
Challenges and Prospects of Blockchain for Islamic Finance:

A Contemporary Perspective

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Abstract:

This study investigates the application of blockchain technology in Islamic finance. It outlines the main types of blockchain and their general financial uses. Attention is given to blockchain's relevance for Islamic financial systems. The findings show that blockchain's decentralized design enhances trust, security, and operational efficiency. At the same time, technology presents both advantages and limitations. Islamic finance faces additional barriers to adoption. These include technical, legal, environmental, and Shariah-related challenges. The study emphasizes the need for practical solutions to support effective implementation. It also calls for clearer Shariah guidance and broader stakeholder awareness.

Keywords: Blockchain; Finance; Islamic finance; Shariah compliance; Financial innovation.

Jel Classification Codes: G23, O33, Z12.

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1. Introduction :

Islamic finance and the digital economy offer promising opportunities for both Muslims and non-Muslims, as both groups now seek converging solutions to pressing challenges; particularly the restoration of trust in financial systems that have significantly eroded. While some technologists envision a world free of intermediaries, others simply seek faster and more efficient modes of transaction. In both cases, the core challenge lies in ensuring accountability; embedding a sense of responsibility within the newly emerging systems. These systems are built upon the principles of risk and profit-sharing, which are foundational to our economies, including the underutilized asset-sharing economy (Mohamed & Ali, 2018).

Blockchain technology is rapidly gaining traction among organizations affiliated with the Organisation of Islamic Cooperation. Numerous Islamic financial institutions are planning to adopt blockchain systems to reap the associated benefits. For instance, authorities in Dubai announced their strategy to implement blockchain across both the public and private sectors by 2020.

Islamic financial institutions are increasingly employing blockchain technology to handle complex financing conditions and conduct transactions that comply with Shariah principles. This includes Shariah-compliant alternatives to conventional insurance, automation of back-office operations, and microinsurance. Moreover, blockchain-backed cryptocurrencies may be utilized within Islamic finance to fund small and medium-sized enterprises (SMEs), facilitating payment systems that are both efficient and cost-effective (Mohamed & Ali, 2018).

Undoubtedly, blockchain can contribute significantly to the success of Islamic banks and financial institutions. Free from concerns related to interest (riba) and other non-compliant elements, Islamic banking systems can operate with enhanced productivity. Loan management and related services become more streamlined, fraud and risks are mitigated, and the high costs typically associated with Islamic finance can be reduced. Given that Islamic financial products generally incur higher processing costs than their conventional counterparts, blockchain serves as an exceptionally efficient tool for minimizing back-office expenses in Islamic financial institutions.

The primary challenge in the future will concern the legal enforceability of smart contracts and the development of a globally harmonized regulatory framework to facilitate genuine cross-border peer-to-peer lending. The legality of a transaction in one jurisdiction does not necessarily guarantee its legality elsewhere. Although blockchain technology has attracted increasing attention within Islamic finance, there is still no clear consensus on how it can be meaningfully reconciled with Shariah principles. Much of the existing discourse remains divided, with technical studies examining system capabilities on one side and Shariah-oriented analyses debating permissibility on the other. What is largely missing is a holistic discussion that connects technological

functionality with Islamic financial objectives and real-world implementation. To address this shortcoming, this paper is guided by the following research question: How can blockchain technology be incorporated into Islamic finance in a way that aligns with Shariah principles, and what opportunities and constraints influence its adoption? By engaging with this question, the study aims to offer an integrated perspective that is relevant to scholars, practitioners, and regulators. Accordingly, the objectives of this paper are as follows:

- To provide an introductory overview of blockchain technology and its relevance to Islamic finance.
- To enhance knowledge and build capacity within the Islamic finance sector concerning blockchain technology.
- To understand the implications of blockchain for Islamic finance and anticipate future developments.
- To explore and critically examine current applications of blockchain within the domain of Islamic finance.

The remainder of this paper is structured as follows. Section 2 introduces the conceptual foundations of blockchain technology, including its core components and different types of blockchain systems. Section 3 reviews recent trends in blockchain investment and discusses the persistent trust and regulatory challenges associated with technology. Section 4 examines the principles of Islamic finance and critically analyzes the compatibility of blockchain with Shariah requirements, highlighting key application areas such as smart contracts, digital currencies, zakat, and waqf management. Section 5 discusses the major technological, legal, regulatory, and institutional challenges hindering blockchain adoption in Islamic finance. Section 6 concludes the paper by summarizing the main findings and offering policy implications and directions for future research.

2. The Conceptual Foundations of Blockchain

2.1 Components of Blockchain

The term « blockchain » refers to a suite of technologies that include: blockchain data structures, public-key cryptography, distributed ledgers, and consensus mechanisms (Castiglione Maldonado, 2018). In its simplest form, blockchain consists of a linked series of data-storing units known as « blocks ». Many online commentaries compare blockchain to a Google Spreadsheet that allows multiple contributors to edit simultaneously, thanks to a consensus or “locking” mechanism. However, blockchain is significantly more complex and possesses unique features that make it a highly attractive technology for labeling, storing, and tracking anything of value. Bitcoin remains one of the earliest and most well-known applications of blockchain technology (Castiglione Maldonado, 2018).

Each blockchain block contains three main components :

- The data itself (representing anything of value) .
- A unique « hash value » (a cryptographic code generated through complex mathematical algorithms) .
- A reference to the hash of the preceding block (Sylvester, 2019).

2.2 Types of Blockchain

Blockchain systems can generally be classified into three types; public, private, and hybrid, depending on their application (Sultan, Ruhi, & Lakhani, 2018):

a. Public Blockchain

Public blockchains are open-source and not owned by any single entity. They are visible to all, and participation in consensus is unrestricted. Bitcoin is a well-known example of a public blockchain. In this model, anyone can download the protocol or software, run a full node on their local device, and verify transactions on the network; thus, actively participating in the consensus mechanism. Due to its public nature, any user can audit transactions via public block explorers, although transaction participants remain pseudonymous. The key advantages of public blockchains include their ability to disrupt traditional business models by removing intermediaries. Additionally, they eliminate the need for centralized servers or administrators, drastically reducing the costs associated with developing and operating decentralized applications (Abojeib & Habib, 2019).

b. Private Blockchain

Also referred to as permissioned blockchains, these systems restrict access to authorized participants only. They allow designated entities to control read/write permissions and typically do not require mining or traditional consensus algorithms since a single authority governs the network. Private blockchains are usually administered by one organization or a centralized authority and consist of a limited number of nodes. They are particularly useful for resolving issues related to internal efficiency, security, and fraud in traditional institutions. However, they do not offer the full benefits of decentralization, which remains a core appeal of blockchain technology (Abojeib & Habib, 2019).

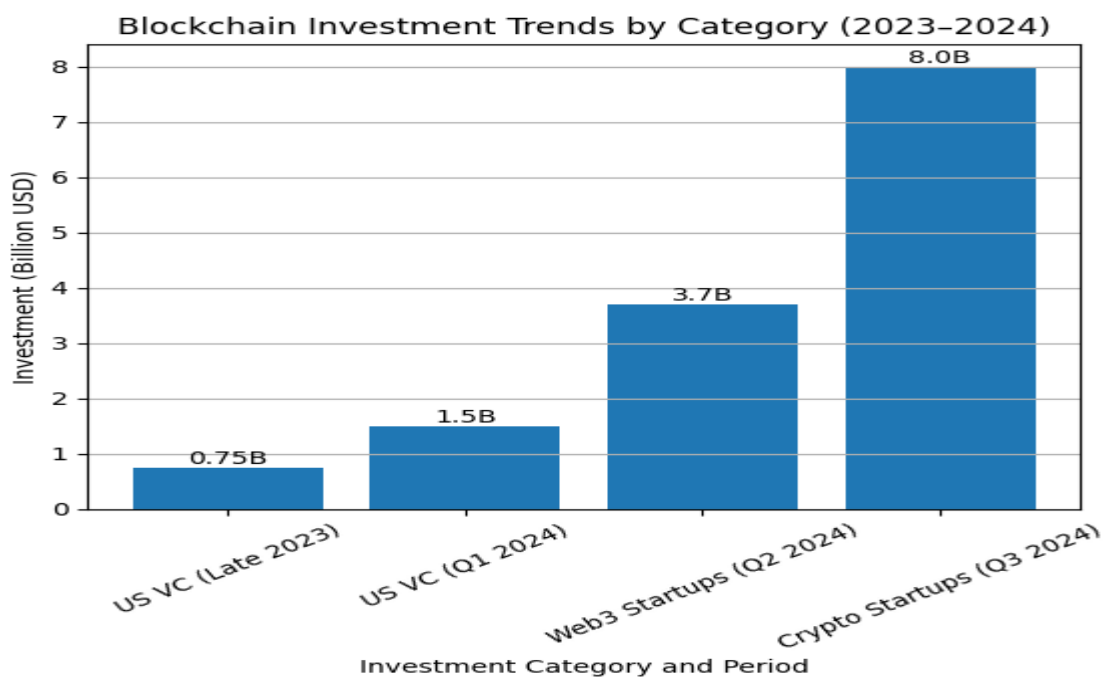
c. Hybrid Blockchain

Hybrid blockchains are accessible only to a predefined group of participants. The consensus process is managed by known and trusted servers using a rules-based governance model agreed upon by all stakeholders. Copies of the blockchain are distributed solely among relevant participants, rendering the network partially decentralized. Also known as « consortium blockchains », these systems are governed by a coalition of institutions authorized to function as full nodes. Unlike public blockchains, access to transaction verification is limited. Consensus is achieved via a pre-selected group of validators, with protocols defining the minimum number of required signatures to validate a block. Access to blockchain data may be public or restricted to participating members only. This model offers several advantages, such as reduced transaction costs, avoidance of data duplication, and modernization of legacy systems. It also helps streamline document handling and eliminate partially manual compliance procedures (Abojeib & Habib, 2019).

3. Blockchain Investments

Leading financial services companies have continued to make substantial investments in blockchain-based startups. After a sharp decline post-2022, the market showed signs of resilience. In the first quarter of 2024, U.S. venture capital investment into crypto companies reached \$1.5 billion, doubling from its low in late 2023 (Silicon Valley Bank, 2024). By the second quarter of 2024, Web3 startups raised a total of \$3.7 billionan ; 18% year-over-year decrease, but a 42% increase from the previous half-year, indicating renewed investor interest (Crunchbase, 2024). By the third quarter of 2024, overall crypto startup investments had reached \$8 billion, with 85% of this capital directed toward early-stage deals; the highest proportion since Q1 2020 (Galaxy Research, 2024). These investment trends are illustrated in Fig N° 1.

Fig N° 1: Blockchain Investment Trends (2023- 2024)



Source : created by author based on Silicon Valley Bank, Crunchbase and Galaxy Research data.

This development raises a critical question: Why is it still difficult to trust blockchain technology? By its very nature, blockchain is designed to foster trust. However, in practice, companies encounter trust-related challenges at nearly every juncture. First, users must trust the technology itself. As with any emerging technology, there are uncertainties regarding blockchain's reliability, speed, security, and scalability. Concerns also persist around the lack of standardization and limited interoperability.

Adding to this trust gap is a widespread lack of understanding. Many executives remain unclear about what blockchain truly is and how it could reshape the core dimensions of business. Although public discourse has evolved beyond Bitcoin, more recent trends such as ICOs (Initial Coin Offerings) merely hint at blockchain's transformative potential. Blockchain's dual role; as a new infrastructure and a means to digitize assets through

tokenization, marks a paradigm shift. It represents not only a technological innovation but also a new mindset, akin to virtual reality headsets or unmanned aerial systems.

Another challenge lies in building trust within the blockchain network itself. Paradoxically, while blockchain aims to achieve consensus, the early stages of its implementation are often hindered by the need to establish rules and standards. This is especially evident in payment systems and banking mechanisms. While existing systems follow specific rules, there is no consensus yet on how blockchain-based alternatives should function, highlighting the need for clearly designed and operationalized frameworks.

Similarly, regulatory comfort remains a concern. Most regulatory bodies are still adapting to blockchain. While some jurisdictions have begun studying related financial issues, the global regulatory landscape remains unstable. It is indeed paradoxical that a technology intended to create consensus may itself be obstructed by the absence of agreed-upon rules and standards.

Blockchain may also prove unsuitable for certain types of data. The range of data stored on a blockchain is as broad and diverse as human activity itself. Providing an exhaustive overview of blockchain's applications is nearly impossible. However, a few key areas include (Drescher, 2017):

- Payments: Managing ownership and transfer of digital fiat currencies.
- Digital Currencies: Creating digital payment instruments independent of central banks or governments.
- Micropayments: Efficiently processing small transactions that are otherwise costly via traditional channels.
- Digital Assets: Managing the creation, ownership, and transfer of assets with inherent or represented value.
- Digital Identity: Verifying identity through unique digital credentials.
- Notarization Services: Digitizing, storing, and verifying documents or contracts for ownership and transfer purposes.
- Compliance and Auditing: Tracking organizational activities for regulatory reporting and internal audits.
- Taxation: Calculating and collecting taxes based on transaction histories, minimizing avoidance and duplication.
- Voting Systems: Creating and managing secure digital ballots.
- Record Management: Safely storing medical records and other sensitive documents.

4 .Blockchain Applications in Islamic Finance

Islamic finance, as an ethical and alternative form of financing, directs capital toward real economic activities with social and developmental impact. It channels both financial and economic resources to meet the material and social needs of all members of society. Its key characteristics include asset-backed transactions and equity-based profit and risk-sharing. As a distinct segment within the broader financial ecosystem, Islamic finance plays a vital role in enhancing financial inclusion, supporting startups, and attracting capital from Islamic investors.

Islamic finance is unique in that it is directly governed by the ethical tenets of a major world religion. These tenets not only provide general investment guidelines but also give rise to a distinctive set of financial products. Grounded in Shariah (Islamic law), Islamic finance governs a wide range of life aspects, including religion, politics, economics, banking, commerce, and legal matters. Its objective is to structure financial practices and instruments in accordance with Islamic ethical and legal principles.

The foundational Shariah principles for financial transactions include: the prohibition of interest (riba), avoidance of excessive uncertainty (gharar), adherence to profit and risk-sharing, and the promotion of socially beneficial investments. Prohibited activities include investing in businesses involved with alcohol, gambling, or other forbidden industries. Similarly, speculative transactions and the sale of unknown or non-existent items are strictly forbidden (Elasrag, 2011).

Islamic finance relies on the concept of Shariah, often translated as "Islamic law." It offers detailed guidelines governing both individual and institutional behavior across all spheres of life (Ilias, 2010). Today, Shariah-compliant finance is a vibrant and widely accepted component of international financial markets. It offers a new platform for emphasizing ethical business and financial conduct; an approach that resonates beyond the Arab and Muslim worlds. By encouraging a re-evaluation of fundamental values in global finance, it seeks to mobilize the financial resources necessary for developing human capital and achieving sustainable socio-economic growth.

Core principles of Islamic finance include:

- Prohibition of interest (riba).
- Requirement that capital serves a social and ethical purpose, not merely the pursuit of unrestricted profit.
- Exclusion of investments in industries considered unlawful under Shariah (e.g., alcohol, gambling, narcotics).
- Prohibition of speculation (maysir) and excessive uncertainty (gharar).
- Emphasis on asset-backing and productive economic activity.

As of 2023, the global Islamic finance industry has witnessed significant expansion, with total assets reaching approximately USD 4.9 trillion; an 11% increase from the previous year. This growth has been largely fueled by the banking sector and the rising issuance of sukuk (Zawya, 2024). According to projections by the London Stock Exchange Group (LSEG), the industry's total assets are expected to exceed USD 6.7 trillion by 2027 (LSEG, 2024). These developments underscore the industry's transition from a niche market to a mainstream component of the global financial system. Islamic finance holds strong potential to support the United Nations' Sustainable Development Goals (SDGs) through innovative funding mechanisms. Compared to individual contributions, institutionalized zakat or charitable giving; combined with investments in sukuk (Islamic bonds), can enhance outreach, ensure better targeting, and offer more sustainable and strategic solutions.

However, several challenges remain, including inefficiencies, lack of transparency in fund collection and allocation, and divergent scholarly views on how to interpret Shariah rulings related to modern instruments (Gratiyana Ningrat, 2018).

Nonetheless, recognition of blockchain's transformative power and smart contract capabilities is growing across sectors and regulatory environments. Although it may take time for regulators to adapt, broader adoption is expected to pave the way for sound governance.

The debate is not necessarily about whether cryptocurrencies like Bitcoin are Shariah-compliant. That question remains within the jurisdiction of Islamic scholars. Rather, the focus should be on the more critical features of blockchain, including:

- Its peer-to-peer transactional nature .
- Its fully decentralized architecture .
- Its autonomous operational model.

Islamic finance emphasizes the application of righteous behavior, and blockchain has the potential to "code" these behaviors into intelligent systems; ensuring that compliance is maintained autonomously without external intervention. Thus, blockchain platforms could become self-executing, self-regulating, self-correcting, and self-performing. (Hasni bin Wan Sulaiman, 2017).

There are numerous compelling use cases for blockchain in Islamic finance that promise a range of significant benefits :

4.1 .Smart Contracts

Smart or automated contracts in blockchain offer an effective mechanism to ensure that any product or service complies with the principles of Islamic law. These contracts allow for the inclusion of specific terms; whether with the client or a third party, directly into the blockchain. To prevent the rapid escalation of interest rates, Islamic banks can benefit from smart contracts, which help reduce uncertainty (gharar) and speculation (maysir). There are various forms of Islamic contracts, such as profit-sharing (mudarabah), agency (wakalah), and partnership (musharakah); which can be structured and managed more effectively using smart contracts.

Contractual agreements are essential to enabling commerce, they record mutually agreed execution conditions that support either fulfillment or dispute resolution. Muslim merchants traditionally rely on legal and institutional frameworks based on Shariah for purposes of accountability and governance, with scholars interpreting legal rules and acting as mediators in commercial disputes. Documented records enhance trade efficiency, transparency, and monitoring.

Islamic law serves as the institutional foundation for Muslim communities, embedding ethical rules for business conduct and laying the groundwork for trust, equity, and fairness. As the world evolves, technology can be

harnessed to achieve the objectives of Shariah more efficiently and with less risk. Traditional reliance on physical documents often leads to delays, inefficiencies, and vulnerability to errors and fraud. Financial intermediaries, while reducing risk and enhancing integration, also create overhead and increase compliance burdens.

Smart contracts; based on distributed ledger technology, can enhance efficiency, reduce costs, and improve productivity in managing contractual relationships. Numerous financial institutions are exploring smart contracts across banking, finance, and insurance sectors, including takaful. While early prototypes use simplified versions of smart contracts, further development is needed to address legal enforceability, regulatory compliance, scalability, security, and the complexity of current financial instruments (Mohamed & Ali, 2018).

Smart contracts are composed of complex software code designed to automate the execution and settlement of agreements. These are programmable contracts that self-execute once predefined conditions are met. Once all parties agree to the terms, the contract is encoded and deployed on a distributed ledger. When the coded condition is satisfied, the system triggers a corresponding action. By eliminating direct human intervention, smart contracts enhance contractual efficiency and minimize opportunities for errors, misinterpretations, delays, or disputes.

Bitcoin was the first to support basic smart contracts in that it could transfer value from one user to another, contingent on fulfilling specific conditions. However, Bitcoin's functionality is limited to monetary transfers. In contrast, Ethereum introduced a more advanced scripting language, enabling developers to create decentralized applications and custom smart contracts or "autonomous agents." Ethereum's Turing-complete programming environment allows broader computational instructions, ensuring no single authority can unilaterally alter or censor applications.

This technology theoretically combines past user control with the convenience of modern digital access. Every time a user saves, edits, or deletes a note, the change is reflected across all network nodes. Smart contracts can also function as multi-signature accounts, releasing funds only with predefined stakeholder approvals. They can manage agreements such as insurance, domain registration, or membership records.

Current smart contract models utilize blockchain and public-key encryption to encode contract terms. The system uses two keys: one public (known to all) and one private (known only to the recipient). During a smart contract transaction, the sender encrypts the message into unreadable ciphertext using algorithms to secure data. Only the recipient with the private key can decrypt it into readable plain text. This cryptographic security makes reverse engineering extremely difficult or nearly impossible (Hazik Mohamed, 2017).

It is essential for Islamic financial institutions to overcome challenges related to skills and innovation by forming strategic partnerships with smart contract experts. Effective collaboration requires Islamic banks, financial service providers, and insurers to build conceptual understanding of smart contracts and to design innovative products

and services that integrate this technology. Successful outcomes are likely to arise from joint initiatives involving accelerators, innovation labs, incubators, or direct partnerships with blockchain-based smart contract startups.

4.2 Cloud Storage

One of blockchain's key advantages for Islamic banking lies in enabling access to cloud storage. This reduces potential disputes and enhances client relationships by allowing banks and customers to securely access important data. Cryptographic algorithms ensure secure access to information and data, helping avoid operational issues.

Cloud storage uses a distributed model where data is stored across multiple geographically separated servers managed by a service provider. It presents a logical memory structure that enables service providers to transparently store users' data across various locations (Aaron Wheeler, 2015).

- At minimum, cloud storage provides space for digital data and a basic interface for file management. Services like Dropbox operate under this model. More advanced cloud services integrate backend systems with software-as-a-service (SaaS) solutions; for example, Google Drive with Google Docs. Despite the benefits, some significant risks must be considered (Jan L. Harrington, 2016):
- Security becomes a major concern as companies relinquish direct control over their data .
- Trust must be placed in the provider's ability to prevent unauthorized access.
- Access depends on consistent internet availability. Unlike in-house servers, cloud systems are inaccessible during connectivity outages.
- Responsibility for data uptime shifts to third-party providers.
- Generally, data owners lose a degree of control when opting for cloud storage; The more sensitive the data, the greater the risks associated with cloud-based solutions.

4.3 .Digital Currencies

Various types of digital currencies exist, though their development is not simple. Managing them requires comprehensive systems and protocols. Nonetheless, they offer advantages such as enhanced security and incentivized structures for miners.

4.4 .Zakat Collection

Zakat, one of the key instruments of Islamic social finance, has also been disrupted by blockchain. Blockchain enhances transparency by showing exactly where charitable funds are going and for what purpose. In many Islamic countries, zakat collection has been institutionalized and is overseen by authorized religious bodies in accordance with Shariah regulations. However, the process is still plagued by inefficiencies and a lack of transparency, coupled with scholarly disagreements and bureaucratic hurdles (Noordin, 2018).

Zakat refers to the mandatory transfer of a specific portion of wealth or property from eligible individuals to those entitled to receive it. It is one of the five pillars of Islam and is mentioned 32 times in the Qur'an. Eligible recipients include eight categories, such as the poor and needy, clearly defined in Islamic jurisprudence (Abojeib & Habib, 2019).

The zakat obligation is calculated annually based on one's net wealth relative to a threshold (nisab), which typically equals the value of three ounces of gold. Those whose wealth exceeds this amount for a full lunar year are obliged to pay zakat. The standard rate is 2.5% of qualifying assets such as cash, savings, investments, rental income, and tradable goods.

Since cryptocurrencies like Bitcoin qualify as liquid assets, Muslims must include their crypto holdings in zakat calculations if held for a full lunar year. Blockchain technology makes the entire zakat process traceable, auditable, and immutable; ideal traits for managing charitable donations effectively. It was inspired by devout Muslims who wanted to use cryptocurrencies for religious contributions but lacked suitable platforms.

4.5 .Enhancing Waqf (Endowment) Utility

Blockchain can also improve the management of waqf, a charitable endowment in Islamic law. In many ways, waqf mirrors the blockchain concept: it is permanent, unalterable, and not owned by any single entity. In practice, it closely resembles the Western legal concept of trust.

Waqf is a form of perpetual charity dedicated to Allah, encompassing physical assets, fixed properties, or cash. Donors may specify broad or specific purposes, such as aiding the poor or supporting orphans. The principal asset must not be sold or redistributed; only the income generated may be used. Waqf properties are considered the property of Allah and cannot be inherited, traded, or given away (Abojeib & Habib, 2019).

Historically, waqf played a vital role in community development and poverty alleviation across the Islamic world. Today, many waqf institutions suffer from mismanagement, limiting their social impact. Rebuilding trust requires improved governance and transparency.

Finterra, a blockchain-based startup, has developed a crowdfunding platform for smart contracts linked to waqf projects. This initiative aims to enhance fundraising, asset management, and ownership transfers.

Participants can propose waqf project ideas on the platform and fund them collaboratively. If project goals are met, waqf tokens are issued and distributed among contributors. These tokens may grant stakeholder rights, revenue sharing, or be exchanged within Finterra's ecosystem or other blockchain networks (Abojeib & Habib, 2019).

5 .Challenges and Obstacles of Blockchain in Islamic Finance

The list of challenges impeding the implementation of blockchain in Islamic finance is extensive. These challenges span across technical, commercial, market-based, legal, regulatory, and behavioral-educational

domains. Key among them are scalability (technical), innovation (business), trust in the network (behavioral), and evolving regulatory frameworks (legal). Mastery of trade-offs and informed choices around blockchain databases and middleware are among the core competencies required for effective deployment. It all starts with a clear understanding of the strengths and weaknesses of each approach. Finding the right balance between what blockchain excels at and its limitations is crucial. Furthermore, storing blockchain data comes with difficulties related to historical and analytical transaction reporting and compliance requirements.

5.1 .Government Interventions

Governments have historically been skeptical of cryptocurrencies, particularly Bitcoin, which lacks backing from sovereign institutions. Several countries and central banks; including Russia, China, and the European Union, issued early warnings against Bitcoin use. Although some now permit the issuance and exchange of cryptocurrencies and real-world asset-backed tokens, regulatory scrutiny remains high. Until policymakers grow more comfortable with technology, restrictive measures are likely to persist.

Governments can unintentionally send mixed signals to markets, regulators, and law enforcement agencies, who often serve as their proxies. Excessive early regulation may hinder the private sector's leadership in blockchain innovation. While certain regulations are necessary to protect consumers and enforce minimum standards, overly aggressive intervention can be counterproductive. Compliance itself is costly; especially for financial service providers who already invest billions annually to stay updated on legal requirements. Early blockchain platforms prioritized transactional capabilities, but they will need enhanced tax and reporting features to integrate into traditional accounting systems (Mougayar, 2016).

Potential compliance-related breakthroughs may include:

- Acceptance of cryptocurrency-backed tokens as real-value assets.
- Legal recognition of blockchain-based transactions.
- Legal enforceability of smart contracts.
- Validation of peer-to-peer transaction authenticity via blockchain.

5.2 .Underdeveloped Ecosystem Infrastructure

Blockchain requires its own technological infrastructure, as well as a vibrant ecosystem of stakeholders to support it. The protocol itself is just the minimum requirement. Its real utility emerges through supporting tools and development environments. The surrounding ecosystem has a direct impact on the market adoption of blockchain. Without user uptake, technology has limited influence.

A thriving blockchain ecosystem includes:

- Startups creating new products and markets.
- Solution and service providers delivering institutional-grade implementation.

- Investors and venture capitalists backing innovation.
- Lawyers, influencers, analysts, volunteers, and local communities.
- Developers working on core or extended functionalities.
- Early adopters, including both consumers and enterprise clients.

It typically takes time before new applications surface around foundational technologies. Early replication of existing models allows users to gain experience with fewer expectations. While theoretically any application can be adapted with blockchain components, this doesn't always translate into practical success. Some blockchains enable "virtual machines" to run programs without deep developer expertise. One criticism of blockchain is the lack of widely accepted "killer applications" that drive mass consumer adoption. Broad market understanding of blockchain's core capabilities is also lacking, and addressing this requires a concerted educational effort.

5.3 .Regulatory Uncertainty

Until regulators clearly define their positions, confusion and uncertainty will continue to pervade the blockchain space. Blockchain's open and decentralized trust model differs from traditional systems, which rely on central "trust providers." Regulators, accustomed to overseeing centralized intermediaries, must adapt to a system in which trust is distributed via cryptographic consensus.

New regulatory innovation is necessary; possibly including blockchain-specific certifications. In general, policymakers respond to emerging technologies in three ways (Mougayar, 2016):

- Take no action and let the market evolve naturally.
- Control points of bottleneck; e.g., exchanges or software providers who require licensing.
- Integrate real-time regulation at transaction points, possibly via automated data pipelines or audit mechanisms.

5.4 .Security and Privacy Standards

Security remains an ongoing concern in blockchain. Institutions, especially banks, are wary of adopting public blockchains for internal operations due to perceived security risks. In public blockchains, transaction visibility and traceability are default features. While this promotes transparency, it also raises confidentiality issues. However, encryption techniques and zero-knowledge proofs now enable anonymous yet verifiable transactions. Trusting a decentralized network of machines over a known institution represents a mental shift. Blockchain-based trust is a new model; similar to how online payments were initially distrusted in the early days of the internet. Eventually, just as e-commerce payments gained broad acceptance, so too will decentralized trust networks (Mougayar, 2016).

Standardization occurs in two ways: through broad market adoption or pre-agreed frameworks developed by standard-setting bodies. Standards offer benefits such as network effects, interoperability, and reduced risk, but

they also entail trade-offs. Competitive advantage may stem from execution speed or innovation beyond these standards. Blockchain will offer both opportunities and risks in standardization.

Practical Steps for Public Engagement Include:

- Raising public awareness and interest in blockchain.
- Providing professional certification programs.
- Offering formal academic qualifications in blockchain.
- Delivering training from blockchain service providers.

5.5 .Human Capital Costs

Most users struggle with technological complexity, especially when core blockchain infrastructure remains technically challenging. While user-friendly blockchain apps are emerging, many users may not even realize they're interacting with blockchain-based services. Large-scale platforms like Amazon or payment solutions could serve as reference models.

The shortage of qualified professionals in blockchain and Islamic finance remains a serious hurdle. Converting existing staff into blockchain advocates requires substantial time and investment. Organizations need a critical mass of internal experts to sustain innovation and adoption. Although many blockchain tools are open-source and free to begin with, full-scale implementation incurs costs beyond standard Information Technology (IT) projects.

5.6 .Immature Middleware Solutions

Middleware acts as the glue between blockchain infrastructure and application development. Once simplified tools for blockchain integration become widely available, it will mark the start of a new adoption phase. Middleware software development kits (SDKs) play a key role in enabling comprehensive project deployment.

5.7 .Scalability

Scalability is a persistent challenge in blockchain systems. As networks grow, so do their size and computational demands. Balancing decentralization and security while expanding network scale presents unprecedented technical difficulties. Scaling decentralized networks with secure and economically viable models remains a frontier yet to be fully realized .

6 .Conclusion

After exploring a range of relevant topics, this study has reached the following conclusions:

- Blockchain is a decentralized system founded on principles of trust, security, and speed, making it suitable for conducting various types of financial transactions.
- Blockchain technology has both advantages and disadvantages; it is not possible to definitively categorize it as wholly positive or negative.

- Islamic finance faces several challenges in adopting blockchain, including environmental, technical, legal, and Shariah-related issues.
- Blockchain in Islamic finance remains a promising area for exploration, particularly in applications such as smart contracts, financial services, and remittance systems.
- Based on the findings, the study offers the following recommendations:
- Propose viable solutions to the challenges and barriers hindering the application of blockchain technology in Islamic finance.
- Organize more training sessions, seminars, and conferences targeting diverse segments of society to raise awareness about blockchain technology.
- Clarify Shariah rulings and jurisprudential opinions regarding the permissibility and use of blockchain in Islamic financial practices.
- Encourage further academic research and studies focusing on the role and impact of blockchain technology in Islamic finance.

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