

Blockchain Technology and Its Role in Developing the Performance of Financial Institutions: An Analytical Approach

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ABSTRACT

This study aims to analyze the role of blockchain technology as one of the modern financial technology (FinTech) innovations by highlighting its applications in the financial sector and its contribution to improving financial service efficiency, enhancing transparency, and accelerating transactions. The study also examines the key technical, economic, and regulatory challenges facing its adoption, alongside the prospects for its development amid digital transformation. The study concludes that blockchain technology offers promising opportunities for developing financial services; however, capitalizing on its advantages remains contingent upon the ability to overcome its technical and regulatory challenges and provide a conducive environment for its applications.

Keywords: Financial Technology (FinTech), Blockchain, Financial Services, Smart Contracts.

Introduction:

Recently, the financial sector has witnessed growing interest in financial technology (FinTech) as a key manifestation of digital transformation, owing to the innovative solutions it provides aimed at improving financial service efficiency, developing payment methods, enhancing transparency, and accelerating transaction execution.

Among the most prominent FinTech applications is blockchain technology, which represents a modern revolution in the world of documentation and automation. This technology has garnered attention across all sectors in the era of digital transformation, as it manages and records transactions within a database that forms a complete ledger of these transactions across a distributed network.

Despite the opportunities offered by blockchain technology for developing financial services, its economic impacts are not homogeneous; rather, they vary depending on the nature of applications, the adopted infrastructure, and the surrounding regulatory framework. Hence, the importance arises of analyzing the potential gains of this technology and comparing them with the challenges that may limit its diffusion, thereby determining its actual contribution to the development of the financial sector.

Accordingly, this study aims to analyze the contribution of blockchain technology to improving financial service efficiency and to review the key challenges associated with its use, relying on the descriptive-analytical approach.

The research problem is formulated in the following question:

To what extent does blockchain technology contribute to improving the efficiency of financial services, and what are the main challenges limiting its use in the financial sector?

1. Concepts Related to Financial Technology (FinTech)

The term **Financial Technology (FinTech)** is a newly introduced term in the field of business and finance. In reality, however, it serves as an extension of the concept of financial innovation that prevailed in the early twentieth century.

With the advent of the Fourth Industrial Revolution during the third millennium and the proliferation of technology—which has become the backbone of every national economy—the concept of financial innovation has transitioned into financial technology.

1.1. Concept of Financial Technology

As a term, Financial Technology is a blend of two words: technology and finance, abbreviated as **FinTech**. It is a relatively broad term that has evolved into its own dedicated industry known as the FinTech sector. The latter has been growing rapidly in recent times, with new services and applications emerging annually for both consumers and businesses.

- According to the **Digital Research Institute in Dublin**, FinTech refers to recent technological inventions and innovations within the financial sector. These innovations

include a suite of digital software used in banking operations, such as customer transactions and financial services like money transfers, foreign exchange, interest and profit rate calculations, and estimating expected investment returns, among other banking operations

- ¹.
- According to the **Financial Stability Board (FSB)**, FinTech is defined as technology-enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services ².

In short, FinTech can be defined as the technology or innovations that seek to compete with traditional financial methods in the delivery of services.

Islamic Financial Technology (Islamic FinTech), on the other hand, encompasses all FinTech applications and products that comply with Islamic Law (Sharia) and are adopted within Islamic financial and banking institutions.

1.2. Importance of Financial Technology

The significance of FinTech can be summarized in the following points:

- **Broad Service Coverage:** It covers a wide range of financial services, such as crowdfunding operations, mobile payment solutions, international remittances, and online portfolio management tools, which traditional banks have failed to offer to a large base of clients³.
- **Achieving Financial Inclusion:** FinTech applications have enabled millions of customers to attain financial integration as a result of the ease of access to financial services.
- **Risk Reduction:** It mitigates risks, particularly those related to contractual uncertainty, which used to be an inherent characteristic. Distributed ledger technologies (whether centralized or decentralized) have made it possible to reduce non-disclosure risks, lack of transparency, or counterparty insolvency risks. Moreover, smart contracts have contributed to reducing legal risks, while Regulatory Technology (RegTech) aids in mitigating compliance and legal risks⁴.
- **Cost and Time Efficiency:** It reduces the cost and time required for banking operations while rendering them more secure and transparent.
- **Boosting GDP Growth:** It enhances Gross Domestic Product (GDP) growth by facilitating access for both individuals and corporations to a vast and diverse array of financial products, services, and credit facilities.
- **Providing Competitive Advantage:** It offers a competitive edge to financial institutions and FinTech startups. The more technologically advanced these institutions are, the greater their ability to compete at regional and international levels⁵.

1.3. FinTech Technologies

A set of modern technologies has emerged alongside the Fourth Industrial Revolution that are deployed in the banking and financial sector, enabling FinTech to introduce and innovate new services. These technologies include:

1.3.1. Artificial Intelligence (AI)

AI refers to intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans. The term is often applied to describe machines or computers that mimic cognitive functions that humans associate with the human mind, such as learning and problem-solving ⁶. AI has spurred a breakthrough in financial services, rendering them faster and more precise in responding to clients.

1.3.2. Cloud Computing

This technology relies on transferring computer processing power and storage capacity to the "cloud"—a server accessed via the Internet. Unlike traditional computing, which requires all data, programs, and applications used or created by the user to reside on personal devices, cloud computing eliminates the need for users to store data locally or run varied or complex software. The infrastructure of cloud computing relies on advanced data centers⁷.

1.3.3. Big Data

The International Organization for Standardization (ISO) defines Big Data as data sets with unique characteristics—such as volume, velocity, variety, variability, and veracity—that cannot be efficiently processed using traditional technologies ⁸. Through large data sets, insights regarding consumer preferences, spending habits, and investment behaviors can be extracted and utilized to develop predictive analytics. Furthermore, the collected data assists in formulating marketing strategies and fraud detection algorithms.

1.3.4. Distributed Ledger Technology (Blockchain)

Blockchain technology is widely adopted in the financial industry, primarily due to its ability to securely store transaction records and other sensitive data. It is a connected network of entities interacting with each other in the form of data blocks in a decentralized manner⁹.

1.3.5. Biometrics

This technology refers to the use of unique biological traits—such as fingerprints, facial recognition, and iris scans—to identify an individual. It provides a higher level of security compared to traditional methods, with key advantages including its ability to combat fraud.

1.3.6. Robotic Process Automation (RPA)

RPA refers to the process of assigning manual tasks to software robots rather than humans in order to streamline workflows within financial institutions.

1.4. FinTech Applications

There are several FinTech applications, including:

1.4.1. Personal Asset and Wealth Management

This domain focuses on optimizing wealth management processes for both corporations and individual consumers. Wealth management is an investment advisory service that combines various financial services to cater to high-net-worth clients. In practice, it is a consultative process where an advisor gathers information regarding the client's goals and designs a tailored strategy using appropriate financial products and services¹⁰.

1.4.2. Payments

This system is offered by financial and banking institutions to make electronic payment transactions safe and convenient. It is characterized by strict compliance with regulations that ensure all financial movements are conducted with complete confidentiality to guarantee user protection and security. Through this ecosystem, startups offer diverse services such as bill payments and smart-device payments via digital wallets. It is the most widespread domain compared to other financial services, as companies focus on these services to expand their customer base rapidly at a lower cost¹¹.

1.4.3. Digital Banking Model

Many banking institutions are adopting digital technologies to enhance their services, including¹²:

- **Digital Financial Services:** Services provided via digital infrastructure, including mobile devices and the Internet, characterized by reduced cash usage.
- **Digital Finance:** A new product category now available in Islamic banks; an example includes electronic Murabaha provided by Abu Dhabi Islamic Bank.
- **Digital Branches:** Operating in institutions such as Kuwait Finance House, these offer various services including opening new accounts online, managing sub-accounts, withdrawals, deposits, and more.

1.4.4. Virtual Cryptocurrencies and Blockchain Technology

Blockchain technology is commonly confused with virtual cryptocurrencies, as well as blockchain with Bitcoin. Bitcoin was the first virtual cryptocurrency to emerge, conceptualized by an anonymous entity under the pseudonym Satoshi Nakamoto. Bitcoin was designed as a peer-to-peer electronic payment method over networks without the need for government intervention or a central authority; hence, it represents a form of electronic cash executed in an encrypted manner¹³.

Blockchain technology, on the other hand, is the underlying chain of blocks behind most forms of cryptocurrencies. It was invented to resolve the lack of trust when conducting transactions between two anonymous parties without requiring a third-party intermediary, such as exchange companies, insurance firms, or central banks. Blockchain serves as the core infrastructure for Bitcoin.

1.4.5. Insurance Technology (InsurTech)

InsurTech seeks to simplify the insurance industry while improving its efficiency by leveraging smartphone applications, the Internet of Things (IoT), and Artificial Intelligence to maximize the impact of insurance services.

1.4.6. Regulatory Technology (RegTech)

RegTech involves harnessing advanced technologies like AI and Machine Learning (ML) to streamline financial compliance procedures. Key aspects include Anti-Money Laundering (AML) and Know Your Customer (KYC) verification processes¹⁴.

1.4.7. Crowdfunding

Crowdfunding allows individuals to fund new products, ideas, and ventures. It involves three main parties: the entrepreneur who requires funding, the contributors who fund the projects, and the platform/intermediary that facilitates information sharing to foster product and service development¹⁵.

2. Nature of Blockchain Technology

Blockchain technology is considered one of the most prominent and foundational innovations of financial technology (FinTech). It is also the most captivating and influential in the world of business and finance alike. Today, blockchain has become a focal point of discussion and holds the potential to grow into the cornerstone of record-keeping and data systems worldwide, especially with the proliferation of digital currencies.

2.1. History of Blockchain (Distributed Ledger)

In 1991, researchers Stuart Haber and Scott Stornetta introduced a practical computational solution for timestamping digital documents in a way that prevented anyone from accessing or tampering with them. The system utilized a series of cryptographically secured blocks to ensure that timestamped documents were stored within a defined chronological framework. In 1992, the Merkle tree was integrated into the design, making the technology more efficient by allowing multiple documents to be aggregated into a single block. However, this technology eventually faded, fell out of use, and its patent expired four years before the inception of Bitcoin. In 2008, Satoshi Nakamoto published his landmark research paper, "A Peer-to-Peer Electronic Cash System," introducing the concept of an electronic cash system named Bitcoin. Thus, blockchain technology enabled the invention of Bitcoin as the first digital currency¹⁶.

In 2013, Ethereum was introduced as an alternative to Bitcoin, whose capabilities were not tailored to the needs of general-purpose applications. Ethereum added immense value to the crypto and digital currency industries, paving the way for the emergence of smart contracts that operate independently and execute automatically on the blockchain.

With the growing daily adoption of smart contracts in transactions, the limitation of current technologies in supporting small-transaction volumes became apparent. This necessitated the development of decentralized applications, encompassing open-source platforms to support cryptocurrency encryption and decentralized consensus mechanisms¹⁷.

2.2. Definition and Components of Blockchain Technology

2.2.1. Definition of Blockchain Technology

- It is a digital technology based on a massive cloud database through which individuals can execute transactions or transfer funds via a network of decentralized computers distributed globally. Blockchain resembles a general ledger in accounting, as it functions as a public database where digital information regarding exchange operations between a sender and a receiver is stored¹⁸.
- It is also defined as a decentralized software mechanism that allows for the tracking and recording of assets and

transactions without the presence of a trusted authority, such as a central bank. Blockchain networks establish proof of ownership using unique digital signatures based on public cryptographic keys known to everyone on the network and private keys known exclusively to the owner. Complex algorithms achieve consensus among users, ensuring that transaction data cannot be altered after verification, thereby reducing the risk of fraud¹⁹.

Since the blockchain records all executed transactions, it evolves into a stack of data blocks appended to one another to form a chain of blocks. These blocks are added chronologically in a linear order to display the complete set of blocks.

Key features of blockchain include ²⁰:

- It requires no central authority to control the flow of information.
- Participating members in the chain do not necessarily need to know one another.
- All network members hold an identical copy of the ledger, which is automatically updated upon every addition.
- No entity has the power to approve or reject a transaction provided the user is authorized to execute it.
- The strength of the system lies in its robust encryption and decentralization.
- Only authorized individuals can access and view the data.
- High resistance to hacking and breaches.

2.2.2. Components of Blockchain Technology

Blockchain technology consists of four main components:

1. **The Block:** It represents the building block of the chain, consisting of a set of operations or tasks intended to be performed or executed within the chain. Examples of blocks include transferring funds, recording data, tracking a status, or similar activities. Each block typically accommodates a specific limit of operations and information and cannot accept more until the internal operations are fully finalized, after which a new linked block is created. The primary objective is to prevent fictitious transactions within the block that could cause the chain to freeze or prevent it from recording and finalizing transactions²¹.
2. **The Data (Transaction):** This refers to the sub-operation taking place within a single block, or the individual instruction executed within the block, which collectively constitutes the block itself.
3. **The Hash:** It serves as the distinct DNA of the blockchain, sometimes referred to by some as a digital signature. It is a code generated by an algorithm within the blockchain software called the hash mechanism, and it performs four main functions²²:
 - Distinguishing the chain from other chains, as each chain receives its own unique hash.
 - Identifying and distinguishing each block from others within the chain, with each block receiving a unique hash as well.
 - Encoding every piece of information inside the block with a distinct hash.

- Linking blocks together within the chain, where each block is linked to both its preceding hash and succeeding hash, causing the hash to flow in a single direction from the original block to the subsequent one, and so forth. It is worth noting that the hash does not permit alterations to previously generated blocks.

4. **Timestamp:** This element is closely linked to the hash process, whereby any operation conducted via blockchain technology is assigned a unique timestamp that distinguishes it from others. These two elements enhance the security of the technology and the accuracy of the transmitted operations and data, thereby increasing trust in the system regarding data preservation, confidentiality, and security²³.

3. Types of Blockchain

Blockchain can be classified into public, private, or hybrid networks depending on its applications:

- **3.1. Public Blockchain:** An open infrastructure that is accessible to everyone for viewing and conducting transactions. Bitcoin and Ethereum belong to this category.
- **3.2. Private Blockchain:** Defined as a platform controlled by a single or centralized institution with a limited number of participants within that organization. It offers the advantage of resolving efficiency, security, and fraud issues prevalent in traditional institutions²⁴.
- **3.3. Hybrid (Consortium) Blockchain:** Also known as federated blockchains, this type is public only to a privileged group. It can be considered only partially decentralized as it integrates elements of both public and private blocks.

4. Mechanism of Blockchain Operation

The operational mechanism of blockchain relies on distributing data across a set of computers. These computers verify the validity of data before adding it, in exchange for a reward determined by the system. Consequently, these nodes encrypt each transaction and link it to the preceding transaction using cryptographic techniques that prevent modification or tampering. Blocks are linked together using a public key utilized across the network to identify the transaction, alongside a private key possessed exclusively by the transaction owner.

To conceptualize the operational stages of blockchain, they can be outlined as follows:

- Encrypting the data and information involved in the operations to form a **block**.
- Executing the transaction directly from the sender to the receiver without a third-party intermediary (**peer-to-peer**).
- Verifying the transaction through a massive network of computers called **nodes**, followed by adding the verified block to the chain in exchange for a commission earned by the entity that decodes the block through trial-and-error guessing.

The following figure illustrates the blockchain operation mechanism:

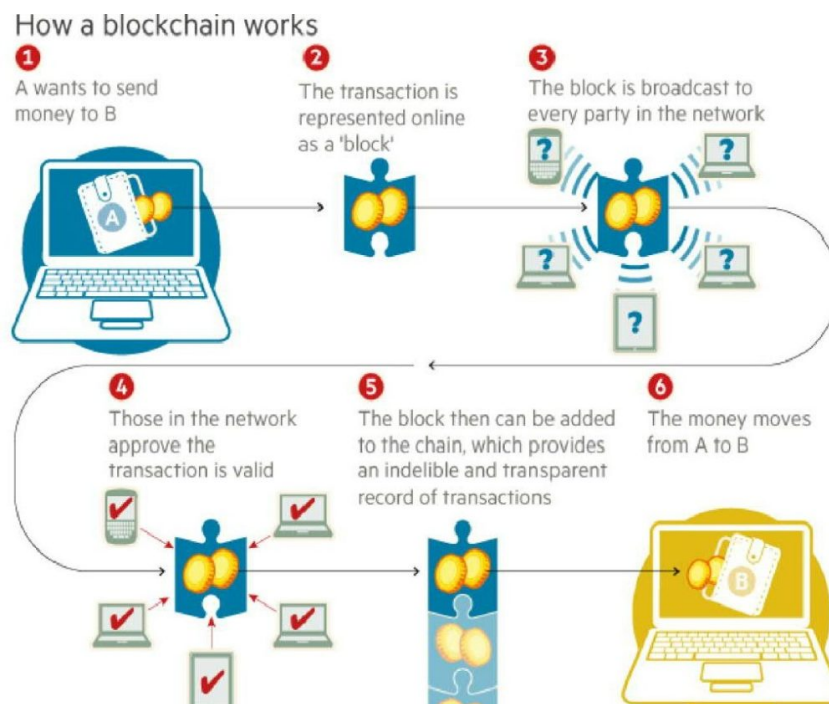
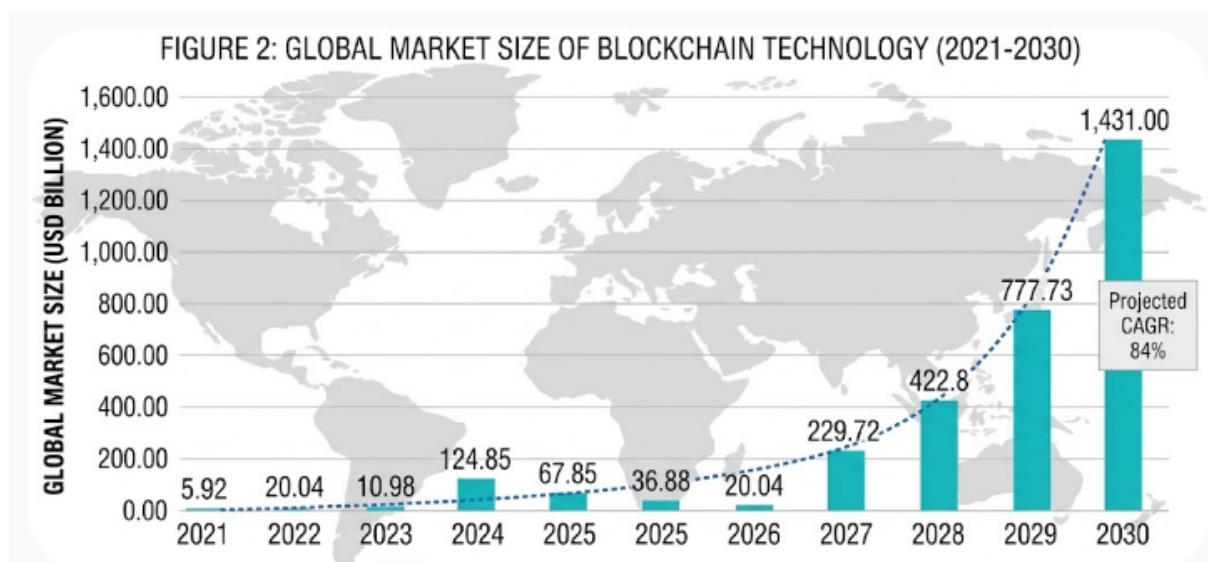


Figure 1: Blockchain Operation Mechanism

Source : Michael Crosby and other, **BlockChain Technology**, Sutardja Center for Entrepreneurship & Technology Technical Report, 2015, p : 7.

.5 Fields and Applications of Blockchain Technology

The market for blockchain solutions and applications reached approximately **\$5.92 billion in 2021** and is projected to rise to **\$1,431 billion by 2030**, reflecting a compound annual growth rate (CAGR) of **84%**, as illustrated in Figure 2.



Source: General Authority for Small and Medium Enterprises (Monsha'at), **Blockchain Technology and Its Future in the Kingdom of Saudi Arabia**, p. 15. Available at:

Fields and Applications of Blockchain Technology (Continued)

Blockchain applications extend across various domains beyond merely transferring funds—whether virtual or traditional.

In general, existing applications of blockchain technology can be categorized into four main groups ²⁵:

1. **Smart Contracts Applications:** Such as betting, escrow services, and digital rights management.
2. **Cryptocurrency Applications:** Such as e-commerce, global payments, peer-to-peer (P2P) remittances and lending, and microfinance.

3. **Collateral & Financial Instrument Applications:** Such as private markets, debt instruments, crowdfunding, and financial derivatives.
4. **Record-Keeping Applications:** Such as healthcare, title registries, property ownership, electronic voting, intellectual property, among many other examples.

3. Opportunities and Challenges of Deploying Blockchain Technology in the Financial Sector

Interest in blockchain technology has intensified as a result of the rapid evolution of financial technology (FinTech), owing to the capabilities this technology provides for developing financial transactions and enhancing their efficiency. However, capitalizing on this technology remains contingent upon its ability to address the technical, economic, and regulatory challenges it faces.

3.1. The Role of Blockchain Technology in Improving Financial Service Efficiency

Blockchain technology enables the recording and verification of financial transactions through a distributed digital ledger, which may contribute to streamlining intermediary procedures and accelerating transaction execution.

This technology is particularly prominent in payment and settlement systems, where it can foster the development of information exchange and transaction verification processes among financial institutions. Furthermore, smart contracts allow for the automation of executing financial commitments under predetermined conditions, potentially reducing operational errors. As highlighted in a report by the Committee on Payments and Market Infrastructures (CPMI) at the Bank for International Settlements (BIS), distributed ledger technology presents both opportunities and challenges in the realms of payment, clearing, and settlement, calling for a rigorous assessment of its impacts on efficiency and safety²⁶.

3.2. Challenges of Utilizing Blockchain Technology

Despite the potential offered by blockchain technology, its adoption within the financial sector encounters a series of challenges:

1. **Technical Challenges:** Issues regarding scalability and processing speed emerge prominently, especially when transaction volumes surge. As the number of users and transactions increases, the network may experience constraints that affect settlement time and transaction costs. Potential risks also encompass cybersecurity threats, the potential exploitation of software vulnerabilities, and design flaws in smart contracts.
2. **Economic Challenges:** Adopting this technology may necessitate substantial investments in digital infrastructure, system upgrades, and human capital development.
3. **Legal and Regulatory Challenges:** Legal and regulatory aspects pose additional hurdles, particularly concerning the determination of liability, user protection, anti-money laundering (AML) compliance, and maintaining financial stability. In this context, the International Monetary Fund (IMF) emphasizes that digital financial innovations yield opportunities for service enhancement; however, they

simultaneously introduce challenges that require a delicate balance between efficiency and financial stability.

Accordingly, the success of blockchain applications relies not only on their technical efficacy but also demands a clear regulatory framework, effective risk management mechanisms, and an economic assessment tailored to the specific nature of each application.

4. Prospects of Using Blockchain Technology in the Financial Sector

The future of blockchain in the financial sector is contingent upon its capacity to integrate with traditional financial systems and provide practical solutions to existing challenges. Key areas gaining attention include: advancing payments and settlements, asset tokenization, and automating certain operations using smart contracts.

The International Monetary Fund (IMF) indicates that distributed ledger technologies (DLT) and asset tokenization could enable the development of financial market infrastructures by integrating some processes of asset registration, ownership transfer, and settlement.

Consequently, the financial sector may lean toward hybrid models that combine traditional institutions with blockchain-based technologies, rather than fully disintermediating financial entities. This trajectory requires developing digital infrastructure, upskilling human resources, and fostering collaboration between financial institutions and regulatory authorities, alongside establishing appropriate standards for security, transparency, and user protection.

Therefore, it can be concluded that blockchain technology offers opportunities to enhance financial services, improve certain payment and settlement operations, and strengthen transaction traceability. However, realizing these gains remains conditional upon addressing technical, economic, and regulatory challenges. Hence, blockchain cannot be regarded as a comprehensive substitute for the traditional financial system; rather, it should be viewed as a tool for modernizing some of its components when the requisite institutional, technical, and regulatory conditions are met.

Conclusion :

This study demonstrates that blockchain technology represents one of the promising tools for advancing the financial sector, given its potential to improve payment and settlement efficiency, enhance transparency, and automate select financial operations. Nevertheless, its deployment is not devoid of technical, economic, legal, and regulatory challenges that could impair its effectiveness if not systematically addressed within an integrated institutional framework.

Accordingly, the future of blockchain in the financial sector does not hinge merely on its technical adoption, but rather on its alignment with the nature of financial technologies, its capacity to integrate with legacy systems, and the availability of necessary safeguards to protect users and maintain financial stability and security. Thus, it should not be viewed as a full replacement for the traditional financial system, but as a vehicle for developing certain components and refining its performance, provided that suitable technical, regulatory, and economic conditions are established.

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