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A REVIEW ON BLOCKCHAIN INTEGRATION IN FINANCIAL INSTITUTIONS: OPPORTUNITIES AND RISKS

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Abstract: The fast digitization of financial services has led to the emergence of blockchain technology that has the capacity to transform how traditional banks operate. Blockchain technology can be used to host the transparent, secure and efficient making of transactions without intermediaries. It refers to a distributed, immutable digital ledger. This article provides an in-depth overview of blockchain technology, its fundamentals, principles, and a variety of types them. It proceeds to analyze the increasing role of blockchain in the financial industry. It reveals that blockchain technology can make financial organizations more reliable, time-saving, and budget-effective. This assessment extends further on how it assists marginalized communities in accessing bank services and how it ramps up client activity using trust-based systems being two factors that help in financial inclusion. Also, it examines how blockchain technology, which entails smart contracts, automation, and the combination with AI and ML, might increase the efficiency of operations. With the help of analysis of existing research and practice, the article provides a comprehensive understanding of how the technology of blockchain is transforming the landscape of the field of finance and introducing new dimensions of innovation, transparency, and trust in the international system of money circulation.

Keywords: Blockchain, Financial Institutions, Digital Ledger, FinTech, Smart Contracts, Operational Efficiency.

1 INTRODUCTION

Various digital technologies, such as blockchain, have completely transformed the financial system in a very short period of time. Blockchain technology is not new as it originated in 2008 when Nakamoto created a white paper concerning Bitcoin. It is a decentralized digital ledger that supports trustless and instantaneous transactions that are transparent and unalterable between parties without trusting each other [1]. The unique advantages of blockchain are connected with enhanced efficiency, reduced costs, and preventing fraud (thanks to a higher level of transparency). All these are good qualities of financial systems, as they are automatically inefficient and require third-party interventions.

Data blocks in a blockchain are cryptographically connected and time-stamped and stored in an unchangeable linear structure. This is a blockchain technology, which is referred to as distributed ledger technology (DLT). Each block contains hashed details of the prior block thus data integrity and resistant to tampering are assured. Within the realm of financial transactions, this type of architecture eliminates the need for manual checks and also increases the security against manipulation [2]. The decentralized character of the system serves to increase the trust factor, since, unlike the traditional centralized systems of the financial infrastructure, there is no single point of failure.

Despite technological advancements in finance, challenges such as high transaction costs, economic crime, and unequal financial inclusion remain persistent concerns. Potentially alleviating many of these issues is blockchain technology, which enables the secure decentralized transfer of digital assets amongst users independent of any one governing body [3]. Generally, blockchain has a wide array of application uses beyond financial transactions blockchain technology is also being applied to healthcare, education, and logistics just to name a few, but it has especially disruptive potential in finance by streamlining business operations related to money transfers, trading, and regulatory compliance (e.g., KYC, AML).

Blockchain technology was initially linked fundamentally with Bitcoin, and now is being viewed as a fundamental technology used in the wider FinTech ecosystem [4]. Scholars and practitioners are starting to recognize that blockchain technology is not just about cryptocurrencies and that it will act as a facilitator of innovation across a range of commercial sectors. Thus far, it has defined and linked blockchain to a variety of features (decentralization, disintermediation, transparency, safety, etc.), all of which are now positioned to challenge traditional financial systems. This paper intends to examine how their financial institutions are integrating blockchain technology [5][6]. This paper will highlight the mechanisms and opportunities for the use of blockchain, but also the risks and challenges that will still need to be surmounted for the implementation of sustainable technologies in their future banking structures.

1.1 Structure of the paper

The following is the structure of the paper: The Several kinds of blockchain technology are discussed in Section 2. In Section 3, it'll look at how it can improve financial inclusion and efficiency. Problems with scalability and interoperability are discussed in Section

4. Section 5 provides a literature assessment of current works, while Section 6 offers a summary of important findings and suggestions for further study.

2 OVERVIEW OF BLOCKCHAIN TECHNOLOGY

Blocks are the building blocks of the blockchain; after they have recorded a transaction, they are added to the blockchain's permanent database [7]. Each block in a blockchain is sequentially linked, much like a linked list. To see how each block stores the hash of the previous block, refer to Figure 1.

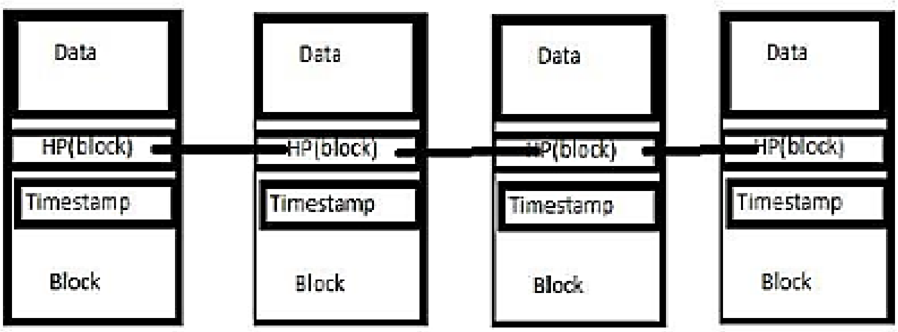

Figure 1: Blockchain as A Linked List of Blocks Connected by Hash Pointers.

A network of interconnected computers, or "nodes," is the building block of a blockchain. Users are able to interact within the blockchain by means of public and private keys [8]. By using their public key to sign their own transactions, users can access their private key within the network. It ensures the network's authenticity, integrity, and non-repudiation. Before continuing with the transmission, every node in the blockchain verifies the validity of the incoming transaction. Discarded are any unexpired transactions. Rules for each database transaction should be provided by each Blockchain network. Every blockchain client has these rules pre-programmed, so they can check the legitimacy of incoming transactions.

2.1 Key Components of Blockchain Technology

Blockchain technology may seem hard to understand, but it can be made easier by looking at each part separately. The most fundamental kind of blockchain technology integrates ideas from accounting with popular cryptographic primitives and algorithms from computer science [9][10]. In this section, we'll cover each major component separately: hash functions for cryptography, addresses, blocks, asymmetric-key cryptography, transactions, and ledgers.

2.1.1 Cryptographic Hash Functions

Blockchain technology makes extensive use of cryptographic hash algorithms. One way to secure data is by using a cryptographic hash function, which can be applied to inputs of almost any size and produces a relatively unique output. With this method, anybody can independently extract data from an input, hash it, and get the same output, demonstrating that the data was unaltered.

2.1.2 Asymmetric-Key Cryptography

Blockchain makes use of asymmetric-key cryptography. In asymmetric-key cryptography, two mathematically connected keys, a public key and a private key, are used. The process's security can be preserved by making the public key public, but the data must remain hidden in order for the private key to preserve its cryptographic protection [11]. There is a connection between the two keys; however, knowing the public key is inefficient for determining the secret key.

2.1.3 Addresses and Address Derivation

Several Blockchain networks include a hash algorithm that takes a user's public key and adds some additional data to generate a brief string of alphanumeric characters to use as an address. [12]. It is common practice to use addresses for the "to" and "from" endpoints throughout Blockchain transactions. In comparison to public keys, addresses are both shorter and do not have any private information. One approach to address construction is to generate a public key, encrypt it using a cryptographic technique, and then transform the output textually:

2.2 Types of Blockchains

Data accessibility is a key factor. It can classify blockchain in the following ways [13]:

- **Public Blockchain:** This Blockchain is open for all users to see and conduct transactions on.
- **Private Blockchain:** A single entity or all subsidiary organizations within the same group can access read/write transactions in this Blockchain paradigm.
- **Community/Consortium Blockchain:** In this Blockchain concept, multiple organizations form a consortium that can process transactions in both directions.

- **Hybrid Blockchain:** A new category has emerged that allows for combinations of the three existing blockchain types: public, private, and community/consortium. Hybrid Blockchain allows for a wide variety of blockchain platform configurations.

2.3 Blockchain in the Financial Industry

Decentralized and immutable ledgers are a feature of blockchain technology that could drastically alter the way data is maintained. Aside from banking, blockchain technology is applicable to nearly every business [14][15]. Redesigning the backend of the banking system and cutting operational costs are both possible outcomes. For banks to overcome their present problems, blockchain technology is essential. A few advantages of blockchain technology are these: (i) processes can be efficiently automated; (ii) tasks can be automated, cutting out intermediaries and transaction costs; (iii) records can be verified and kept forever, improving accountability, transparency, and trust; and (iv) decentralization can reduce reliance on third parties, promoting independence and data security. However, there are certain worries about blockchain technology. One such worry is whether or not it is suitable for use in the financial industry.

3 OPPORTUNITIES OF BLOCKCHAIN IN FINANCIAL INSTITUTIONS

Blockchain technology's decentralization feature has reduced its price and increased its accessibility, opening up numerous mainstream applications for the technology. Knowing where a money transfer came from is just one of many benefits that blockchain technology can provide [16][17]. Assuming they are used correctly, Blockchain features make the system more trustworthy and secure [18]. Blockchain technology can enhance several sectors, including land records, asset registries, voting records, national identification, financial transaction records, and traceability.

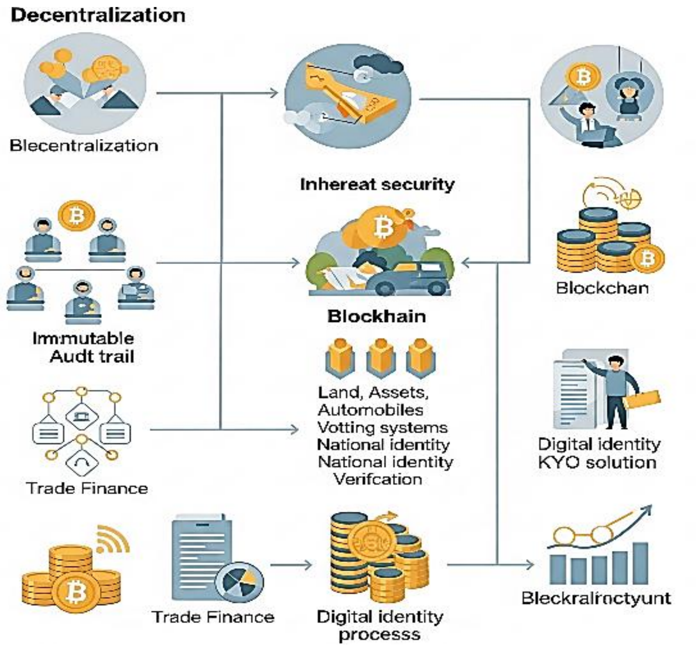

Figure 2: Opportunities of Blockchain in Financial Institutions

All of these things can help integrate the massive informal sector into the official economy and eradicate corruption on a grand scale (Figure 2). Incorporating blockchain technology with other state-of-the-art advancements like AI, ML, data analytics, and robotic process automation can substantially improve India's current trade financing system. Numerous applications of blockchain technology in digital identity management and know-your-customer seem to be in the works.

3.1 Consumer Trust in Financial Services

Encouraging trust is crucial for maintaining client loyalty and retention. Research has established a strong relationship between trust and consumer behaviour, showing that trust influences whether customers continue to use a financial institution’s services and recommend them to others[19][20]. A report by PwC (2016) revealed that 88% of consumers are willing to share personal information with financial institutions they trust, demonstrating the critical role that trust plays in fostering long-term relationships. In addition to influencing loyalty, consumer trust is linked to financial inclusion and economic stability. Trust is fundamental in encouraging engagement with banking and financial services, particularly among underserved populations. Consumers' faith in financial institutions is crucial to the success of financial inclusion programs, which seek to ensure that everyone has access to banking services. Without this trust, efforts to engage underserved communities in the financial system will be limited, impacting broader economic growth.

3.2 Improving Operational Efficiency and Automation

The profitability and satisfaction of a bank's customers are directly affected by how well its operations are run [21]. Small gains in efficiency can add up to big changes in the bottom line for banks in this cutthroat industry. Though effective, the conventional approaches to improving operational efficiency, like process reengineering and automation, are narrow in scope and effectiveness. AI and ML have opened up new possibilities for banks to increase operational efficiency via automated processes, advanced analytics, and decision-support tools. With AI-powered chatbots, for instance, customer support may be offered around the clock, reducing the need for human engagement while simultaneously enhancing consumer delight. In a similar vein, machine learning algorithms can guard against fraud, reducing the likelihood of monetary loss and strengthening the safety of banking operations as a whole.

3.3 Enabling Financial Inclusion

The elements of financial inclusion, an innovative idea, have been debated in relation to its definition [22]. Although there isn't a one, agreed-upon definition of financial exclusion, the idea is constantly changing in academic circles and in EU policy. The need for financial inclusion is becoming an increasingly pressing policy issue at the global level. Financial exclusion is defined by the European Commission as "difficulty accessing and/or using financial services and products in the mainstream market that are appropriate to their needs and enable them to lead a normal social life in the society in which they belong" [23][24]. To put it simply, financial exclusion happens when specific individuals or businesses are not allowed or do not want to use traditional banking services. These services include savings and checking accounts, loans, insurance, and payment processing. Financial inclusion seeks to ensure that all people, particularly those more vulnerable, have access to financial services, rather than limiting them to specific demographics. This is attainable through a variety of programs that educate individuals on effective financial management and other cutting-edge approaches.

4 RISKS AND CHALLENGES IN BLOCKCHAIN ADOPTION

Blockchain technology, despite its potential, faces several barriers that hinder its widespread implementation in financial institutions [25]. To guarantee its effective acceptance and integration, the following issues must be resolved.

- **Lack of adoption:** Blockchains, being ecosystems, can only function properly with widespread use. To provide an example, a supply chain with track-and-trace capabilities can only be achieved when the organization and its suppliers both use a blockchain network. Based on their research, APQC determined that just 29% of companies were either testing blockchain technology or had completely implemented it. The expectation was that blockchain's use would increase within that period.
- **Skills gap:** Blockchain technology is still in its early stages, hence there is a significant lack of experts who can design and build blockchain systems. An overwhelming majority of survey takers(49%) cited a lack of qualified candidates as their greatest obstacle in the 2020 study [26]. For quite a while, the market for blockchain expertise has been extremely competitive.
- **Trust among users:** The third major obstacle to widespread blockchain adoption is the general public's distrust of the technology. It can look at this difficulty from two angles: There is a chance that businesses would question the trustworthiness of blockchain and its users.
- **Financial resources:** The lack of capital is the fourth barrier to blockchain's broad adoption, according to APQC's study. Many businesses couldn't afford to embrace blockchain technology because of the pandemic and disruption in 2020. On the other hand, the epidemic showed us that businesses, and IT departments in particular, are incredibly adaptable.

4.1 Security Risks and Attacks with Blockchain

Blockchain has several potential uses, such as in the cryptocurrency market, banking, the decentralization of the IoT, identity management, data registration and verification, and many more. The fact that this technology has so many potential uses outside cryptocurrency in almost every industry demonstrates its versatility, though. Financial institutions, payment processors, and insurance companies can all benefit from blockchain technology for inter-entity monetary transactions. Goods management and tracking are two areas where the logistics industry can put it to use. One such usage is its incorporation into the electrical network via the energy sector's generation means [27]. Health management and medication tracing are two areas where the pharmaceutical and medical sectors can put it to use. All along the value chain of a work, the audiovisual industry can employ blockchain to handle rights. Bookings, identities, bags, and tariffs can all be better managed with its help in the tourism industry. Industry 4.0 might be radically altered by blockchain technology, which might make real-time, trustworthy registration of IoT devices possible and enable safe communication within industrial networks. Furthermore, blockchain technology has the potential to enhance resource, identity, licensing, transaction, and event management within the public sector. For blockchain technology to be useful in digital identification, it must provide a foolproof, safe, and absolute method of identity authentication while also giving users complete command over their data's usage by outside parties.

4.2 Scalability and Interoperability Issues

As blockchain adoption grows, the ability of the network to scale efficiently becomes a significant challenge. Scalability issues not only impact transaction speed and cost but also affect storage, consensus performance, and overall security. Below are key areas where scalability poses a concern:

4.2.1 Scalability of Networks

The maximum number of transactions that a blockchain network can make is dependent on the capacity of such a network. When blockchain-based systems want to continue operating without reducing quality of work, but at the same time also reduce costs, they should be certain that there is potential to handle growing traffic and handle transactions. In case of network scaling, there are a plethora of issues with blockchain-based solutions [28]. The number of transactions that can be performed in tandem is determined by the capacity of the blockchain network. As the network expands in terms of transactions and users, it faces the risk of increased transaction length of transactions and the cost of transactions.

4.2.2 Storage Capacity Expansion

Another significant problem is the quantity of data that could be stored by blockchain-based systems. Nodes responsible for maintaining a full version of the ledger might also have some issues as transactions on the blockchain grow. Since the network grows, participating and keeping a full copy of the blockchain becomes more difficult for nodes.

4.2.3 Scalability via Consensus

Blockchain-based systems have to find consent algorithms that allow many transactions. As the number of transactions in the system increases, the ecosystem could also slow down and become more expensive to confirm. Blockchain-based systems aiming at keeping their transaction costs and performance stable need to ensure that the consensus algorithms they use can handle the larger transaction volume due to their size and complexity.

4.2.4 Scalability in Security

The amount of security risk of blockchain networks is directly proportional to the number of nodes. The security of the blockchain network should always be the crucial aspect, despite the fact that many users and nodes are going to be added. It is important to know how to bone off attacks where more nodes in the network come to the consensus process. The other problem with blockchain-based systems, as far as security is concerned, regards scalability.

4.3 Technological Immaturity and Standardization Gaps

The popularity of blockchain is increasing, yet the technology is not at the stage where it can be used in large corporations. Most of the platforms are at an infant stage of development, and thus, the features and functionalities are not robust, reliable, and scalable. This immaturity results in frequent updates, compatibility issues, and limited integration with existing legacy systems [29]. Along with that, the guidelines of the blockchain application industry-wide are very scarce. There are no established protocols, data formats, and consensus processes, and thus there is that open-mindedness that institutions find it challenging to engage one platform as soon as a change can obsolete them or can fail to interoperate with others in the future. The ambivalence of regulations also adds to making the technology options difficult to make, since the regulations required are different in different jurisdictions. Financial institutions are not willing to invest massively when there is no consistent legal and technical framework. In order to have wide and safe adoption of blockchain technology in the banking industry, such gaps should be sealed.

5 LITERATURE OF REVIEW

In this review, they look at how blockchain and AI are changing the financial sector. They highlight the benefits of speed, security, transparency, and low cost, but they also mention the challenges of regulation, scalability, privacy, and infrastructure in relation to banking, audits, DeFi, and data storage.

Kurniawati et al. (2025) studying the existing research on blockchain technology and its application in financial audits in order to identify the possible advantages and disadvantages of incorporating this technology into the field of accounting and finance. This research summarizes the outcomes of recent studies published in indexed journals using the Systematic Literature Review (SLR) methodology. The research indicates that blockchain technology can significantly enhance audit efficiency and prevent data manipulation. Nevertheless, there are a few obstacles to overcome during execution, such as concerns about privacy, rules, and the necessity of sufficient technical infrastructure [30].

Yusran et al. (2024) Blockchain technology as it pertains to conventional banks, with an emphasis on how it might improve upon current shortcomings while opening up new avenues for expansion. The research uses Structural Equation Modelling (SEM) with Smart-PLS to examine how Blockchain's fundamental properties, like immutability, decentralization, and automation through smart contracts, affect the uptake of DeFi. Financial institutions' preparedness to use DeFi solutions is positively correlated with their perceptions of the benefits of Blockchain, according to the findings. Regulatory hurdles and the necessity for technological scalability are two of the major concerns that this study explores in order to encourage broader usage [31].

Tiwari et al. (2024) the game-changing impact of blockchain technology on the financial sector, exploring the pros, cons, and possible results of adopting blockchain technology while showcasing its role in enhancing efficiency and reducing transaction fees. Also included is a comparison of the many blockchain technologies currently in use within the FinTech industry. AI-enabled chatbots simplify banking, while AI-powered blockchains increase scalability and decrease operational costs. AI is also used in decentralized finance. Additionally, the discussion covers the integration of UPI in regulating compliances and the exploration of decentralized methods of operations across the FinTech sector by disrupting network middlemen [32].

Gupta et al. (2024) blockchain deployments in many industries, including their characteristics, challenges, and benefits. This study served as a thorough literature review, analyzing 20 publications. Based on the three primary criteria of benefits, challenges, and practicality, these were classified into four categories: healthcare, government, manufacturing, and finance. Conclusions drawn from comparing outcomes along these dimensions are classified as follows: benefits (informational, economic, technological, organizational, and strategical), challenges (technological, organizational, adoption, environmental, operational, usability, environmental, and sustainable), and functionalities such as point-to-point transmission, data protection, security, data ownership, and transaction processing [33].

Chen (2023) A novel intelligent system with high practicability and operability is required to address this issue, guarantee the efficient and effective completion of all internal unit tasks, and maximize the advantage of resource utilisation. Additionally, this system needs to be able to handle the sensitive financial information that is required by government agencies. Given the gravity of the situation, this research starts by detailing the guiding principles for the storage system's architecture before diving into an analysis of the particle swarm optimization algorithm's implementation. Building and testing a secure storage system requires this. The findings show that financial data storage systems used by public institutions and optimized using the particle swarm method are fast, fault-tolerant, hardware-compatible, and can process security data in about 8 seconds [34].

Rane, Choudhary and Rane (2023) Presents the use of AI and blockchain is revolutionizing the banking industry by making transactions more secure, transparent, and efficient. The immutable record of transactions made possible by blockchain, a decentralized ledger, makes it a great option for protecting financial institutions from cyberattacks and fraudulent activity. However, financial operations can benefit from AI's predictive analytics, machine learning, and automation, which allow for risk assessment, decision-making, and data analysis in real-time. By integrating KYC and AML procedures, this integration makes it easier to comply with regulations and lessens the need for middlemen. Smart contracts can be made more flexible and sensitive to changes in the market by including AI algorithms. Financial ecosystems are on the brink of a revolution due to this convergence [35].

The comparative summary of previous research based on key findings, challenges, and future description is provided in Table 1.

Table 1: summarizes the literature on Blockchain Integration in Financial Institutions, including its approach, main findings, challenges, and future directions.

Author	Focus On	Key Findings	Challenges	Future Directions
Kurniawati et al. (2025)	Blockchain in financial audits	Enhances audit efficiency and prevents data manipulation	Privacy concerns, regulatory issues, and need for infrastructure	Secure, scalable blockchain solutions tailored for auditing
Yusran et al. (2024)	Blockchain in traditional financial institutions	Immutability, decentralization, and smart contracts enhance DeFi readiness in institutions	Regulatory barriers and scalability requirements	Address regulatory frameworks; improve scalability for institutional adoption
Tiwari et al. (2024)	Blockchain's transformative role in FinTech	Reduces costs, enhances efficiency; AI integration boosts scalability and automation	Technological integration and compliance issues	AI-blockchain synergy in FinTech; role of UPI in compliance
Gupta et al. (2024)	Blockchain applications across sectors including finance	Identified benefits (economic, strategic, etc.) and challenges (adoption, usability, sustainability) in blockchain implementation	Technological, organizational, and sustainability concerns	Cross-sectoral optimization strategies; better usability models
Chen (2023)	Secure financial data storage for public institutions	Designed secure, high-performance storage system; fast processing and high fault tolerance	Need for intelligent storage design and compatibility	Advanced optimization for blockchain-based storage; integration with institutional workflows
Rane, Choudhary and Rane (2023)	The banking industry's use of blockchain technology and AI	The immutability, transparency, and security of transactions are all improved by blockchain technology. AI automates processes, evaluates risks, and provides predictive insights. When combined, they make smart contracts more flexible and simplify KYC/AML.	Integration complexity, interoperability issues, data privacy concerns, and regulatory uncertainty.	Explore adaptive smart contracts, enhanced regulatory compliance frameworks, and scalable AI-Blockchain models.

6 CONCLUSION AND FUTURE WORK

The distributed ledger system known as blockchain is causing a stir in the banking industry thanks to the many benefits it offers in terms of efficiency, transparency, and security. As a result, it has the potential to increase financial inclusion, build trust, and enhance operations. Scalability problems, unclear regulations, a lack of trained workers, and an absence of sufficient empirical evidence on practical applications are some of the obstacles to broad adoption. Future studies should concentrate on creating interoperable and scalable frameworks, connecting blockchain to new technologies like AI and the Internet of Things, and creating standardised protocols and regulatory harmonization so that it can reach its maximum potential. Collaborative efforts and long-term studies will be essential to support its sustainable integration into mainstream financial systems. Additionally, pilot programs and cross-sector partnerships can offer valuable insights into practical deployment. Understanding user behavior, ensuring data privacy, and building public confidence will further drive acceptance and long-term success of blockchain in finance.

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