



Islamic Banking Requirements via Blockchain Technology: Reality and Challenges



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article info

Article history:

Received:

09 September 2026

Accepted:

27 September 2026

Published:

01 October 2026

Keywords:

Blockchain Technology

Islamic Banking

FinTech

Shariah Compliance

Smart Contracts

Regulatory

Requirements

JEL Classification:

G21, G23, O33, P43

abstract

This study mainly aims to identify basic concepts about financial technology (FinTech) and its significance, exploring its utility in Islamic banking. It outlines the structural requirements for applying FinTech to Islamic finance to facilitate decentralized transactions and exchange without standard intermediaries while maintaining high levels of security and trust. This is achieved through blockchain technology as a modern, pioneering paradigm. Consequently, Islamic finance benefits from this technology as a Shariah-compliant alternative to conventional financing, which assists nations in mobilizing frozen capital, providing funding, and optimizing the utilization of savings.

1. Introduction

Technological development facilitates human life by eliminating bureaucracy, increasing transparency, and reducing transaction costs-advantages proven by blockchain technology since its inception. It connects the world peer-to-peer without central administrations or standard intermediaries. Furthermore, this technology mitigates classical technological vulnerabilities, such as data breaches, unauthorized hacking, and privacy violations. Following global economic crises, particularly the 2008 financial crisis, there has been a growing demand for an alternative economic framework grounded in transparency that circumvents bureaucratic barriers and traditional financial intermediation.

With the growing necessity for an alternative system, combining technology and finance became an imperative path. Blockchain began to prove its structural efficacy within global

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How to cite: Kaf, R. M. (2026). Islamic Banking Requirements via Blockchain Technology: Reality and Challenges. *Journal of Entrepreneurship and Business Administration*, 2(2), 45-55.

DOI: <https://doi.org/10.34118/jeba.v2i2.4897>

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finance, establishing efficiency and gaining systemic trust. This success necessitates its integration into alternative financial systems, primarily Islamic finance. Islamic finance commands significant public confidence and appeals to a broad demographic of economic agents seeking an alternative system that aligns with their ethical and Shariah principles. While the adoption of blockchain by Islamic banks may currently appear optional, it will become an institutional necessity as conventional counterparts fully adopt the technology. Therefore, Islamic financial institutions must align with current financial technology developments to ensure operational sustainability and market competitiveness.

Accordingly, this research delineates the significance of financial technology in Islamic banking, identifies the core structural requirements for deploying blockchain, and examines real-world implementations alongside the challenges facing Islamic finance.

1.1. Research Problem

What are the primary operational, legal, and religious requirements necessary for the successful implementation of blockchain technology in Islamic banking?

1.2. Hypothesis

Given that Islamic banking has expanded significantly over the past decade and established its presence within major global monetary and financial markets, the challenges it faces regarding digital transformation and blockchain integration are fundamentally classified into Shariah-compliant, legal, technical, and environmental requirements.

1.3. Research Objectives

- Defining the systemic importance of FinTech.
- Delineating the operational mechanics and advantages of blockchain technology.
- Systematizing the requirements for implementing blockchain within Islamic finance.
- Analyzing the contemporary realities and challenges of blockchain applications in the Islamic financial sector.

1.4. Methodology

This study adopts a descriptive and analytical approach. It establishes the institutional value of financial technology, highlights the structural role of blockchain, and classifies the foundational requirements needed to link blockchain networks with Islamic banking infrastructure.

2. Financial Technology (FinTech)

The structural importance of FinTech has intensified in recent years, and its conceptual framework has expanded across diverse socio-economic sectors.

2.1. Conceptual Framework of FinTech

Financial technology refers to modern technological inventions and innovations within the

financial sector. These innovations encompass digital software systems utilized in banking operations, including customer transactions, fund transfers, currency exchange, profit-and-loss computations, and predictive investment analytics (Boukhari, 2022).

22. Fields of FinTech Application

FinTech covers numerous interconnected domains, including artificial intelligence (AI), big data analytics, crowdfunding platforms, cryptocurrencies, payment and remittance systems, insurance technology (InsurTech), smart contracts, regulatory technology (RegTech), and blockchain (distributed ledger technology). These fields exhibit high levels of interdependence: smart contracts run on blockchains and leverage AI, while RegTech and InsurTech utilize machine learning models for risk optimization (Abd al-Karīm, 2019).

23. Institutional Importance of FinTech

Financial technology enhances service delivery efficiency, systemic stability, security, institutional innovation, and macroeconomic growth, despite encountering operational risks (Walker, 2019).



Fig. 1. Supply and Demand Factors for Artificial Intelligence and Machine Learning. Source: (Islamic Financial Services Board, 2018, p. 60)

Figure 01 illustrates the supply and demand drivers supporting the adoption of AI and machine learning architectures, as detailed in the IFSB Islamic Financial Services Industry Stability Report. The reporting emphasizes critical protocols that service providers must deploy to manage operational and cybersecurity threats expanding alongside financial digitalization. AI and machine learning applications offer significant benefits to systemic stability by refining regulatory oversight and systemic risk monitoring. Concurrently, the emergence of tech-first enterprises deploying sophisticated algorithmic tools outside standard regulated boundaries could elevate these firms into systematically critical financial nodes. If such unregulated entities capture critical market volumes, operational breaches or structural default could prompt widespread contagion across domestic and global networks. Consequently, deploying AI applications requires rigorous risk management frameworks and synchronized supervisory oversight (Islamic Financial Services Board, 2018, p. 60).

3. Blockchain Technology

Blockchain represents one of the most prominent innovations in FinTech, utilized for its structural efficiency in expanding market access rapidly, securely, and at a lower cost. It is deployed in clearing and settlement, cross-border payments, peer-to-peer (P2P) transfers, digital currencies, and digital identity verification. In 2008, Satoshi Nakamoto introduced Bitcoin as a peer-to-peer electronic cash system. Although blockchain gained public prominence through Bitcoin, it functions as the underlying decentralized architecture, whereas Bitcoin is merely one application running on it. (Pardo, 2018)

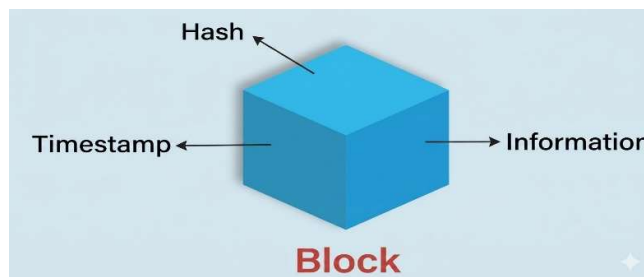
3.1. Conceptual Framework of Blockchain

Blockchain is defined as a distributed, decentralized ledger database that permanently records transactional history across a network of peer-to-peer computing nodes. It manages a growing list of cryptographic records termed blocks, where each block contains a verified timestamp and a cryptographic link to the preceding block (Denis & Ulrika , 2017). From a commercial perspective, blockchain functions as a peer-to-peer network for exchanging assets, transactions, and values without centralized intermediaries. Legally, it serves as a decentralized mechanism for transaction validation. The technology integrates software engineering, distributed computing, cryptography, and economic game theory to deliver a stable, scalable infrastructure for securing digital assets (Sāsī, 2019).

3.2. Core Components of Blockchain Architecture

Blockchain networks rely on four fundamental elements (Pardo, 2018):

- The Block: The structural unit of the ledger that aggregates transactions or data operations. Each block has a defined storage capacity, and once finalized via network consensus, a new block is cryptographically linked to it to prevent fraudulent transactions.
- The Data/Information: The individual sub-operation or internal instruction executed within a single block boundary.
- The Hash: The cryptographic signature or "digital DNA" generated via mathematical algorithms. It uniquely identifies each block and links them sequentially.
- The Timestamp: A secure cryptographic record logging the exact execution time of an operation within the ledger (Filippi, 2018).



Fi. 2. Architectural Components of a Blockchain Block. Source: (Bin 'Āmir & Taḥsīn, 2018)

3.3. Operational Mechanics of Blockchain

Distributed ledgers function via three primary operational protocols (Khalīfah, 2018):

- Open Ledger: All data within the ledger framework is fully visible to participants across the

network.

- Distributed Database: Centralized servers are eliminated. Complete ledger records are distributed globally across all network nodes.
- Mining / Consensus: Node processors resolve intensive cryptographic puzzles to discover valid signatures.

3.4. Types of Blockchain Networks

Architecturally, distributed ledgers are classified into three primary categories (Māhir et al., 2018):

- Private Blockchains: Frameworks deployed with restricted node networks governed by a central founding institution.
- Public Blockchains: Permissionless architectures completely open to global node deployment.
- Consortium / Federated Blockchains: Network infrastructures managed jointly by selected institutional leaders rather than a solitary central unit. An example is the R3 Consortium founded in 2014, uniting over 70 global banking groups using the Corda platform to support heavy interbank clearing.

3.5. Structural Characteristics of Blockchain

Distributed ledgers provide several distinct architectural advantages (Ḥamdī & Awqāsim, 2019): Elimination of centralized third-party transaction oversight; direct peer-to-peer verification; high system cryptology; and resilience against single-point network failure.

3.6. Potential Applications of Blockchain

Distributed technologies are categorized into four core groups (Munīr, 2018):

- Smart Contract Applications: Automated escrows, betting management, and digital rights tracking.

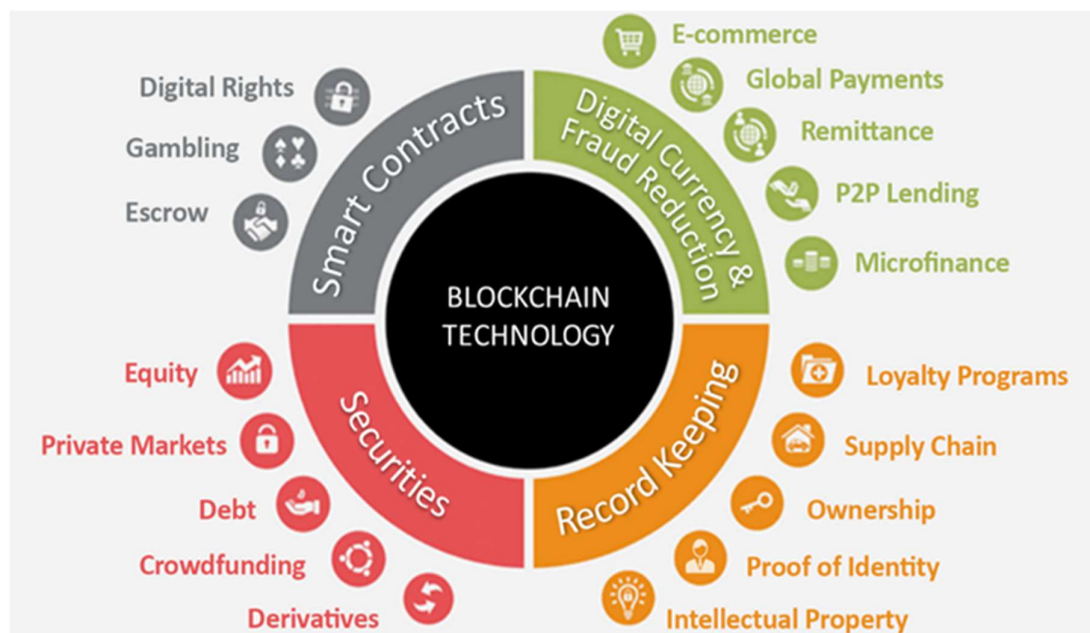


Fig. 3. Mapping of Broad Blockchain Applications Across Global Industries. Source: (Denis & Ulrika , 2017)

- Digital Currency Architectures: E-commerce processing, global cross-border payments, and P2P direct lending.
- Asset Securities and Collateralization: Private market equity management, debt tokenization, and crowdfunding.
- Immutable Record Keeping: Medical data storage, property titles, patent management, and identity verification.

3.7. Systemic Barriers and Implementation Challenges:

Despite structural advantages, distributed network deployment presents several institutional challenges (Al-Sayyid & Mājid, 2018):

institutional resistance due to legacy legislation; limited technical awareness among staff; lack of International unified regulations; and risks of potential security leakage on shared ledgers.

- Institutional and Regulatory Inertia Regarding Disruption: There is a distinct reluctance to adopt blockchain technology due to its potential to radically disrupt existing legal and regulatory frameworks. By eliminating the need for traditional intermediaries, it poses a direct threat to intermediary institutions and job roles across the financial, administrative, and business sectors, potentially leading to widespread structural unemployment, similar to historical waves of technological advancement. (Al-Sayyid & Mājid, 2018)
- Knowledge Deficit and Technological Immaturity: The majority of individuals and professionals within tech and service sectors possess insufficient literacy regarding blockchain mechanics. Their familiarity is often rudimentary and limited to its association with Bitcoin. This challenge is compounded by the relative novelty of the technology, which requires more time to achieve operational maturity and expand its practical application use cases. (Al-Sayyid & Mājid, 2018)
- Absence of Standardized Global Frameworks: The sector currently suffers from a lack of unified international standards, benchmarks, or regulatory metrics to govern and harmonize blockchain operations globally. (Al-Sayyid & Mājid, 2018)
- Legislative Resistance and Illicit Exploitation Vulnerabilities: Policymakers and legislators often resist adoption because integrating decentralized systems demands a radical overhaul of existing bureaucratic procedures, statutory laws, and institutional policies. Furthermore, the permissionless and pseudonymous nature of certain blockchain networks creates risks of exploitation for orchestrating illicit activities, such as drug trafficking and the illegal arms trade. (Al-Sayyid & Mājid, 2018)
- Data Vulnerabilities and Privacy Infringements: Participants encounter significant privacy risks upon joining a distributed ledger, including the potential compromise or unlawful seizure of personal data. Such data breaches can be maliciously exploited to manipulate or illegally liquidate personal assets, compromise professional positions, and expose users to systemic operational threats. (Al-Sayyid & Mājid, 2018)

4. Requirements for Implementing Blockchain in Islamic Finance

As an emerging infrastructure, blockchain requires specific technical, legal, Shariah-compliant, and environmental conditions to be met before widespread adoption in Islamic finance.

4.1. Technical Requirements

- Network Security and the 51% Attack: Public blockchains remain vulnerable to majority hash-rate dominance, known as a 51% attack (Hasan, Hassan, & Aliyu, 2020). When a single mining pool controls over half of the network's processing power, malicious actors can prevent transaction confirmations, block token generation, or execute double-spending attacks (Munir, 2018).
- Scalability Limitations: The historical growth of a blockchain ledger can outpace hardware storage capacities. For instance, the Bitcoin ledger processes roughly seven transactions per second (TPS), which is insufficient for real-time global retail volumes (Zheng, Xie, Dai, Chen, & Wang, 2018)
- Privacy and Information Leakage: Although users operate under cryptographic pseudonyms, transaction values and wallet balances remain visible on public ledgers (Marcella, 2015).

4.2. Legal and Regulatory Requirements

Integrating blockchain requires updates to domestic and international legal frameworks. Regulators face challenges in keeping pace with rapid technological updates, creating a shortage of specialized tech-legal experts (Munir, 2018).

International legal bodies must address legal ambiguities within decentralized networks, including estate inheritance procedures, asset freezing, and asset seizures (Sāsī, 2019).

4.3. Shariah Requirements

Shariah compliance for blockchain transactions focuses on four distinct classical jurisprudential questions (Sāsī, 2019):

a. The Contractual Session (*Majlis al-Aqd*)

The contractual session is defined as the physical or constructive gathering of parties for execution (Khalifah, 2018). According to Shariah Standard No. 38 issued by AAOIFI (Hay'at al-Muḥāsabah wa-al-Murāja'ah lil-Mu'assasāt al-Māliyyah al-Islāmīyah, 2017) digital interactions via text, email, or web interfaces carry the legal status of an exchange between absent parties (*Al-Aqd bayna Gha'ibayn*), similar to traditional written correspondence.

b. Contractual Form (*Al-Sighah*)

According to AAOIFI Shariah Standard No. 38, clicking an acceptance icon or confirming an electronic prompt on a digital interface constitutes a valid legal acceptance under Shariah, provided the system configuration does not require secondary authentication (Hay'at al-Muḥāsabah wa-al-Murāja'ah lil-Mu'assasāt al-Māliyyah al-Islāmīyah, 2017)

c. Constructive Possession (*Al-Qabd al-Hukmi*)

In blockchain transactions, possession is classified as constructive, finalized when a transaction is written into a block and reflected in the transferee's digital wallet address (Hay'at

al-Muḥāsabah wa-al-Murāja'ah lil-Mu'assasāt al-Māliyyah al-Islāmīyah, 2017). However, the time delay required for network miners to validate a transaction impacts contract validity depending on the asset class. For ribawi goods or currency exchange (Al-Sarf), where simultaneous possession is a condition of contract validity, parties must wait until network confirmation occurs and the block updates in the public registry before separating. Similarly, for forward sales (Al-Salam), full payment must be confirmed on-chain prior to the separation of the contracting session to avoid the prohibited sale of debt for debt (Hay'at al-Muḥāsabah wa-al-Murāja'ah lil-Mu'assasāt al-Māliyyah al-Islāmīyah, 2017).

d. Contractual Options (Khiyar al-Aqd)

In digital auction frameworks executed via blockchain networks, a bidder cannot revoke an offer until the virtual bidding session closes. Furthermore, if the seller explicitly stipulates binding commitment up to a specified duration, the offer cannot be rescinded after the session concludes (Hay'at al-Muḥāsabah wa-al-Murāja'ah lil-Mu'assasāt al-Māliyyah al-Islāmīyah, 2017).

4.4. Environmental Requirements

Proof-of-work mining consensus requires significant electricity consumption, creating sustainability concerns. In response, contemporary sustainable development frameworks encourage a transition toward renewable energy sources or energy-efficient consensus mechanisms (Pardo, 2018).

5. Applications of Blockchain in Islamic Finance

Islamic financial institutions can deploy blockchain across several core operational fields:

- Smart Contracts: These self-executing software protocols automate contractual terms without human intervention (CORLUKA & LINDH, 2017). Standardized Shariah-compliant smart contracts can manage debt extensions (Mudayanat) or partnership agreements (Musharakat).
- Trade Finance and Supply Chain Tracking: Blockchain allows exporters, importers, and financing banks to share transactional data on a transparent ledger (Marcella , 2015).
- Fraud Mitigation: In contrast to centralized architectures, blockchain's decentralized architecture requires consensus across nodes, making data tampering easily detectable and reducing financial fraud (Ittiḥād al-Maṣārif al-'Arabīyah, 2018).
- Payment Systems and Cross-Border Remittances: Decentralized networks eliminate intermediary clearing houses, allowing banks to settle interbank obligations and manage retail remittance transfers with greater speed and lower costs (Walker, 2019).
- Regulatory Compliance and Auditing: Because blockchain transaction registries are permanent and tamper-evident, Islamic financial institutions can utilize them to generate verifiable audit trails for automated financial and Shariah auditing (Ḥamdī & Awqāsim, 2019).

6. Institutional Case Studies in Islamic Banking

Several Islamic financial institutions have implemented blockchain solutions:

- Emirates Islamic Bank & Al Hilal Bank (UAE): In 2017, Emirates Islamic Bank integrated blockchain protocols into check clearing systems. Al Hilal Bank executed a Shariah-compliant Sukuk transaction on a blockchain platform under Abu Dhabi Global Market (ADGM) regulatory oversight (Māhir et al., 2018)
- Al Rajhi Bank (Saudi Arabia): In October 2017, Al Rajhi Bank completed a cross-border remittance trial utilizing the Ripple network between its corporate headquarters in Riyadh and its retail branches in Jordan (Munīr, 2018).
- Islamic Development Bank (IsDB): The Islamic Corporation for the Development of the Private Sector (ICD), the private-sector branch of the IsDB group, partnered with FinTech firms to build blockchain platforms designed to address interbank liquidity management and facilitate real-time commodity trading in a Shariah-compliant manner (Khalifah, 2018).

7. Current Realities and Geo-distribution of Islamic FinTech

In 2018, approximately 93 FinTech firms were documented operating globally within the Islamic finance ecosystem. Southeast Asian nations lead the integration of technology and Islamic banking, whereas Arab states show lower rates of digital adoption (Islamic Financial Services Board, 2018).

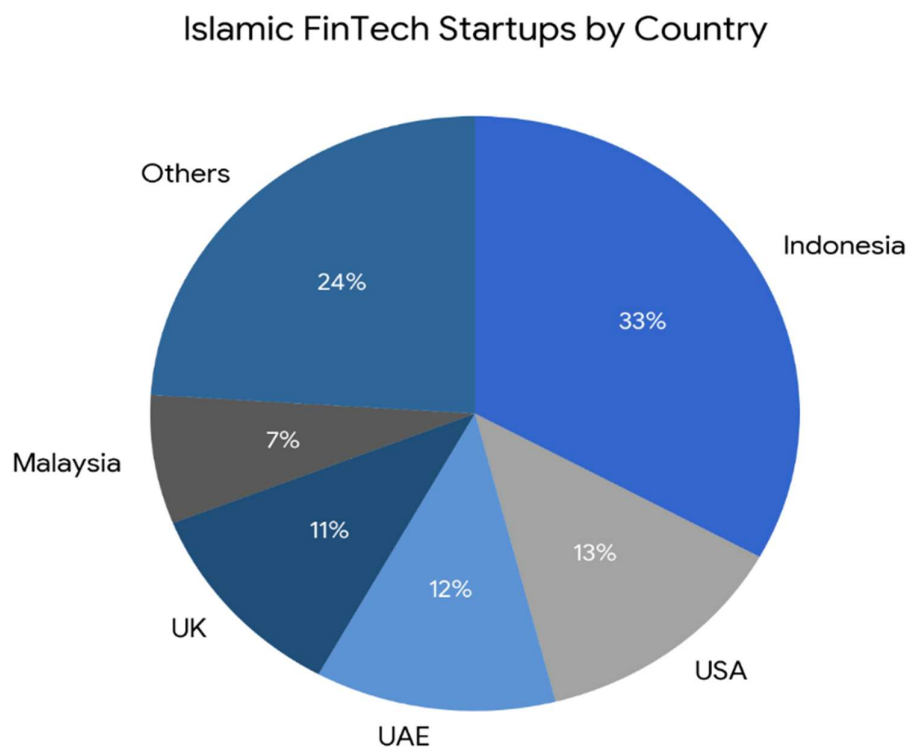


Fig. 4. Number of Islamic FinTech Startups by Country

As illustrated in Figure 02, there is a pronounced emphasis within Southeast Asian nations on integrating Islamic banking infrastructure with modern financial technology. Furthermore, given the growing global significance of Islamic finance, a substantial Western interest is observed, particularly from the United States and the United Kingdom, in developing Islamic FinTech solutions. Conversely, Arab states exhibit a recognizable lag in the adoption and development of Islamic financial technology.

Table 1

Prominent Islamic FinTech Startups across Selected Global Jurisdictions. Table data from standard report inputs. Source: (Hasan, Hassan, & Aliyu, 2020)

FinTech Entity Name	Country	Core Operational Activity
Invespropti.id	Indonesia	Real estate crowdfunding investments structured via Shariah-compliant mechanisms.
Ethis	Singapore	Pioneer Islamic real estate crowdfunding platform focused on sustainable development finance.
Kapital Boost	Singapore	Crowdfunding platform specialized in SME purchasing liquidity and growth capital.
ATA Plus	Malaysia	Licensed equity crowdfunding platform optimizing community investments.
MyFinB	Malaysia	Big data and predictive analytics provider specialized for Islamic banking infrastructure.
Invoice Wakalah	Pakistan	Peer-to-peer invoice financing and working capital platform utilizing Wakalah models.

8. Conclusion and Recommendations:

8.1. Core Findings

- Blockchain operates as an unalterable digital ledger that enables decentralized transaction tracking across a secure network without relying on third-party verification.
- While financial technology improves operational efficiency, digital innovation must be balanced with consumer protection and systemic financial stability.
- Islamic financial institutions must proactively adopt digital platforms and artificial intelligence models to maintain market relevance.
- Adopting blockchain is shifting from an operational option to a competitive necessity.
- Within the Arab region, institutions in the Gulf Cooperation Council (GCC) display the highest adoption rates of Islamic FinTech solutions. (Hasan, Hassan, & Aliyu, 2020)

8.2. Policy Recommendations

- Expanding Academic Literature: Academic institutions should expand research on distributed ledgers, particularly in Arabic, focusing on jurisprudential analyses of automated instruments.
- Fostering Financial Innovation: Islamic banks must design modern financial products that combine digital efficiency with classical Shariah principles to compete globally.
- Strategic FinTech Alliances: Commercial Islamic banks should form joint ventures and strategic alliances with agile FinTech startups to retain market share.
- Regulatory Sandbox Harmonization: Central banks and national financial regulators must establish regulatory frameworks that encourage digital innovation while managing risks related to capital flight, money laundering, and cybersecurity threats.

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