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INTEGRATING SMART CONTRACTS INTO ISLAMIC FINANCE: APPLICATIONS, LEGAL CHALLENGES & REGULATORY GOVERNANCE

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Abstract

The global financial landscape is currently undergoing a structural transformation characterised by the emergence of Digital Bank 4.0, where blockchain-based smart contracts play a pivotal role in the automation of financial agreements. However, a significant conceptual gap remains between the deterministic nature of self-executing code and the ethically grounded requirements of Islamic commercial law (fiqh al-muʿāmalāt). Employing a doctrinal legal methodology and qualitative conceptual synthesis, this paper investigates the integration of smart contracts into the Islamic financial ecosystem. The study systematically maps technological capabilities onto specific instruments, including retail banking products, tokenised sukuk, and emerging Islamic Decentralised Finance (DeFi) protocols. Furthermore, the analysis identifies critical challenges regarding contractual capacity, the principle of niyyah (intent), and the conflict between blockchain immutability and the virtues of iḥsān (benevolence) and khiyār (rescission). As its primary contribution, the paper proposes a four-layer integrative model comprising Shariah compliance, technical execution, legal regulation, and human oversight. This framework is specifically anchored in the Malaysian regulatory context, referencing the Securities Commission Guidelines on Digital Assets and the Bank Negara Malaysia regulatory sandbox. The study concludes that whilst automation enhances transparency and reduces gharar (uncertainty), a human-in-the-loop architecture is essential to uphold the principle of amānah (trustworthiness) and ensure that financial technology remains aligned with the maqāṣid al-sharīʿah.

Keywords: *Smart, Contracts, Islamic, Finance, Compliance.*

INTRODUCTION

The global financial landscape is undergoing a profound structural transformation which is driven by the convergence of artificial intelligence, big data analytics, and distributed ledger technologies. Scholars have characterised this transition as the era of Digital Bank 4.0, which is a phase defined not merely by the digitalisation of existing processes but by the emergence of autonomous and self-executing financial systems that operate with minimal human intervention (Mat Rahim et al., 2018).

Among the most consequential innovations within this paradigm is the smart contract, which is defined as a computerised protocol or script of code deployed on a blockchain that automatically verifies and executes the terms of an agreement upon the fulfilment of pre-defined conditions (Giancaspro, 2017; Mat Rahim et al., 2018).

By eliminating the need for intermediaries, reducing transaction costs, and encoding contractual obligations directly into dedicated digital infrastructure, smart contracts represent a fundamental reimagining of how financial agreements are formed, executed, and enforced.

Yet, despite these technical advantages, the integration of smart contracts into Islamic finance remains conceptually underdeveloped and practically unrealised. This gap is not merely a matter of technological adoption, as it reflects a deeper jurisprudential tension. Islamic commercial law, referred to as fiqh al-muʿāmalāt, does not evaluate financial instruments solely on the basis of efficiency or legality under civil law. Rather, every transaction must conform to a distinct set of moral, spiritual, and contractual principles rooted in the Qur'ān, Sunnah, and ijtihad of Muslim jurist.

Prohibitions against ribā (interest), gharar (uncertainty), and maysir (speculation), alongside requirements for valid offer and acceptance (ījāb and qabūl), contractual capacity (al-ahliyyah), and discernible intent (niyyah), impose normative constraints that the deterministic logic of blockchain code does not naturally accommodate.

As Mat Rahim et al. (2018) observe, smart contracts have not been fully implemented in Islamic finance due to unresolved concerns regarding their conformity with Islamic contract theory and legal principles, which are concerns that existing literature has addressed only in fragmented and domain-specific terms.

This fragmentation constitutes the central literature gap that this paper addresses. The existing literature tends to treat smart contracts and Islamic finance as parallel but separate fields of inquiry. Technical analyses of blockchain-based agreements rarely engage with the requirements of shariah compliance, while Islamic finance literature has been slow to reckon with the structural possibilities and hazards introduced by programmable, self-executing code (Idelberger et al., 2016).

No integrated conceptual framework currently exists that systematically maps smart contract capabilities onto Islamic finance instruments, identifies the legal and shariah challenges that arise from such integration, and proposes a governance framework capable of enabling compliant and secure deployment.

This study aims to construct such a framework, proceeding from the recognition that the gap between smart contracts and Islamic finance is not irresolvable. Instead, its resolution requires a deliberate conceptual framework that is simultaneously grounded in blockchain mechanics, tailored to the objectives of shariah (maqāṣid al-sharīʿah), and responsive to the emerging regulatory landscape of Islamic digital finance.

To this end, the paper addresses three primary research questions. The first question explores how smart contracts can be systematically mapped onto Islamic finance instruments and sectors. The second question investigates the legal, technical, and shariah challenges that hinder the adoption of smart contracts within Islamic financial structures. Finally, the third question identifies the governance architecture across regulatory, institutional, and technological dimensions, that can enable the compliant and secure deployment of smart contracts in Islamic finance.

The paper proceeds through a structured sequence of analysis. Section two establishes the theoretical foundations by examining the mechanics of smart contracts,

including the critical distinction between procedural and logic-based or declarative contract architectures, alongside the core principles of Islamic commercial jurisprudence. Section three presents an application framework that maps smart contract capabilities onto specific Islamic finance instruments and sectors.

Section four conducts a systematic analysis of the legal and shariah challenges arising from this integration. Section five proposes a multi-level regulatory governance framework with particular attention to the role of human oversight in preventing automated Islamic financial systems from becoming unaccountable black boxes (Philipponnat, 2025). The last section synthesises these analyses into an original four-layer integrative conceptual model, and the paper concludes with a set of research propositions and directions for future scholarship.

THEORETICAL FOUNDATIONS

Islamic Finance Principles As Design Constraints

Islamic finance is governed by a normative legal framework derived from fiqh al-muʿāmalāt, the branch of Islamic jurisprudence concerned with commercial and financial transactions. This framework emphasises ethical, transparent, and socially responsible economic activity, and it imposes substantive constraints on the design of any financial instrument, including those mediated by digital technology (Ayub, 2007).

At its core, fiqh al-muʿāmalāt is anchored in three foundational prohibitions. The first is ribā, which refers to any predetermined, unjustified increment in a financial exchange and is most commonly understood as the prohibition of interest or usury. The second is gharar, which denotes excessive uncertainty or informational asymmetry in contractual terms, the presence of which renders a transaction legally void. The third is maysir, which prohibits speculative or chance-based transactions that produce unearned gain at the expense of another party (Usmani, 2002; Rizwan et al., 2025).

Beyond these prohibitions, Islamic contract law stipulates a set of positive requirements that must be satisfied for a financial agreement to be considered valid. These include the presence of a clear and unambiguous offer and acceptance (ījāb and qabūl), the legal capacity of all contracting parties (al-ahliyyah), a lawful and identifiable subject matter, and genuine mutual consent that is free from coercion or deception (Ahmad et al., 2024; Atiyah et al., 2024).

Of particular significance is the concept of niyyah, or intention, which extends the evaluation of contractual validity beyond mere formal compliance to encompass the ethical purpose underlying the transaction. A contract that satisfies all formal requirements but is designed to circumvent the spirit of shariah may still be considered invalid on grounds of niyyah (Rizwan et al., 2025).

These prohibitions and requirements are grounded within the framework of maqāṣid al-sharīʿah, which refers to the objectives of Islamic law. Muslim jurists identify five primary objectives, namely the preservation of religion, life, intellect, lineage, and wealth (Al-Shāṭibī, 2011).

In the context of Islamic finance, the preservation of wealth, or ḥifẓ al-māl, is particularly relevant, as it provides a normative basis for evaluating financial innovations in terms of their ability to promote distributive justice, prevent exploitation, and serve the broader public interest, known as maṣlaḥah (Dusuki & Abdullah, 2007). It is within this maqāṣid-oriented framework that the potential and limitations of smart contracts in Islamic finance should be assessed.

Smart Contract Mechanisms: Conceptualising Procedural and Declarative Architectures

A smart contract is a software-based agreement deployed on a distributed ledger or blockchain network, wherein contractual terms are encoded as executable code and automatically enforced without the intervention of any intermediary once predefined conditions are met (Giancaspro, 2017; Szabo, 1994). The concept was originally articulated

by computer scientist Nick Szabo in the early 1990s, who envisioned contractual clauses embedded in hardware and software to make their breach costly and, ideally, self-enforcing (Szabo, 1994).

Contemporary smart contracts, most commonly implemented on blockchain platforms such as Ethereum, extend this vision by leveraging distributed consensus mechanisms to ensure that execution is simultaneously transparent, immutable, and verifiable by all parties within the network (Luu et al., 2016; Mat Rahim et al., 2018).

Four technical characteristics define the operational profile of smart contracts and are directly relevant to their evaluation within an Islamic finance context. First, immutability ensures that once a smart contract is deployed on a blockchain, its code and the transactional records it generates cannot be altered or deleted. Second, transparency guarantees that the terms and execution history of the contract are visible to all authorised participants within the network.

Third, decentralisation means that contractual execution occurs without reliance on a central authority, intermediary, or trust agent. Fourth, autonomy allows the contract to operate independently and continuously once deployed, requiring no ongoing human instruction to discharge its obligations (Zulkepli et al., 2023; Idelberger et al., 2016).

A key technical distinction with important implications for Shariah compatibility lies in the difference between procedural and declarative, or logic-based, smart contract architectures. Procedural smart contracts follow a fixed and pre-defined sequence of computational steps, focusing on how a task is to be carried out rather than what outcome should be achieved. In contrast, declarative smart contracts specify the intended outcome or end-state of the agreement, allowing greater flexibility in determining how that outcome is achieved (Idelberger et al., 2016).

This distinction is significant from a jurisprudential perspective. The declarative model is more closely aligned with Shariah principles, which emphasise substantive justice and equitable outcomes rather than rigid formalism (Islamic Finance Review, 2025; Desky & Hye, 2025).

As such, a declarative architecture may be more suitable for Islamic finance applications, as it allows contractual logic to be oriented towards maqāṣid-aligned objectives such as fairness, risk-sharing, and the avoidance of exploitation. This approach is preferable to a purely procedural model, which may enforce pre-determined steps without considering contextual or ethical factors (Idelberger et al., 2016; Rizwan et al., 2025).

Conceptual Convergence and Jurisprudential Tensions

An assessment of the relationship between smart contracts and Islamic finance shows both areas of alignment and important jurisprudential (fiqh) tension. Understanding both aspects is necessary to develop a conceptual framework that is neither overly optimistic nor overly dismissive of the technology's potential. With respect to convergence, the transparency inherent in blockchain-based smart contracts offers a structural mechanism for reducing gharar in financial transactions.

When all contractual terms, pricing structures, and execution conditions are encoded on a public ledger and visible to all parties prior to agreement, the informational asymmetry that gharar is designed to prevent is substantially mitigated (Zulkepli et al., 2023; Atiyah et al., 2024).

Furthermore, the autonomous execution of shariah-compliant conditions, such as the release of funds only upon verification of asset delivery in a murābaḥah transaction, or the distribution of profits according to a pre-agreed ratio in a mushārakah arrangement, can be systematically enforced through smart contract logic in a manner that reduces reliance on human intermediaries and the associated risks of error or manipulation (Rizwan et al., 2025; Ahmad et al., 2024).

The immutable record of all transactions also supports the Islamic principle of amānah, or trustworthiness and accountability, by ensuring that contractual performance is permanently documented and verifiable. With respect to tensions, however, several

fundamental incompatibilities between smart contract logic and Islamic jurisprudence must be acknowledged.

The most consequential of these concerns the concept of niyyah, or intention, which is a prerequisite for contractual validity in Islamic law. Smart contracts, by their nature, execute autonomously on the basis of pre-coded conditions and do not possess, nor can they verify, the subjective intention of the contracting parties. This is particularly problematic when contracts are generated or triggered automatically by software agents, as the attribution of human intent to algorithmically produced agreements becomes jurisprudentially untenable (Giancaspro, 2017; Ahmad et al., 2024).

A second tension concerns the Islamic doctrine of khiyār, or the right of contractual rescission, which permits parties to cancel or modify an agreement under specified conditions, including defect in goods, deception, or mutual consent to terminate. The immutable nature of blockchain-based smart contracts fundamentally conflicts with this doctrine, as once deployed, a smart contract cannot be amended, reversed, or cancelled without extraordinary technical intervention (Zulkepli et al., 2023).

As Zulkepli et al. (2023) observe, this immutability is also incompatible with the Islamic principle of iḥsān, which encourages benevolent flexibility in financial dealings, including facilities for payment rescheduling and contract restructuring that are standard features of Islamic banking products.

A third tension relates to the pseudonymous nature of blockchain transactions, which conflicts with the Islamic contractual requirement for verified legal capacity. Under fiqh al-mu'āmalāt, a valid contract requires that parties be of sound mind, of legal age, and not under duress. Blockchain anonymity makes it technically difficult to confirm whether any of these conditions are satisfied at the time of contract formation, raising concerns about the validity of agreements executed in such an environment (Giancaspro, 2017; Atiyah et al., 2024).

Finally, smart contracts operate strictly within the domain of formal, codifiable logic. They cannot incorporate normative judgements, ethical discretion, or the contextual sensitivity required to evaluate concepts such as ʿurf (custom), maṣlaḥah (public interest), or ʿadl (justice) in any given transaction (Idelberger et al., 2016; Rizwan et al., 2025).

This limitation reflects a deeper divergence between the deterministic logic of computer code and the ethically grounded, contextually sensitive nature of Islamic jurisprudence, a divergence that no technical solution alone can fully resolve. These areas of convergence and tension are summarised in Table 1 below.

Table 1: Convergence and Tensions between Smart Contracts and Islamic Finance Principles

Dimension	Area of Convergence	Area of Tension
Transparency	Reduces gharar through full term disclosure	Pseudonymity conflicts with capacity verification
Immutability	Supports amānah through permanent records	Conflicts with khiyār and iḥsān doctrines
Autonomy	Enforces shariah conditions systematically	Cannot verify or incorporate niyyah
Declarative logic	Aligns with shariah and maqāṣid orientation	Cannot accommodate ʿurf, maṣlaḥah, or ʿadl
Decentralisation	Eliminates ribā-bearing intermediaries	Removes human oversight required by shariah supervisory

Source: Authors' compilation, adapted from Idelberger et al. (2016), Zulkepli et al. (2023), and Rizwan et al. (2025)

APPLICATION FRAMEWORK

The practical mapping of smart contract capabilities onto Islamic financial instruments represents the core applied contribution of this paper. This section categorises specific

deployment opportunities across four principal domains of Islamic finance, namely retail and corporate banking, Islamic capital markets, takaful, and Islamic social finance.

It is important to note that most current implementations remain in an emergent stage, frequently relying on hybrid structures that combine automated logic with human oversight. This reflects the continuing recognition within the industry that fully automated systems are not yet adequate for handling the complex qualitative judgements that shariah compliance demands (Rizwan et al., 2025; Rahmani and Kadari, 2024).

ISLAMIC BANKS

The banking sector represents the primary design space for smart contract integration, particularly in relation to both debt-based and equity-based financing structures. In murābaḥah and tawārruq transactions, the sequential order of execution is jurisprudentially critical to the validity of the contract, as ownership of the asset must be verifiably transferred to the bank before the subsequent sale to the customer can lawfully proceed.

Smart contracts can structurally enforce this sequence by ensuring that asset ownership is confirmed on the blockchain ledger before the execution of the sale leg, thereby eliminating the risk of shariah non-compliance arising from improper transaction sequencing, which is a common consequence of human error in traditional manual systems (Zulkepli et al., 2023).

Furthermore, the automation of cost disclosure and payment scheduling in murābaḥah structures reduces pricing ambiguity and supports the objective of minimising gharar in commercial transactions. Equity-based instruments such as mushārakah and muḍārabah also present significant opportunities for smart contract integration.

Automated profit distribution mechanisms, encoded as self-executing logic on an immutable ledger, ensure that returns are allocated according to pre-agreed ratios without requiring ongoing manual calculation or intermediary reconciliation. This enhances the transparency and enforceability of profit-and-loss sharing arrangements, which have historically been vulnerable to disputes arising from asymmetric information between the capital provider and the entrepreneur (Rahmani and Kadari, 2024; Mat Rahim et al., 2018).

ISLAMIC CAPITAL MARKETS

Within Islamic capital markets, a key application of smart contract technology is the automation of the sukuk lifecycle, including issuance, periodic distribution, and maturity settlement. The emergence of blockchain-based sukuk in jurisdictions such as Bahrain and the United Arab Emirates demonstrates how smart contracts can improve transparency, traceability, and operational efficiency in asset-backed securities (Rizwan et al., 2025).

By encoding contractual terms into self-executing code, issuers can ensure that periodic distributions are triggered automatically once the performance conditions of the underlying assets are fulfilled. This reduces reliance on intermediaries, lowers administrative costs, and improves overall efficiency. In addition, this technological approach may support broader maqāṣid-aligned objectives, particularly financial inclusion.

By lowering entry barriers and transaction costs, smart contract-enabled sukuk structures can allow wider participation, including from smaller investors who previously had limited access to such instruments (Mat Rahim et al., 2018). A practical example is the Blossom Finance Smart Ṣukūk platform, introduced in 2018, which uses blockchain technology to manage data, processes, accounts, and payments related to sukuk issuance through a decentralised network of smart contracts (Blossom Finance, 2018).

This model provides a fully auditable transaction record across the entire sukuk lifecycle. It also adopts a profit-sharing approach, where fees are charged only upon successful project completion rather than upfront, aligning with risk-sharing principles (Rahmani & Kadari, 2024). These developments indicate that the integration of smart contracts into Islamic capital markets is already taking place.

However, current implementations remain limited and largely experimental, which suggests the need for further development, regulatory clarity, and Shariah governance before wider adoption can be achieved.

TAKĀFUL

The takaful sector is well positioned to benefit from the application of parametric smart contracts, where claims are triggered automatically based on verified external data provided by digital oracles, rather than through manual assessment processes. In agricultural takaful, for example, weather oracles can supply verified rainfall or temperature data.

When a pre-defined threshold is reached, payouts are triggered automatically for affected participants without the need for formal claims submission or adjudication. This approach improves operational speed and enhances objectivity in the claims process, while reinforcing the mutual assistance and cooperative nature of takaful arrangements (Rahmani & Kadari, 2024; Gökmen & Yavuz, 2023).

Beyond claims management, smart contracts can also improve transparency in the management of takaful funds. They allow participants to monitor, in real time, the status and utilisation of the mutual risk pool. This enables verification that contributions are managed in accordance with the agreed Shariah-compliant structure.

Such transparency helps address a key governance challenge in takaful, which is maintaining participant trust in the fair and proper management of pooled funds. It also aligns with the Islamic principle of amānah, which emphasises accountability and trust in financial administration (Zulkepli et al., 2023).

ISLAMIC SOCIAL FINANCE

The integration of smart contracts into Islamic social finance addresses a longstanding and critical need for accountability, transparency, and efficiency in the management of zakat and waqf funds. These instruments, which serve as the primary mechanisms of Islamic redistributive finance, have historically been undermined by fragmented governance structures, limited reporting mechanisms, and insufficient donor confidence in the eventual utilisation of contributions (Wan Haniff et al., 2025).

In waqf asset management, smart contracts offer a secure, transparent, and automated mechanism for managing endowment funds from the point of donation through to project disbursement and income distribution. Wan Haniff et al. (2025) propose a sophisticated hybrid model for waqf crowdfunding in Malaysia that integrates blockchain-based smart contracts with artificial intelligence-led risk profiling and real-time shariah auditing tools.

This model directly addresses the regulatory fragmentation and weak governance structures identified in the Malaysian waqf sector by embedding compliance functionality and cross-state auditability into the financing infrastructure itself. The Finterra Waqf Chain platform similarly demonstrates how smart contracts can manage the complete lifecycle of a cash waqf project, from donor registration and fund collection through to shariah-certified project approval and profit distribution (Rahmani and Kadari, 2024; Kamoumia, 2025).

In zakat management, the application of blockchain and smart contracts has demonstrated potential to fundamentally transform the collection and disbursement process by providing donors with an immutable and continuously updated record of how their obligatory contributions are being utilised, thereby fostering trust and reinforcing institutional accountability (Rejeb, 2020; Setiawan and Nurzaman, 2022).

Additionally, smart contracts possess significant potential for automating farāʾiḍ, the mathematically precise distribution of inheritance shares under Islamic succession law (Fokri et al., 2021). By encoding the specific proportional rules of farāʾiḍ into executable code, the distribution of an estate to lawful heirs can be carried out accurately and promptly upon the verification of a designated external trigger, such as a certified digital death record (Mat Rahim et al., 2018).

These applications collectively indicate that smart contracts are capable of enhancing institutional integrity and maqāṣid-alignment across all principal domains of Islamic finance, provided that their deployment is accompanied by appropriate shariah oversight and technical governance mechanisms.

LEGAL AND SHARIAH CHALLENGES

The transition from traditional contract execution to automated, blockchain-based protocols introduces a dual-dimensional set of challenges that must be systematically addressed before smart contracts can be considered fully viable within shariah-compliant financial frameworks. These challenges arise from the fundamental divergence between the deterministic and inflexible logic of computer code and the ethically grounded, contextually sensitive requirements of both Islamic jurisprudence and contemporary civil law (Idelberger et al., 2016; Rizwan et al., 2025).

Shariah Compliance Challenges

The most foundational question confronting the integration of smart contracts into Islamic finance is whether the execution of a computer script can satisfy the affirmative requirements for a valid Islamic contract. Islamic contract law requires the presence of a genuine and comprehensible offer and acceptance, known as ījāb and qabūl, as well as the verified legal capacity of all contracting parties (al-ahliyyah) and a discernible contractual niyyah, or intention.

Whilst it may be argued that coded instructions are capable of representing a form of offer and acceptance in digital form, significant concerns persist regarding the clarity and interpretability of such expressions, particularly in the context of complex multi-party transactions (Ahmad et al., 2024). Empirical findings further suggest that the autonomy of contracting parties is effectively curtailed when the execution phase is delegated entirely to an algorithm that cannot account for situational changes, unexpected events, or the evolving preferences of the parties (Ahmad et al., 2024; Atiyah et al., 2024).

A second shariah challenge concerns the immutability of blockchain-based smart contracts and its incompatibility with the Islamic principle of iḥsān, which encompasses the virtue of benevolence and compassionate flexibility in financial dealings. The principle of iḥsān encourages creditors to grant extensions or relief to debtors experiencing financial distress, through mechanisms such as payment rescheduling, debt restructuring, or voluntary remission of outstanding obligations.

Because the code governing the terms of a deployed smart contract cannot be modified without extraordinary technical intervention, this technological rigidity is structurally incompatible with the compassionate and adaptive approach to contractual relations that Islamic jurisprudence requires (Zulkepli et al., 2023).

This tension also extends to the doctrine of khiyār, or the right of contractual rescission, which permits parties to cancel or modify an agreement under specified conditions, including the discovery of a material defect, evidence of deception, or mutual consent to terminate. The irreversibility of smart contract execution fundamentally impedes the exercise of khiyār in any situation where cancellation requires qualitative human judgement rather than a pre-coded trigger condition (Rahmani and Kadari, 2024; Ahmad et al., 2024).

Civil And Contract Law Challenges

Beyond the shariah dimension, smart contracts encounter significant legal hurdles within civil legal frameworks. The pseudonymous nature of decentralised blockchain networks makes it technically difficult, and in many cases impossible, to verify the identity and legal capacity of the contracting parties. This is particularly problematic in Islamic contexts, where minors, individuals lacking sound mental judgment, and persons under duress are legally precluded from entering into binding financial agreements (Giancaspro, 2017; Ahmad et al., 2024).

Existing identity verification mechanisms, such as Know Your Customer protocols, are not natively integrated into most public blockchain architectures. This results in a structural mismatch between the anonymity of decentralised systems and the specific capacity requirements of Islamic contract law.

Legal scholars also identify a significant interpretive vacuum when disputes arise from smart contract execution. Computer code is incapable of incorporating normative standards such as good faith, reasonableness, or ʿadl, which denotes absolute justice in Islamic jurisprudence (Yusuf & Martinez, 2025). Unlike traditional contracts, which rely on the ex post adjudication of disputes through courts, arbitration panels, or tribunals, smart contracts operate on an ex ante basis, where enforcement is programmed before any breach occurs (Idelberger et al., 2016).

This irreversibility creates major difficulties for legal redress. Coding errors, ambiguous logic, or unforeseen circumstances may result in permanent financial losses that are difficult to recover (Rizwan et al., 2025). Furthermore, the lack of a clear remedial framework for such errors raises questions regarding the jurisdictional competence of civil courts and tribunals, especially in cross-border transactions involving multiple legal systems (Giancaspro, 2017).

CYBER, OPERATIONAL AND ENVIRONMENTAL RISKS

The dependence of smart contracts on digital infrastructure introduces a further layer of substantive ethical and operational risks. Historical case studies demonstrate that the pseudonymity and decentralised nature of smart contract platforms have been exploited for illicit financial activities, including money laundering and the operation of fraudulent investment schemes (Benson et al., 2024; Gabbiadini et al., 2025; Jamwal et al., 2024).

Such activities frequently involve the concealment of material information from participants, which may itself constitute a technologically mediated form of gharar that undermines the transactional integrity required by Islamic commercial law (Ahmad et al., 2024; Rahmani and Kadari, 2024).

Smart contracts are also inherently vulnerable to hacking, code exploitation, and sophisticated technical errors that can result in the total and permanent loss of assets stored on the blockchain (Gabbiadini et al., 2025). The reliance on external oracles to supply the data inputs that trigger contract execution introduces a further dimension of uncertainty, as any fraudulent manipulation, technical failure, or inaccurate data feed will cause the contract to execute erroneously, with no straightforward mechanism for reversal or compensation (Rahmani and Kadari, 2024; Philipponnat, 2025).

This oracle-dependency problem constitutes a new and technically sophisticated form of gharar, in that the validity of contractual execution is made contingent on information whose accuracy cannot be guaranteed at the point of encoding. Finally, the significant energy consumption associated with certain blockchain consensus mechanisms, most notably Proof-of-Work protocols, raises environmental concerns that merit consideration within an Islamic ethical framework.

The doctrine of khilāfah, which establishes the human duty of responsible stewardship over natural resources and the created environment, provides a shariah-grounded basis for evaluating the environmental sustainability of the technological infrastructure upon which Islamic smart contracts are built. The adoption of more energy-efficient consensus mechanisms, such as Proof-of-Stake protocols, may therefore constitute not merely a technical preference but an ethical imperative from a maqāṣid-oriented perspective (Rizwan et al., 2025).

REGULATORY GOVERNANCE FRAMEWORK

The governance of smart contracts within Islamic finance necessitates a multi-dimensional approach that balances technological innovation with the ethical imperatives of the shariah. Effective governance in this domain cannot be achieved through technological design alone. It requires a structured architecture of institutional oversight spanning international

standard-setting bodies, national regulatory authorities, and institutional-level shariah committees, each operating within a coherent and mutually reinforcing framework.

Malaysia occupies a particularly significant position within this landscape, having established itself as a global pioneer in the regulation of digital Islamic assets through a regulatory posture that may be characterised as "cautious progressivism", wherein innovation is actively facilitated whilst doctrinal integrity is preserved (Rizwan et al., 2025; Ghaffour, 2026).

MULTI-LEVEL GOVERNANCE ARCHITECTURE

A structured governance architecture operating across three distinct levels is proposed to ensure that smart contracts function within a legally and religiously sound environment. This framework is designed to address the jurisdictional, institutional, and technical dimensions of shariah-compliant smart contract deployment. It recognises that a single level of governance is insufficient to manage the comprehensive legal and religious challenges associated with this technology.

At the international level, standard-setting bodies such as the Accounting and Auditing Organisation for Islamic Financial Institutions (AAOIFI) and the Islamic Financial Services Board (IFSB) must assume responsibility for establishing harmonised protocols for code auditing, digital shariah compliance certification, and cross-border interoperability standards.

The absence of such harmonised protocols currently represents one of the most significant structural barriers to the global scalability of Islamic smart contract applications, as institutions operating across multiple jurisdictions face inconsistent and sometimes conflicting shariah interpretations (Rahmani and Kadari, 2024). Complementary oversight at the international level from bodies such as the Bank for International Settlements and the Financial Action Task Force is also necessary to address the anti-money-laundering and counter-terrorism financing risks associated with pseudonymous blockchain transactions.

At the national level, the Malaysian regulatory framework provides a model of considerable relevance. Both Bank Negara Malaysia and the Securities Commission Malaysia have recognised the transformative potential of blockchain technology in financial services, whilst maintaining that any digital instrument must receive formal shariah approval from the relevant advisory councils prior to commercial deployment (Rizwan et al., 2025).

The Securities Commission Malaysia's Guidelines on Digital Assets provide a legal basis for the issuance of digital tokens and the operation of initial exchange offerings, which are directly applicable to tokenised sukuk and other shariah-compliant digital instruments (Securities Commission Malaysia, 2024).

Furthermore, Bank Negara Malaysia's Digital Asset Innovation Hub facilitates controlled experimentation by allowing Islamic fintech providers to test smart contract protocols under direct regulatory supervision, thereby enabling the identification and mitigation of compliance risks before commercial deployment (Ghaffour, 2026). The Securities Commission Malaysia's recent launch of a consultation paper on tokenised capital market products further signals an evolving and proactive regulatory stance that is attentive to developments in this area (Securities Commission Malaysia, 2025).

At the institutional level, internal shariah committees must collaborate closely with software developers and blockchain engineers to verify that the underlying logic of each smart contract adheres to the specific requirements of the relevant fatwā and to the broader principles of fiqh al-muʿāmalāt. This institutional-level governance is particularly critical because shariah compliance in automated systems cannot be adequately evaluated through ex post auditing alone.

Rather, it must be embedded at the design phase through what may be termed a "shariah-by-design" approach, in which prohibited elements are screened and eliminated before deployment rather than detected and remediated after execution (Wan Haniff et al., 2025). This three-level governance architecture is summarised in Table 2 below.

Table 2: Multi-Level Governance Model for Islamic Smart Contracts

Level	Responsible Entities	Key Governance Functions
International	AAOIFI, IFSB, BIS, FATF	Harmonised smart contract standards, cross-border shariah protocols, AML/CFT compliance
National	BNM, Securities Commission Malaysia, MDEC, JAKIM	Licensing, regulatory sandboxes, Shariah Advisory Council oversight, digital asset guidelines
Institutional	Internal Shariah Committees, Smart Contract Audit Firms	Code validation, fatwā-level compliance verification, blockchain governance protocols

Source: Authors' compilation, adapted from Rizwan et al. (2025), Rahmani and Kadari (2024), and Wan Haniff et al. (2025)

DIGITAL SHARIAH SUPERVISION: A "BY-DESIGN" IMPERATIVE

A critical element of the proposed governance framework is the principle that shariah compliance must be treated not as an ex post audit function but as a foundational design requirement embedded from the earliest stages of smart contract development.

This "by-design" approach requires sustained collaboration between shariah scholars and blockchain developers to ensure that the affirmative requirements of a valid Islamic contract, including properly encoded offer and acceptance (ījāb and qabūl), verified contractual capacity (al-ahliyyah), and a discernible transactional intent (niyyah), are reflected in the executable logic of the code (Rizwan et al., 2025).

The Malaysian regulatory environment supports this approach through the Shariah Advisory Council of Bank Negara Malaysia, which serves as the authoritative national body for determining the shariah compliance of financial instruments and is empowered to issue binding rulings on digital financial products (Ghaffour, 2026).

The governance gap identified in the Malaysian waqf crowdfunding sector by Wan Haniff et al. (2025), namely the fragmentation of regulatory oversight between federal and state jurisdictions and the absence of real-time shariah audit mechanisms, underscores the practical consequences of treating compliance as an afterthought.

Their proposed hybrid model, which integrates real-time shariah auditing tools and automated compliance dashboards directly into the smart contract infrastructure, offers a concrete operational illustration of what the "by-design" principle entails in practice. This model is directly applicable to a broader range of Islamic financial instruments beyond the waqf context.

THE "HUMAN-IN-THE-LOOP" IMPERATIVE

Another essential part of the proposed governance framework is the need for continuous human oversight within automated financial systems. As algorithmic decision-making in finance becomes more complex, there is a risk of developing unaccountable black box systems. Philipponnat (2025) notes that these systems produce financial outcomes based on logic that regulators, consumers, and even the institutions themselves may not fully understand or be able to challenge.

Smart contracts must not operate without any human intervention to uphold the principle of amānah, which includes trustworthiness, accountability, and responsible stewardship. It is necessary to include a mandatory human oversight layer in the governance architecture so that human agents can perform qualitative assessments at important stages.

These assessments include evaluating the creditworthiness of a customer before approving finance and verifying the delivery of assets in murābaḥah transactions. Furthermore, human agents must determine if a debtor is eligible for debt restructuring under the principle of iḥsān and ensure that qualified shariah supervisors regularly review the algorithmic screening logic (Philipponnat, 2025; Zulkepli et al., 2023).

This human-in-the-loop requirement ensures that technology remains a tool for ethical finance. It prevents the system from becoming a self-governing mechanism that replaces the moral and jurisprudential judgement of human agents.

UPGRADABLE PROXY CONTRACTS AS A TECHNICAL GOVERNANCE MECHANISM

The tension between blockchain immutability and the need for contractual flexibility, identified in Section IV as a fundamental Sharīʿah challenge, necessitates a technical governance solution that can accommodate necessary contractual amendments without compromising the transparency and integrity of the transaction record. The implementation of upgradable proxy contract architecture represents the most technically viable solution currently available.

This architecture operates through a proxy contract that stores the address of a separate, modifiable logic contract. When contractual terms require revision, the owner of the proxy can suspend the execution of the existing logic set and deploy a revised version, whilst all historical transactional data stored on the blockchain remains fully intact and auditable (Zulkepli et al., 2023).

This mechanism is particularly important for facilitating payment rescheduling, debt restructuring, and other forms of debtor relief that are required by the principle of iḥsān in Islamic financial dealings. By utilising proxy patterns, Islamic financial institutions can accommodate the amendments required by Sharīʿah principles whilst preserving the transparency and immutability that give blockchain-based contracts their distinctive value.

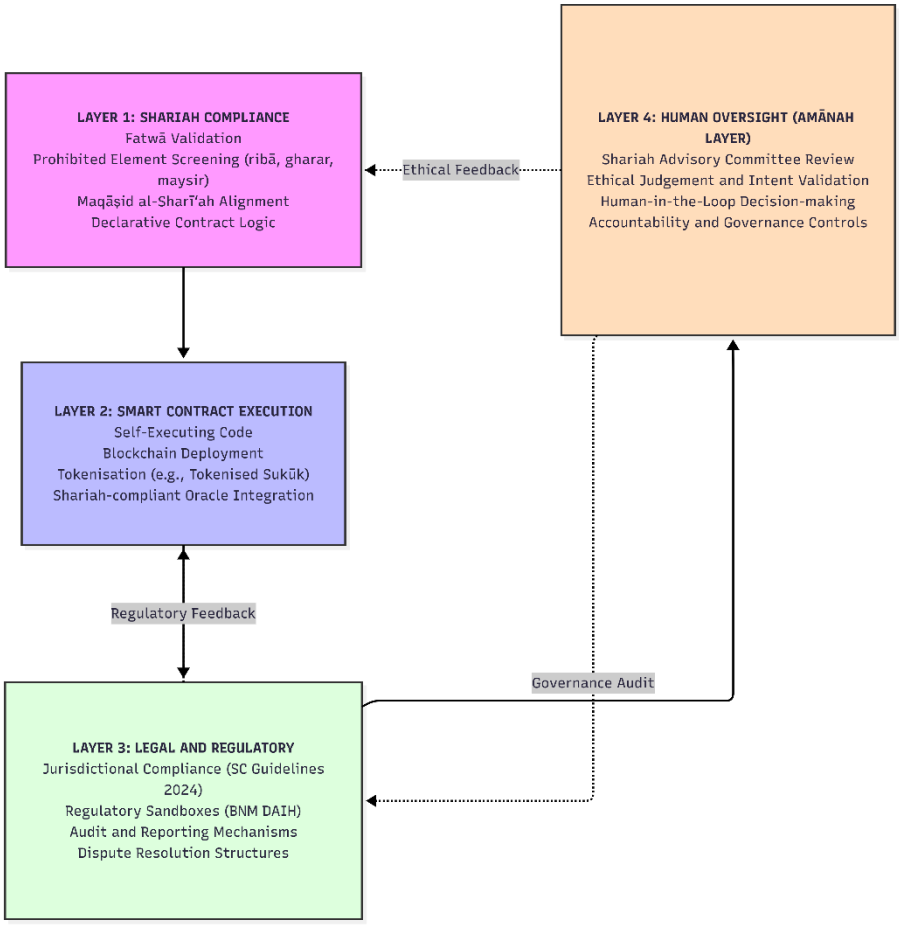
This technical solution must, however, be deployed with appropriate governance controls to ensure that the override authority cannot be exercised arbitrarily, and that all amendments are subject to prior approval from the institutional Sharīʿah committee.

INTEGRATIVE CONCEPTUAL MODEL

The primary contribution of this study is the proposal of a four-layer integrative conceptual framework. This framework is designed to align the technical capabilities of blockchain-based smart contracts with the religious and ethical requirements of Islamic finance. This model rejects the simple idea that code is law, which is common in general technology literature.

Instead, it supports a shariah-by-design approach. In this model, ethical and legal compliance is a basic design requirement rather than a final regulatory check. The framework functions as a vertical stack where each layer supports the next, while bidirectional feedback loops ensure that the system remains under constant ethical and legal review.

Figure 1: Four-Layer Integrative Model for Islamic Smart Contracts



Layer 1: The Shariah Compliance Layer

The first layer acts as the foundation and the primary filter. Every proposed Islamic smart contract application must pass through this layer before technical development begins. This stage uses declarative contract logic to define what outcomes must be achieved. These outcomes must align with the maqāṣid al-sharī'ah, such as the preservation of wealth and the prevention of exploitation.

By including screening mechanisms for ribā, gharar, and maysir during the design phase, the model ensures the underlying logic is inherently compliant (Rizwan et al., 2025). Fatwā validation by qualified scholars is a mandatory step at this stage. This validation process must be formally recorded to provide evidence for the audit trail maintained in Layer 3.

Layer 2: The Smart Contract Execution Layer

The second layer provides the technical infrastructure within which shariah-validated contractual logic is deployed on the blockchain. This layer encompasses the self-executing code, the blockchain deployment protocol, the tokenisation of Islamic financial instruments such as sukuk and waqf assets, and the integration of shariah-compliant oracle systems that supply verified external data to trigger contract execution.

The use of shariah-compliant oracles is of particular importance at this layer, as verified and accredited data feeds reduce the risk of oracle-generated gharar by ensuring that automated execution is triggered by accurate and independently verifiable real-world events (Zulkepli et al., 2023). Upgradable proxy contract structures are also used here to manage the challenges associated with blockchain immutability.

Layer 3: The Legal and Regulatory Layer

The third layer ensures that the deployed smart contract instrument is anchored within the applicable legal and regulatory landscape. In the Malaysian context, this layer encompasses compliance with the Securities Commission Malaysia's Guidelines on Digital Assets, alignment with Bank Negara Malaysia's Shariah Advisory Council rulings, and participation in supervised regulatory sandbox environments such as the Digital Asset Innovation Hub (Securities Commission Malaysia, 2024; Ghaffour, 2026).

This layer also establishes the audit trails, reporting mechanisms, and dispute resolution structures necessary for jurisdictional compliance and ex post accountability. The governance dashboards and automated reporting modules proposed by Wan Haniff et al. (2025) in the context of waqf crowdfunding represent a practical implementation of the audit and reporting functions assigned to this layer.

Layer 4: The Human Oversight (Amānah) Layer

The most important part of this framework is the dedicated human oversight layer. It is called the Amānah Layer because it focuses on the Islamic principles of trustworthiness and responsible stewardship. This layer solves the problem of rigid and deterministic code. Computer code is unable to use moral discretion or qualitative ethical judgement. Qualified shariah advisory review the automated transactional logic regularly at both the national and institutional levels.

They are responsible for validating the niyyah and ethical alignment of the outcomes. They also authorise any necessary changes to the contract logic (Philipponnat, 2025). This human-in-the-loop approach ensures that the technology remains a tool for ethical finance rather than a self-governing system.

THE INTERACTION OF FEEDBACK LOOPS

The four layers connect through bidirectional feedback loops as shown in Figure 1. Ethical feedback moves from the Amānah Layer back to the Shariah Compliance Layer. This allows for ongoing religious calibration based on transaction results. Regulatory feedback moves from the Legal and Regulatory Layer to the Execution Layer to ensure technical protocols stay compliant with new laws.

Finally, the governance audit moves from the Amānah Layer to the Legal and Regulatory Layer to provide supervisory accountability. This bidirectional structure distinguishes the model from simple linear systems and reflects the dynamic nature of shariah governance.

RESEARCH PROPOSITIONS

The preceding analysis leads to the formulation of five formal research propositions. These statements are intended as principled conceptual claims that synthesise the theoretical and applied arguments developed within this study. They serve as a contribution to the scholarly discourse on Islamic financial technology and provide a foundation for future empirical and jurisprudential investigation.

Proposition 1: Declarative smart contract architectures demonstrate greater compatibility with maqāṣid-oriented Islamic jurisprudence than procedural architectures.
Procedural smart contracts are characterised by a rigid, step-by-step execution logic that prioritises formalistic adherence to pre-specified code instructions, irrespective of whether the outcomes produced are equitable or contextually appropriate.

Declarative architectures, by contrast, encode the desired end-state or outcome of the agreement rather than the procedural pathway to achieving it, thereby allowing the execution logic to be oriented towards substantive justice and maqāṣid-aligned outcomes (Idelberger et al., 2016). This design philosophy aligns closely with the Islamic jurisprudential principle which prioritises the objective of a legal rule over its mechanical application.

Declarative models therefore provide a more suitable and jurisprudentially coherent foundation for Islamic financial instruments that seek to realise the higher objectives of the shariah (Mat Rahim et al., 2018; Rizwan et al., 2025).

Proposition 2: Blockchain pseudonymity creates a fundamental and currently unresolved conflict with the shariah requirements of legal capacity and niyyah.

The anonymity inherent in decentralised blockchain networks prevents the robust verification of the identity, age, mental competence, and contractual capacity of participants.

Under the framework of fiqh al-muʿāmalāt, a valid contract requires that all parties possess the legal standing to enter into a binding agreement and that their participation reflects a discernible and genuine niyyah, or intention. Without the integration of identity verification mechanisms at the protocol level, such as accredited digital identity solutions that satisfy Know Your Customer standards whilst preserving user privacy, the use of smart contracts in Islamic finance remains structurally susceptible to a form of gharar regarding the very eligibility and intentionality of the contracting parties (Giancaspro, 2017; Ahmad et al., 2024).

Proposition 3: The inherent immutability of blockchain necessitates the adoption of shariah-sanctioned technical override mechanisms to give effect to khiyār rights and the principle of iḥsān. Classical Islamic contract law grants parties the right of rescission known as khiyār, and emphasises the virtue of iḥsān, or benevolent flexibility, in financial dealings, particularly in circumstances of financial hardship.

The immutability of standard smart contracts, wherein deployed code cannot be modified or reversed without extraordinary technical intervention, prevents the exercise of these rights and runs counter to the compassionate character of Islamic financial jurisprudence (Zulkepli et al., 2023). The deployment of upgradable proxy contract patterns, subject to mandatory shariah committee authorisation, constitutes the most technically viable mechanism currently available for resolving this tension whilst preserving the transparency and integrity of the blockchain record (Zulkepli et al., 2023; Mat Rahim et al., 2018).

Proposition 4: Regulatory sandboxes represent the most viable near-term pathway for the controlled and shariah-compliant experimentation and adoption of Islamic smart contracts.

A cautious and supervised approach to the commercial use of Islamic smart contracts is essential due to operational and cybersecurity risks. Regulatory sandboxes, such as the Digital Asset Innovation Hub by Bank Negara Malaysia, provide a structured environment for testing protocols. This allows regulatory authorities and Shariah Advisory Councils to supervise the process directly. This controlled setting helps to identify and fix compliance failures before the technology enters the broader market (Ghaffour, 2026; Rahmani and Kadari, 2024).

Proposition 5: A mandatory human-in-the-loop governance layer is necessary to preserve amānah and prevent automated Islamic financial systems from becoming instruments of unaccountable algorithmic decision-making.

The automation of financial transactions must not result in the creation of systems that are opaque, uncontestable, and unresponsive to the ethical judgements that shariah-compliant finance requires. To maintain the principle of amānah, encompassing trustworthiness, accountability, and responsible stewardship, human oversight must be integrated as a mandatory and non-negotiable governance layer within all Islamic smart contract deployments.

This oversight ensures that qualitative moral discretion, contextual sensitivity, and the authority to grant relief in accordance with iḥsān are exercised by human agents at critical decision points, thereby preventing the technology from operating as an autonomous system that displaces rather than supports the ethical framework of Islamic jurisprudence (Philipponnat, 2025; Wan Haniff et al., 2025).

CONCLUSION

The integration of smart contracts into the Islamic financial ecosystem represents a sophisticated challenge which requires a synthesis of technological rigidity and jurisprudential flexibility. This study has addressed its primary research questions by demonstrating that smart contract capabilities can be systematically mapped onto retail banking, tokenised sukuk, parametric takaful, and social finance vehicles such as zakat and waqf.

While automation offers significant gains in transparency and efficiency, a dual-track typology of challenges remains because autonomous code cannot fully satisfy the requirements of niyyah, ījāb, and qabūl. The fundamental conflict between blockchain immutability and the doctrines of khiyār and iḥsān, alongside the emergence of oracle-dependency as a technically sophisticated form of gharar, requires principled engagement from scholars and practitioners.

To manage these risks, the paper proposes a multi-level governance framework operationalised through an original four-layer integrative model which incorporates a dedicated human oversight layer termed the Amānah Layer. This model advances a shariah-by-design approach where religious compliance is treated as a foundational requirement rather than a final constraint. Such a model ensures that Islamic finance remains responsive to the contextual requirements of justice and social welfare in an increasingly digitised global economy.

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