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Blockchain Applications in Islamic Banking: Advantages & Challenges

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Abstract:

This study analyzes the role of Blockchain technology in developing Islamic banking operations by examining its potential to enhance transparency, security, and Shariah compliance, along with adoption challenges.

Results indicate that Blockchain offers promising opportunities for Islamic banks to innovate financial products and improve operational efficiency, though technical, legal, and Shariah-related challenges must be addressed.

Keywords: Blockchain, Islamic banking, transparency, smart contracts, operational efficiency.

JEL Classification Codes : G 21, G 24, G 29.

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1. INTRODUCTION

The global financial landscape is undergoing a radical transformation driven by rapid technological advancements, with blockchain technology emerging as one of the most promising innovations poised to reshape financial and banking operations. This technology offers immense potential to enhance transparency, security, and operational efficiency through its decentralized system for managing data and transactions.

Conversely, the Islamic banking sector faces significant challenges in keeping pace with these technological developments while maintaining strict compliance with Islamic Sharia principles, which prohibit *riba* (usury), *gharar* (excessive uncertainty), and other non-compliant practices. Against this backdrop, it becomes imperative to explore blockchain's potential in enhancing Islamic banking operations by delivering technological solutions aligned with Islamic values.

Problematic

In light of the rapid technological advancements transforming the global financial landscape, blockchain technology has emerged as an innovative breakthrough with significant potential to revolutionize financial and banking operations. However, Islamic banks face substantial challenges in adopting and adapting this technology to comply with Sharia principles.

Against this backdrop, the core research problem can be formulated as follows:

"How can Islamic banks leverage blockchain technology to enhance transparency, operational efficiency, and Sharia compliance while addressing the associated technical, legal, and religious challenges?"

Hypothesis

This study hypothesizes that implementing blockchain in Islamic banks can improve operational efficiency, bolster transparency, and ensure adherence to Sharia principles provided that technical, legal, and environmental challenges are adequately addressed.

Importance of the Study

This article explores how blockchain technology can revitalize Islamic finance, making it more effective in achieving its stated goals. As a natural technological complement, blockchain enhances data storage and retention methods, thereby boosting trust, reducing fraud, and promoting honesty in the digital economy.

Study Objectives

This study aims to provide an analytical framework for deploying blockchain in Islamic banks, emphasizing technical, legal, and Sharia challenges, and proposing practical mechanisms to harness its benefits. It seeks to bridge a knowledge gap in fintech's role in advancing Islamic banking—a sector striving to adapt to modern changes without compromising its foundational principles.

Methodology

The study adopts a *descriptive approach* to analyze variables and a *critical analytical approach* to evaluate blockchain's advantages and challenges for Islamic banks, supported by data collection and literature review.

Topics:

The study is organized into three sections:

1. **Conceptual Framework of Blockchain Technology ;**
2. **Challenges of Blockchain Adoption in Islamic Banks;**
3. **The Impact of Blockchain Technology on Islamic Banks.**

2- Conceptual Framework of Blockchain Technology

Blockchain technology is one of the modern technologies used to process and record financial transactions, contracts, physical assets, supply chain information, and anything of value.

2-1 The Emergence of Blockchain

For decades, traditional ledgers and records formed the foundational pillar relied upon by banking and governmental institutions to create and document financial and legal transactions, ensuring the protection of various forms of asset ownership. Within this framework, governments and financial intermediaries (such as banks and other financial institutions) acted as central authorities with the power to manage and oversee transaction records, document changes, and regulate access permissions. These central authorities served as custodians responsible for ensuring the security, stability, and integrity of the ledger and its transaction history, thereby fostering trust among users who relied on these authorities to safeguard their rights (Al-Sagheer & Al-Talib, 2024).

Traditional financial record-keeping systems are characterized by two key features:

1. **Centralized Nature**: A trusted intermediary, endorsed by all users, manages and supervises the ledger and all transactions.
2. **Restricted Access**: The "central authority" controls users' ability to conduct transactions and view data, making the ledger only partially accessible.

However, traditional transaction systems face several limitations, including: (Iftikhar & Saba, 2020).

- Long settlement times,
- Cash reliance in local transactions,
- Multiple intermediaries,
- Cyber security risks, fraud, operational errors,

- Time-consuming procedures,
- Limited access to formal banking services

In response to these constraints, **Distributed Ledger Technologies (DLT)** have emerged as a rapidly evolving innovation in data recording and exchange. DLT relies on a shared and distributed database system, moving beyond centralized and restricted-access models. This technology allows all participating parties to maintain a complete transaction record, marking a radical shift from traditional systems where only central authorities held this power. Blockchain represents the first practical application of DLT (Hashimy et al., 2021).

2-2 Definition of Blockchain

Blockchain can be defined as:

"an electronic ledger system that is shared, real-time, encrypted, and decentralized, used to process and record financial transactions, contracts, physical assets, supply chain information, and anything of value" (Gupta, 2020).

Also known as a "chain of blocks," blockchain introduces an innovative model for creating, managing, and storing data records, characterized by distribution and full transparency. Transactions are stored across all users of the ledger, with each maintaining a complete copy. Any user can request new transactions or audit existing ones (Gupta, 2020).

Also defined as a "modern technology for conducting transactions and deals without intermediaries. These transactions are linked together in a sequential, encrypted manner within an open (distributed) ledger that is not stored in a central location". Based on this, the blockchain system ensures **confidentiality** (being virtually unhackable), **transparency**, and **trust** at all stages of the exchange and transaction process. It also offers **speed**, **low cost**, and the **absence of any central authority**. (KEMMITI, 2023)

The distributed nature of blockchain relies on **consensus mechanisms**, where new transactions require collective approval from participants. Transactions undergo rigorous validation through cryptographic algorithms (a process called **mining**). Once verified, transactions are grouped into **blocks**, which are then permanently added to the chain in an unalterable manner. Miners compete to solve these algorithms and earn transaction fees (e.g., ~€0.10 per transaction) (Boucher, 2017).

Blockchain is divided into four main types:

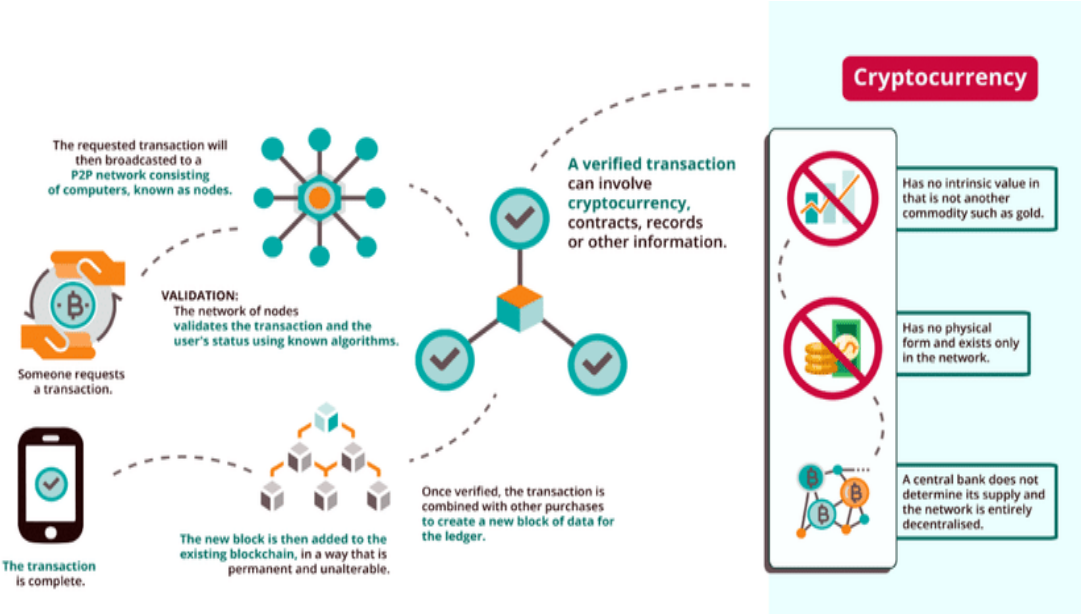
1. **Public Blockchain**: Open to all (e.g., Bitcoin).
2. **Private Blockchain**: Restricted access (Monem & FUND, 2019).
3. **Consortium Blockchains:** Controlled by a group of organizations instead of one entity. Useful for industries like banking or supply chains where multiple parties collaborate.
4. **Hybrid Blockchains:** Combine features of both public and private blockchains, offering transparency and controlled access.

Decentralization enhances security—while hacking traditional systems requires targeting a single central authority, altering a distributed ledger demands simultaneous attacks on all copies, making fraud practically impossible (Boucher, 2017).

2-3 How Blockchain Works

Blockchain enables thousands of interconnected computers to maintain a unified, tamper-proof ledger. Users can transact directly via **digital wallets** (software for managing cryptocurrencies like Bitcoin and Ethereum) without intermediaries, using cryptographic keys (public/private) for security.

Figure N° 1: Blockchain Mechanisms



Source: (Samer Shorman, 2019)

2-4 Steps in Blockchain Transactions:

1. A user initiates a transaction, creating a block.
2. The transaction is broadcast to a **peer-to-peer (P2P)** network of nodes (computers running the blockchain software).
3. Nodes validate the transaction (e.g., via mining).
4. Validated transactions are grouped into a cryptographically secured block.
5. The new block is added permanently to the chain.

Once recorded, transactions are immutable (*The Complete Guide to Blockchain Technology*, n.d.).

2-5 Applications of Blockchain

- **Cryptocurrencies**: Bitcoin (53.7% market dominance) pioneered decentralized digital currencies (Iftikhar & Saba, 2020).

- **Smart Contracts**: Self-executing digital contracts programmed to trigger upon meeting predefined conditions (Iftikhar & Saba, 2020).
- **Digital Tokens**: Represent ownership rights in assets tied to smart contracts (Benalkama, 2021).

Due to the variety of use cases of blockchain technologies, it is difficult to state a definite number of blockchain technology users worldwide. Statistics usually refer to blockchain in connection with Cryptocurrencies.

According to Zippia, over **300 million people** (approximately **3.9% of the world's population**) interact with blockchain technology through cryptocurrencies. Additionally, there are **82 million blockchain wallet users** globally, that shows a significant increase from just **10 million users in 2016**. (kruschecompany, 2025)

The following table displays the number of blockchain users in different regions worldwide:

Table Nº 1: **Number of Blockchain users in different regions worldwide**

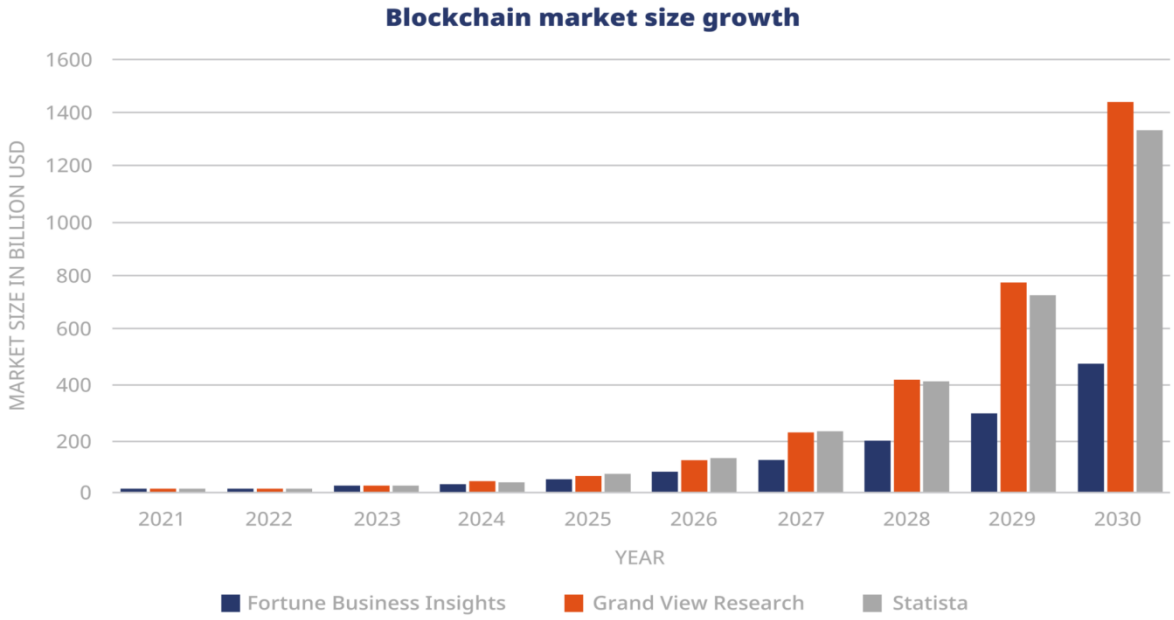
Region	Number Of Blockchain Users
Asia	160 million
Europe	38 million
Africa	32 million
North America	28 million
South America	24 million
Oceania	1 million

Source: (kruschecompany, 2025)

The table above shows that Asia dominates this growth with 160 million users, and global blockchain wallet ownership has skyrocketed by 700% since 2016.

The blockchain technology market is in a high growth stage. Market intelligence company Fortune Business Insights projects growth from $17.57 billion in 2023 to $469.49 billion in 2030 (kruschecompany, 2025).

Figure N° 2: Blockchain market size growth



Source: (kruschecompany, 2025)

2-6 The Biggest Blockchain companies

We can have a look of the 6 biggest blockchain companies that are publicly traded either in the U.S. or Canada, as of December 2022. Activities of these companies include financial technology (fintech), cryptocurrency mining, and manufacturers of blockchain technology: (kruschecompany, 2025)

1. **Coin base Global Inc. (COIN):** Revenue $5.1 billion, Market Cap $9.05 billion. Type: Global provider of financial infrastructure.
2. **Canaan Inc. (CAN):** Revenue $947.5 million, Market Cap $420.9 million. Type: China-based provider of high-performance computing solutions.
3. **Galaxy Digital Holdings Ltd (BRPHF):** Revenue $457 million, Market Cap $310.4 million.
   Type: Financial services such as trading, asset management, etc.
4. **Riot Blockchain Inc. (RIOT):** Revenue $289.9 million, Market Cap $694.3 million. Type: Bitcoin mining.
5. **Silvergate Capital Corp. (SI):** Revenue $273.2 million, Market Cap $592.3 million Type: Provider of financial infrastructure solutions and services.
6. **Marathon Digital Holdings Inc (MARA):** Revenue $149.6 million, Market Cap $551.5 million. Type: Cryptocurrency mining.

2-7 Uses of Blockchain Technology in Islamic Banking

Blockchain technology holds significant potential for application within Islamic banking. The broader applications of this technology within the industry can be categorized as follows: (Dandi, 2025)

a. Smart Contracts: Smart contracts can automate Islamic financial transactions, eliminate intermediaries to reduce costs, increase transparency, and ensure all parties fulfill their obligations. This is particularly beneficial for complex products like **mudarabah** (trustee finance) and **musharakah** (partnership) contracts, as automation guarantees adherence to pre-defined Shariah principles, streamlining processes and ensuring compliance.

b. Digital Currencies: Utilizing blockchain technology, Islamic digital currencies can be developed in full compliance with Shariah principles. Such currencies are designed to avoid *riba* (interest), *gharar* (excessive uncertainty), and *maysir* (gambling), and are anchored in real economic activity. Their ability to enable instantaneous, cost-effective transactions, combined with their inherent Shariah compliance, positions them to gain significant acceptance within the Islamic financial ecosystem.

c. Product Traceability: Blockchain technology can ensure Shariah compliance by providing a transparent and immutable record of a product's entire life cycle, from ethical sourcing to final delivery. This traceability is essential for verifying that products adhere to strict Islamic guidelines, such as those for Halal goods.

d. Sukuk Issuance: Issuing Sukuk on blockchain platforms offers a transformative approach to Islamic finance. The technology streamlines the entire lifecycle—from issuance to trading and settlement—while simultaneously enhancing the efficiency, security, and transparency of these Shariah-compliant investments.

e. Islamic Microfinance: The integration of blockchain technology in Islamic microfinance holds significant potential to reduce transaction costs and enhance financial inclusion. In Bangladesh, Shari'ah-compliant microfinance institutions (MFI) have integrated blockchain technology to offer microloans to small and medium-sized enterprises (SMEs) and individuals, expanding financial inclusion and improving access to finance for underserved populations.

f. Zakat and Islamic Charitable Giving: Blockchain technology can revolutionize Zakat management and Islamic charitable giving by ensuring transparency, traceability, and cost-effectiveness. It creates an immutable ledger to track funds from the contributor (Muzakki) to the recipient (Mustahiq), overseen by Zakat Management Organizations (ZMOs). This system guarantees that funds are used correctly, fulfilling the ethical obligations of Islamic finance while building greater trust and efficiency in charitable distribution.

3- Challenges of Blockchain Adoption in Islamic Banks

Blockchain technology presents multiple challenges as an emerging innovation in the digital age. The primary challenge lies in its novelty and continuous evolution, requiring additional time for maturity and diversified practical applications. While experts highlight its promising potential, they also point to unresolved issues and concerns, reflecting the absence of stable regulatory frameworks and international standards governing its applications. Furthermore, blockchain faces multifaceted challenges—legal, environmental, and Shariah-related—demanding further research and analysis by scholars and policymakers in governmental and institutional sectors (Alshater, 2018). Below, we outline the most prominent challenges:

3-1 Technical Challenges

a. Storage Scalability

Blockchain requires storing all transaction data to verify reliability. As transaction volumes grow exponentially, the demand for larger storage capacities intensifies. The rapid expansion of blockchain poses a challenge to hard drive development rates; for instance, the Bitcoin blockchain now exceeds 100 GB in size. The network risks losing nodes if the ledger grows beyond users' capacity to download and store it. Adding a new Bitcoin transaction necessitates re-downloading the entire 100 GB database.

Additionally, due to block size limits and the time required to create new blocks, Bitcoin's blockchain can process only ~7 transactions per second—far below the capacity needed for millions of simultaneous instant transactions. With limited block space, miners may prioritize high-fee transactions over smaller ones. Proposals to address this include pruning old records and adopting an *Account Tree* model, eliminating the need for nodes to store full transaction histories (Zheng et al., 2018).

b. Privacy Concerns

Although users transact pseudonymously on the blockchain, the transparency of all transactions, balances, and transfers compromises privacy. Studies reveal that Bitcoin transactions can be traced to identify users, and mechanisms exist to link pseudonyms to IP addresses. However, solutions like *Mixing* and *Zerocash* have emerged to enhance privacy (Zheng et al., 2018).

c. 51% Attacks

Blockchain relies on algorithms designed to resist cyberattacks, yet it remains vulnerable to threats like *51% attacks*, where an entity controlling over 51% of the network's hash power can disrupt transactions or manipulate their order. While theoretically possible, Bitcoin has never suffered a successful 51% attack, as security strengthens with network growth. The financial cost of such an attack outweighs potential gains (Zalte-Gaikwad et al., 2023).

d. Data Modification (Forks)

Blockchain requires periodic updates (*forks*) to address issues or improve performance. Due to decentralization, all participants must adhere to a unified protocol (e.g., block size, miner rewards). Challenges arise when updated and non-updated nodes operate under incompatible rules, leading to four scenarios:

1. Updated nodes accept transactions from old nodes.
2. Updated nodes reject old-node transactions.
3. Old nodes accept updated-node transactions.
4. Old nodes reject updated-node transactions.

e. Private Keys and Password Loss

Blockchain uses *public-private key pairs* to verify ownership of digital assets. Losing the private key or password results in irreversible asset loss, as users act as their own "bank".

3-2 Transition and Integration Costs

Adopting blockchain demands significant financial and logistical investments, including infrastructure development, skilled personnel, and iterative problem-solving. Governments and institutions must weigh these costs before implementation.

3-3 Legal Challenges

a. Regulatory Acceptance

Blockchain's decentralized nature clashes with existing legal frameworks, requiring gradual legislative reforms. For instance, smart contracts face limited judicial recognition—only a few jurisdictions (e.g., Arizona) equate them with traditional contracts (Lacasse, 2017).

b. Technical-Legal Misalignment

Parties often lack the expertise to understand smart contract code, necessitating technical translators until blockchain literacy improves.

c. Cross-Border Jurisdictional Issues

Global smart contract enforcement is complicated by divergent national regulations and the absence of standardized governance.

3-4 Shariah Compliance Challenges

a. Decentralization vs. Governance

Key questions arise:

- Does peer-to-peer (P2P) blockchain eliminate *Siyasah Shar'iyyah* (Islamic policy)?
- What role should governments play?
- Is a minimal regulatory role acceptable under Shariah?

b. Cryptocurrencies

Debates persist over the monetary nature of cryptocurrencies and their Shariah compliance, given their lack of intrinsic value and centralized backing.

c. Smart Contracts

Automated contracts raise Shariah concerns, such as:

- Legal validity (*hujiyyah*) and formation (offer/acceptance).
- Capacity (*ahliyyah*) verification in absence of human intermediaries.
- Permissibility of machine-to-machine contracts without human oversight (Banianmer, 2019).

3-5 Environmental Challenges

Blockchain, especially Bitcoin, consumes vast amounts of energy—exceeding the usage of 159 countries at peak times. This stems from:

- Artificial scarcity driving mining competition.
- *Proof-of-Work* (PoW) algorithms (Sapra et al., 2024).

4- The Impact of Blockchain Technology on Islamic Banks

Blockchain technology presents a significant opportunity for Islamic banks to develop operations aligned with Sharia principles. However, its adoption entails both positive and negative contributions, which can be summarized as follows:

4-1 Positive Contributions

a. **Enhancing Transparency and Trust** *(Adegbite, 2024)*

- **Immutable Records:** Blockchain enables the creation of transparent and permanent transaction records, strengthening trust between banks and clients.
- **Facilitating Sharia Compliance:** Its inherent transparency helps Islamic banks demonstrate adherence to Sharia principles, such as the prohibition of *riba* (interest) and *gharar* (uncertainty).

b. **Improving Operational Efficiency** *(Azmat & Thanou, 2023)*

- **Reducing Intermediaries:** Blockchain allows direct peer-to-peer transactions, cutting operational costs and processing time.
- **Smart Contracts:** Automates financial processes (e.g., profit distribution in *Mudaraba* contracts or *Sukuk* issuance), minimizing human error and boosting efficiency.

c. **Mitigating Financial Risks**

- **Fraud Prevention:** Blockchain's near-tamper-proof system reduces risks of fraud and forgery.
- **Risk Management:** Enables real-time transaction tracking, ensuring fair risk distribution among stakeholders.

d. **Promoting Financial Innovation** *(As-Salafiyah, 2021)*

- **Innovative Financing:** Islamic banks can launch blockchain-based products (e.g., smart *Sukuk*), attracting more investors.
- **Financial Inclusion:** Expands access to Sharia-compliant digital banking for underserved populations.

4-2 Negative Contributions

a. **Legal and Regulatory Challenges**

- **Lack of Frameworks:** Most countries lack clear regulations governing blockchain use in Islamic finance.

- **Divergent Fatwas:** Scholars' disagreements on blockchain's permissibility may slow adoption.

b. **High Initial Costs**

- **Technology Investments:** Implementing blockchain requires heavy infrastructure and training investments, burdening smaller banks.

c. **Resistance to Change**

- **Institutional Hesitation:** Traditional banks may resist disrupting legacy systems.
- **Cultural Barriers:** Clients may distrust unfamiliar technologies.

d. **Technical Complexities**

- **System Compatibility:** Banks must adapt existing systems to integrate blockchain.
- **Energy Consumption:** Public blockchains' high energy use may conflict with environmental values.

4-3 Strategic contributions

a. **Global Expansion:** Blockchain helps Islamic banks offer transparent, secure services in international markets.

b. **Reputation Boost:** Positions Islamic banks as innovative, Sharia-compliant institutions.

c. **Client Relationship Development:** Enables clients to track investments and verify compliance, strengthening trust. *(Abojeib et al., n.d.)*

While blockchain offers transformative potential for Islamic banks, its success hinges on addressing regulatory, financial, and cultural hurdles. Strategic collaboration among banks, scholars, and regulators is critical for sustainable adoption.

5- Conclusion:

The application of blockchain in Islamic Financial Institutions (IFIs) offers a new approach to develop Islamic finance contracts across technical, operational, and Sharia-compliance dimensions. Specifically, it can revolutionize equity-based contracts, creating an efficient, secure, and innovative investment model that addresses the shortcomings of the traditional framework.

The study concluded that blockchain technology represents a promising opportunity for Islamic banks to enhance their performance and competitiveness by providing innovative solutions that improve transparency, efficiency, and Sharia compliance. However, adopting this technology requires addressing technical, legal, and Sharia-related challenges.

Results:

The results highlight the importance of investing in qualified human resources and developing regulatory frameworks compatible with this technology to ensure its effective and sustainable utilization by Islamic banks. The key findings can be summarized as follows:

- Blockchain technology helps create transparent and immutable transaction records, strengthening trust between banks and customers.
- The inherent transparency of blockchain aids in demonstrating Islamic banks' adherence to Sharia principles, such as the prohibition of *riba* (interest) and *gharar* (uncertainty).

- Blockchain provides a highly secure and nearly tamper-proof system, reducing fraud and forgery risks.
- Implementing blockchain requires significant investments in infrastructure and training, which may pose a financial burden for smaller banks.
- The lack of consensus among scholars regarding the permissibility of certain blockchain applications may slow its adoption.

Recommendations:

Based on the findings, the study proposes the following recommendations:

1. **Developing Regulatory Frameworks:** Collaborate with Sharia and regulatory bodies to establish clear standards for blockchain implementation in Islamic banks.
2. **Training and Capacity Building:** Equip employees in Islamic banks with the skills to understand and utilize blockchain applications in line with Sharia principles.
3. **Enhancing Institutional Collaboration:** Establish cooperative platforms among Islamic banks to share research, development, and implementation costs.
4. **Innovating New Financial Products:** Design blockchain-compliant financial products, such as smart *sukuk* or digital zakat platforms.

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