dependency**:** many Algerians prefer cash transactions, reflecting a lack of trust in digital banking systems.
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Adopting AI and advanced technologies will not only modernize Algeria's financial sector but also reduce operational costs, enhance customer trust, and mitigate risks associated with the digital transformation of financial systems.

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