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Blockchain Governance: The Development and Application of a Framework for Waqf Institutions

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The effectiveness of waqf administration is impeded by poor management of assets, opacity, and unstandardized reporting. Blockchain is expected to solve these issues due to its ability to record and trace every transaction, allowing administrators to discharge their accountability to waqf stakeholders. While there have been numerous proposals for waqf blockchain, there is no explicit framework for the governance of blockchain in waqf institutions. We propose a governance of blockchain framework for waqf institutions based on IT governance dimensions and blockchain governance dimensions from the literature. The framework comprises three dimensions (formation and context, actors, and means of governance/decision making) that subsume eight sub-dimensions across three layers and three stages. We then apply the framework on a blockchain-based waqf organization to examine its usefulness. The framework is among the first to be designed for waqf institutions.

Keywords: blockchain governance, governance of blockchain framework, waqf institutions

Introduction

Blockchain is often recognized as a disruptive technology that has and will affect industries and bureaucracy, with use cases ranging from healthcare to supply chain management and from identity management to financial services (Mohanta, Panda, & Jena, 2018; Morabito, 2017; Nofer, Gomber, Hinz, & Schiereck, 2017). Researchers have given much attention to the technology, especially following the rise in cryptocurrency prices and offerings in recent years. Current research has focused on blockchain technology and its applications (Wang, Zhang, Yu, & Ning, 2021), on top of the governance of cryptocurrencies (e.g., B. D. Trump, Wells, J. Trump, & Linkov, 2018) and governance of and by blockchain (e.g., Beck, Müller-Bloch, & King, 2018; Campbell-Verduyn, 2018a). Governance of blockchain refers to the governance of the infrastructure via technological, social, legal, or economic means, whereas by blockchain it means the governance of a process using the blockchain itself.

In the areas of Islamic finance and charity, blockchain has likewise been cited as a capable technology that can revolutionize the landscapes of both (Alam, Gupta, & Zameni, 2019; Rabbani, Khan, & Thalassinos, 2020).

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Especially for the latter, blockchain is expected to enhance the transparency of Islamic charity administration (Zulaikha & Arif Rusmita, 2018), as all transactions on the blockchain are recorded and distributed to the participants of the network. Moreover, the data are immutable. However, while there have been several proposals on blockchain-based Islamic charity, there is little recommendation, if any, for the governance framework of this proposed entity.

In Malaysia, the absence of any standardized and periodic reporting, opacity of records, inefficient management of assets, and other issues have led to ineffective waqf administration (Daud, 2019). These issues may reduce stakeholder confidence in the administrators of waqf. Indeed, some foundations initiated by prominent Malaysian Muslims—and these foundations are philosophically Islamic—are established on secular law rather than the waqf act. By so doing, these foundations are able to administer the waqf assets themselves instead of delegating the task to State Islamic Religious Councils (SIRCs) (Malaysian Accounting Standards Board, 2014).

This study therefore focuses on the governance of blockchain in waqf institutions in Malaysia. Specifically, it proposes a framework to aid the implementation of blockchain in those waqf institutions. The framework is based on Weill and Ross's (2004) IT governance model, the blockchain governance frameworks of Pelt, Jansen, Baars, and Overbeek (2020) and Laatikainen, Li, and Abrahamsson (2021), and the lifecycle stages proposed by Rikken, Janssen, Kwee, Bolívar, and Scholl (2019). The proposed framework is then applied to a blockchain-based waqf organization.

The next section discusses blockchain, its mechanism, characteristics, models, and applications. Section 3 then discusses the IT governance model. Section 4 provides the definition of blockchain governance, distinguishing between governance by, of, and with blockchain. It then continues with a summary of blockchain governance frameworks in the literature. Section 5 briefly recaps the governance of waqf in Malaysia. Section 6 constructs a generic governance framework for a private permissioned blockchain. This framework is applied to WAQF Chain, a blockchain developed and managed by the financial technology firm Finterra, in Section 7. Section 8 concludes.

Blockchain

Mechanism and Characteristics

Blockchain is a decentralized network of interconnecting nodes that collectively verify, record, and store blocks of data. These nodes are formed by laptops, computers, or servers. When a node (or user) makes any change to the data, for example by carrying out a purchase order or inputting new information, it is recorded on the block. This change is also identified with a hash, an alphanumeric string generated mathematically from a string of characters. The hash contains details of each transaction, for example sender, recipient, date, or other details (Brito & Castillo, 2013; Salmon & Myers, 2019). After it is forged, a hash is also stamped onto it, connecting it via a chain to the previous block. A block is added into the chain if it has been verified by the nodes via a consensus mechanism (Zīle & Strazdiņa, 2018). Theoretically, the process of recording, forging, and verification repeats indefinitely. The nodes record the entire database, and it is regularly updated and verified.

In a public blockchain, the database is distributed in several nodes sited in various locations, hence the absence of a central point of failure or central authority. While a private blockchain is also comprised of several nodes and the network is distributed, the nodes are typically known, designated computers or servers. In this sense, the decentralization of the network is followed with a centralized locus of decision rights and responsibilities, as the nodes can be easily manipulated, and access to the blockchain is contingent upon the approval of master nodes (Alam et al., 2019; Raval, 2016).

Blockchain is considered immutable and secure because the verified blocks cannot be modified without rebuilding the previous blocks (Hileman & Rauchs, 2017). In a public blockchain, it is theoretically impossible to alter data on the blockchain without the collusion of a majority of participating nodes, which requires excessive cost and resources (Bonneau, 2019). Other advantages of blockchain are the traceability and transparency of data, distribution of database, and elimination of intermediaries (Keerati, 2017).

Models

The classification of blockchain models is based on the authority to read (right to access the network and see its database), write (right to generate and send transactions to the network), or commit (right to update transactions to the network) information into the blockchain. The general mechanism between the models is generally similar. Table 1 summarizes the four models of blockchain and its rights and attributes.

Table 1

Blockchain Models

			Read	Write	Commit	Immutability	Centralized	Efficiency
Blockchain types	Open	Public permissionless	Anyone	Anyone	Anyone*	Virtually impossible to tamper	No	Low
		Public permissioned	Anyone	Authorized participants	All or subset of authorized participants	Possible to tamper	Partial	Medium
	Closed	Consortium	Authorized participants	Authorized participants	All or subset of authorized participants	Possible to tamper	Partial	High
		Private permissioned (enterprise)	Fully private or restricted to a set of limited authorized nodes	Network operator only	Network operator only	Possible to tamper	Yes	High

Note. *Requires significant investment either in mining hardware (proof-of-work model) or cryptocurrency itself (proof-of-stake model). Sources: Hileman and Rauchs (2017).

Public permissionless networks are typically for cryptocurrencies, such as Bitcoin. Anyone (or thing) can access the network and write on it, but it is only committed into the blockchain if the entire network verifies it (i.e., consensus mechanism). It is possible for malicious nodes to commit or tamper with the records, but this requires an exorbitant amount of computer and financial resources (Bonneau, 2019). Incentive on this type of network is typically in the form of coins, such as Bitcoin (BTC) or Ether (ETH). In a public permissioned model, only authorized participants may write and commit onto the network. This necessitates a designated validator, human or otherwise, to approve membership into the network.

In closed systems, the three rights are more restricted, and the locus of decision rights becomes increasingly centralized. The auditability and transparency of the network reduces, simply because access rights are restricted. A private permissioned blockchain is similar to other information technology (IT) solutions used internally in a firm. It is possible to tamper the data because the participating nodes are small and known. Tampering, here, also refers to the revision of incorrect records. Scalability is not an issue because the number of nodes is limited, thus the high efficiency of the network. Incentives in a closed model are in the form of pecuniary and threats of legal prosecution (Hileman & Rauchs, 2017).

Smart Contracts

There are two common blockchain applications: smart contracts and decentralized apps (dApps). Smart contracts are coded into the blockchain algorithm and “deployed using cryptographically signed transactions on the blockchain network" (Yaga, Mell, Roby, & Scarfone, 2019, p. 32). They follow the if-else function, which means that if certain conditions are met, a subsequent action will be executed automatically. Smart contracts can create tokens following the fulfilment of certain conditions (Oliveira, Zavolokina, Bauer, & Schwabe, 2018). For example, if a certain crowdfunding threshold has been met, the smart contract will create and distribute tokens that represent stakes of endowment to the contributors. It has been purported to complement or substitute traditional contracts (Alam et al., 2019).

The logic of smart contracts makes it deterministic, which means that a specific input will produce a specific output. However, if it requires data feed ("oracle") from outside the blockchain network, it becomes non-deterministic due to the variability of the data feed. The codes of the smart contracts can be inspected, but they cannot be modified. Therefore, new contracts or other workarounds must be implemented to overwrite the function of a deployed smart contract. Another option is to execute the self-destruct function of the contract (Christidis & Devetsikiotis, 2016).

Decentralized Apps

Unlike smart contracts, which are written into the blockchain infrastructure, dApps are written outside of the blockchain codes (Raval, 2016). They may either be on-chain or off-chain. A simple example of dApps is cryptocurrency and token. dApps can be completely decentralized and autonomous, but this does not prevent them from being altered. Two ways of doing so are by modifying the state of the blockchain, such that the dApp code is overwritten; and to change the code on which it relies or to which it refers (De Filippi & Mcmullen, 2018).

IT Governance

Information technology (IT) governance is "the decision rights and accountability framework for encouraging desirable behaviors in the use of IT" (Weill & Ross, 2004, p. 1). It is a reflection of the broader organizational governance principles while concentrating on the use of IT to achieve organizational goals (Weill & Ross, 2004). Weill (2004) outlines three dimensions of IT governance: decision rights, accountability, and incentive. Beck et al. (2018) explain these dimensions using the conventional agency theory (Jensen & Meckling, 1976).

Decision rights refer to the authority, responsibility, and capability of individuals in the blockchain to make and monitor decisions and prioritize the interest of certain stakeholders. In traditional governance theory, decision rights are divided into decision management rights (the rights to make and execute decisions) and decision control rights (the rights to ratify and monitor decisions) (Fama & Jensen, 1983). The locus of IT decision rights is on a spectrum, ranging from fully centralized to fully decentralized (Sambamurthy & Zmud, 1999; Weill & Ross, 2005). Typically, a decentralized structure is associated with growth, centralized with profitability, and hybrid with asset utilization (Weill & Ross, 2005). Weill and Ross (2005) detail six types of IT decision-making structures, from centralized to decentralized:

1. Business monarchy, where an individual or group of executives make all IT-related decisions.
2. IT monarchy, where an individual or group of IT executives make all IT-related decisions.
3. Federal system, where the business group leaders and C-level executives collaborate with the IT department.
4. IT duopoly, where IT executives and business leaders jointly make decisions.
5. Feudal system, where business or unit leaders make decisions based on their needs.
6. Anarchy, where an individual or small group of users pursue their own IT agenda.

In a blockchain-based digital economy, and perhaps in some blockchain-based digital ventures, the decision rights are decentralized to take advantage of the strength of blockchain. Decentralization of decision rights means that both record keeping and decision making in a blockchain-based venture are arranged in a decentralized manner (Beck et al., 2018).

Accountability means that the parties responsible for the decisions made at every layer and process of the organization should be identifiable and answerable for their decisions and their outcomes (Liu, Lu, Zhu, Paik, & Staples, 2021). To maximize the accountability of decision agents and prevent self-reward, self-monitoring, or even self-punishment, decision management rights should be distinct from decision control rights (Moldoveanu & Martin, 2001). Therefore, the roles of monitoring and ensuring the accountability of decision makers are typically assigned to a separate entity. The assignment, specification, and enforcement of accountability can be done on or off the IT infrastructure (e.g., contract).

The final dimension is incentive, which motivates and influences the behaviors of stakeholders to do or to not do certain actions. This ensures that the interests of the IT decision makers and stakeholders align, such that the IT infrastructure is employed in line with its design objectives (Beck et al., 2018). To ensure the alignment of incentives, decision makers may be given pecuniary and non-pecuniary rewards (Jensen & Meckling, 1976).

Blockchain Governance

Definition

Blockchain governance is a vague concept as it can be understood as three different concepts: governance by blockchain, governance of blockchain (De Filippi & Mcmullen, 2018; Ølnes et al., 2017), and governance with blockchain (Campbell-Verduyn, 2018b). Governance by blockchain means governing political, economic, and social activities using blockchains and related technologies. Essentially, it is the use of blockchain as a governance tool. De Filippi and Mcmullen (2018) explain that governance by blockchain refers to endogenous ("on-chain") governance rules. These rules are directly coded into the blockchain, governing how it is managed, how decisions are made, and how to vote or resolve disputes. They are akin to laws and procedures that govern a traditional organization. A simple illustration is the verification of transaction records on a public permissionless blockchain infrastructure. Supposing that a node commits a new record into the block, the nodes of the blockchain network will record, verify, and distribute the new record into the blockchain infrastructure. This is done autonomously, and no single individual can stop this process. Likewise, it cannot be easily amended without the collusion of other nodes in the network (Rikken et al., 2019).

Governance of blockchain is "the mechanisms used to facilitate the evolution of blockchain ecosystems, such as protocol improvement processes to make code updates" (Allen, Berg, & Lane, 2021, p. 4). Put simply, it concerns how to govern a blockchain infrastructure, how the blockchain platform should be designed (Howell, Potgieter, & Sadowski, 2019), what consensus mechanism to implement, and how it should be implemented (Puik et al., 2018). Governance of blockchain is consensus-relevant changes to the blockchain infrastructure (Fischer & Valiente, 2021). Consensus-relevance means the acceptance of changes or updates to the internal rules of the blockchain network by all its participants. In the absence of a consensus, the network shall be split into two: one that is followed by those who agree to the new rules and one that follows the old rules (hard fork) (though this is applicable to public networks only). There are on-chain and off-chain rules for the governance of blockchain. On-chain governance is directly embedded into the network ("code is law"), while off-chain governance is specified and enforced by social and legal norms and mechanisms, such as contracts, laws, and conventions (Reijers et al., 2021). Governance of blockchain is the focus of this study.

Allen et al. (2021) note the blurry demarcation between governance of and by blockchain. Blockchain requires governance, yet at the same time it can act as a tool of governance due to "its properties as a distributed ledger that can record votes and aid coordination" (p. 4). For example, innovation in token holder voting, which is part of governance by blockchain, aids collective decision-making related to changes in the blockchain protocol, which is within the scope of governance of blockchain. Indeed, there are interlinks between governance by, of, and with blockchain (the use of blockchain to exercise relative power over others; this classification seems to be unique to Campbell-Verduyn (2018a)). For instance, governance by blockchain may influence the shape and form of governance of blockchain. The features and underlying forms of governance to an extent shape decentralized forms of governance (Campbell-Verduyn, 2018b; Campbell-Verduyn & Goguen, 2018).

Certainly, the end objectives of network participants are heterogenous, but this is not unlike traditional organizations. Nevertheless, the collective purpose of governance of blockchain in a public permissionless network is likely the survival of the network and its wide adoption (Allen, 2020). In a closed network, the objective is expected to be the transparency and distribution of records.

Framework

Blockchain governance framework has been discussed or developed based on various theories and perspectives, including corporate governance (Allen, 2020; Ferreira, Li, & Nikolowa, 2019; Piazza, 2017), IT governance (e.g., Beck et al., 2018; Pelt et al., 2020), comparative economics (e.g., Allen et al., 2021), political and constitutional governance (e.g., Alston, Law, Murtazashvili, & Weiss, 2020), and public governance (e.g., Brinkmann & Heine, 2019). Some are simple, while others consider the numerous layers and processes of the blockchain network (e.g., Allessie, Sobolewski, & Vaccari, 2019; Clavin et al., 2020; Rikken et al., 2019). Some of these frameworks are briefly reviewed below.

Beck et al. (2018) propose a blockchain governance by extending Weill and Ross's (2004) IT governance dimensions of decisions rights, accountability, and incentives and linking them to Jensen and Meckling's (1976) agency theory. Decision rights concern the decentralization of decision making, where technology, not written contracts, is the foundation of the network. In earlier stages, decisions on the blockchain may be planned and executed by a "benevolent dictator", who establishes the foundational system design and resolves emergency situations. As the blockchain grows, decision-making will be gradually decentralized, allowing members of the network to vote on decisions or changes. Disagreements can be voiced, and in extreme cases members may even fork off from the network. The enactment and enforcement of accountability are implemented technically on the blockchain infrastructure instead of institutionally. This can be done through smart contracts, though dispute resolution may necessitate institutional intervention. Anonymity on the blockchain, which could lead to such issues as sock puppet voting, may injure accountability, and so technical identity verification or perhaps a reputation score can be useful. Finally, incentive alignment ensures the survival of the network, which should be the common goal of the participating nodes. There should be incentives for users, token holders, and system developers.

It is simplistic to consider a blockchain infrastructure as a single technology, when it is in fact comprised of multiple layers. The community and governance structure and mechanisms for each layer differ (De Filippi & Mcmullen, 2018). Rikken et al. (2019) discuss blockchain governance framework based on four layers (blockchain/infrastructure, application, company/individual, and institutional) and three stages (design, operate, and evolve/crisis). The infrastructure layer is embedded in the blockchain infrastructure that holds both protocol and data. Governance of blockchain in this layer is on- and off-chain. At the application layer, there should be certain mechanisms for blockchain applications (peer-to-peer transaction, smart contracts, and DAO). At the company level, the roles and responsibilities of individuals working on the blockchain should be clear. Finally, the institutional layer relates to the regulations and standards surrounding blockchain. The design stage is the initial development of the blockchain infrastructure, and decisions are made by one or more individuals. The developed protocols are then automatically executed by the nodes during the operate stage through the consensus mechanism. Necessary updates or issues may cause the blockchain to enter an evolve/crisis stage. Stakeholders may agree to implement changes; the absence of a consensus may result in a hard fork.

Laatikainen et al. (2021) develop a dynamic model of blockchain governance encompassing technical (on-chain protocols) and social (off-chain rules) means to govern the decisions surrounding the blockchain system at the individual, community, organizational, interorganizational, national, and international levels. Decision making in the blockchain system comprises four main aspects: (i) actor and their roles, rights, rules, responsibilities, and incentives; (ii) technological (architecture, implementation, software development, and coordination systems); (iii) business (value context, creation, and capture); and (iv) legal and regulatory. The decisions are made across three stages of formation/design, operation, and evolve/crisis of the blockchain infrastructure.

Pelt et al. (2020) have proposed a framework to understand blockchain governance that is also useful for the design of a blockchain governance framework. The framework "captures the dimensions and layers of blockchain governance in order to guide businesses, regulators, users, and other relevant stakeholders to analyze the governance of blockchains in a structured way" (p. 2). The framework comprises six dimensions and three layers. These dimensions are (i) formation and context, which concern the purpose, formative ideology, license, and foundational design of a blockchain; (ii) roles, which identifies the roles, responsibilities, and accountabilities of the blockchain stakeholders (users, developers, miners) on each layer of governance; (iii) incentives, which capture the motivational factors of the identified roles across the three layers; (iv) membership, which focuses on how membership and participation of the blockchain are managed; (v) communication, which captures the formal and informal means of communication between stakeholders; and (vi) decision making, which captures the execution, monitoring, mechanisms, and processes of decision making. The three layers are (i) on-chain protocol, which is all governance rules coded directly into the blockchain (e.g., voting mechanisms); (ii) off-chain development, which concerns all governance matters related to the development of the blockchain and its associated applications off-chain; and (iii) off-chain community, which is the broader community of the blockchain.

These frameworks are designed for public blockchains, not private networks. This is because private blockchains can be treated like other IT solutions. The participating nodes are known and typically belong to the same entity and share a common goal. Consequently, the degree of decentralization is limited. The value of blockchain is thus not immutability (as it is possible for the nodes to collude to correct past error, for instance), but rather the traceability, transparency, and distribution of records.

Waqf Governance in Malaysia

Waqf institutions in Malaysia are units, departments, or subsidiaries under SIRCs. There are altogether 14

SIRCs across 13 states and three federal territories. SIRCs are under the rule of the Sultan of each state, who holds supreme authority over Islamic affairs. Managers act on behalf of the Sultan to perform day-to-day operations of the SIRCs. The Federal Constitution specifies that SIRCs are the sole mutawallī (trustee) and accountable entity of waqf assets. Even so, the SIRCs, without surrendering their supervisory role, may allow a specific party to be the mutawallī of a waqf project or asset. The Federal government has established JAWHAR under the Prime Minister's Department to coordinate between SIRCs and promote more effective management, delivery, and outcome of services (Aziz & Ali, 2018). However, JAWHAR itself does not manage any waqf assets (Malaysian Accounting Standards Board, 2014).

The Federal Constitution specifies the rights, roles, and responsibilities of SIRCs, but how these are implemented and executed may differ between SIRCs. The federal system allows states to develop their own legislation and management practices of waqf. This results in the different forms of governance, in terms of structure and mechanisms, in each state. For example, some SIRCs have fully embraced the corporatization model of waqf, where they establish subsidiaries for waqf administration. In this case, their governance mirrors the conventional corporate governance model, but perhaps with an "Islamic" flavor (Iqbal & Mirakhor, 2004). To illustrate, the Selangor Islamic Religious Council (MAIS) establishes Perbadanan Wakaf Selangor (Selangor Waqf Board), a subsidiary that specializes in the administration of waqf assets. This structure implies three layers of reporting and decision-making: first, the top manager (chief executive officer) of the subsidiary reports to the board of directors; second, the board of directors reports to the SIRC; and third, the SIRC (more precisely, the board/council[1]) reports to the Sultan. In a non- or partially corporatized waqf institution, for example the Council of Islam and Malay Customs of Terengganu (MAIDAM), there are only two layers of reporting and decision-making: first from the top manager to the board, and second from the board to the Sultan. In this structure, the top manager is typically the secretary of the board. Decisions made by the SIRCs are discussed by the board, who then forward them to the Sultan for endorsement or approval (Mahadi, Sariman, Noordin, Mail, & Fatah, 2018). Another model of reporting and decision making emerges when SIRCs permit a third party to be a mutawallī. Waqf An-Nur Corporation Berhad (WANCorp) receives a mutawallī license from the Johor Islamic Religious Council (MAIJ). WANCorp is required to make regular reports to MAIJ and to include a MAIJ representative in its board of directors.

The current governance models of waqf institutions are still fraught with flaws. The accountability of waqf institutions is under scrutiny because of the lack of transparency: financial information disclosure of the waqf assets is inadequate; some SIRCs lag in their reporting; financial reporting is not mandatory; and the quality of reporting varies between SIRCs due to the absence of standardization (Daud, 2019; Kamaruddin, Hanefah, & Masruki, 2022; Masruki, Hussainey, & Aly, 2018). An SIRC did not include any waqf assets in its financial reports, while several SIRCs did not recognize waqf property (Malaysian Accounting Standards Board, 2014). It appears that the main concern of managers of SIRCs is to discharge accountability to superordinates before the Muslim public (Masruki, Hussainey, & Aly, 2022), which may explain the opacity of waqf administration. These flaws can perhaps be amended by a blockchain network, which permits (authorized) stakeholders to access waqf records at any time.

[1] Also referred to as "Meeting Members" (*Ahli Mesyuarat*). Its members are typically state officials, judges of the Shariah court, academicians, muftis, or other religious figures (Mahadi et al., 2018).

Blockchain Governance Framework for Waqf Institutions

In this section, we propose a governance of blockchain model for waqf institutions based on the blockchain governance frameworks of Pelt et al. (2020) and Laatikainen et al. (2021) and lifecycle stages proposed by Rikken et al. (2019). Pelt et al.'s (2020) framework is originally aimed to understand the governance of blockchain infrastructures. Nonetheless, the dimensions, layers, and questions attached to them (Pelt et al., 2020, p. 11) are useful for determining the best blockchain governance framework design. Laatikainen et al.'s (2021) framework is more concerned with who holds the right to make decisions and the areas of decision making. These frameworks are synthesized in Table 2.

The proposed frameworks encompass Weill and Ross's (2004) IT governance dimensions of decision rights, accountability, and incentive alignment. Decision management rights are defined by identifying the actors and their roles and responsibilities. The locus of decision rights is expected to be centralized, seeing that the Sultan holds the supreme authority. Accountability is defined by identifying the bearers of decision control rights. Moreover, the delineation of responsibilities clarifies the accountable persons. Incentive alignment works by ensuring that the stakeholders receive pecuniary and or non-pecuniary benefits from the oversight, development, and use of the system.

Two points should be noted. First, the two frameworks were developed with the governance of public permissionless blockchain in mind, and so some aspects have been modified to account for the (likely) closed blockchain system of a waqf institution. For example, the design of the blockchain should account for data protection laws. In a public blockchain, this is unnecessary as the actors are typically anonymous. Second, the proposed framework can be applied by for-profit, non-profit, and charity organizations, with the assumption that they employ a closed blockchain infrastructure. Nonetheless, some modifications may be necessary to complement the vision, structure, and goal of each organization.

Following Pelt et al. (2020), we recognize three broad roles distributed across three layers. Off-chain community refers to the broader stakeholders and decision makers; off-chain development to only those responsible for development, software updates, and other similar roles; and on-chain protocol to participants of the network. In conventional governance, the first layer shall refer to top management (e.g., chief information officer (CIO)), the second layer to project or team leaders, and the third layer to public participants. Because we expect the blockchain to be private permissioned, we do not expect network participants to play much role in decision making, hence the absence of any on-chain protocol for that dimension.

The first step in designing a blockchain governance framework is determining its purpose and value context. If the blockchain solution merely aims to preserve and track transaction records, then a closed model is appropriate. If the records on the blockchain are intended for unrestricted public use, then perhaps a public permissioned model is a suitable choice. For a waqf institution, the purpose of a blockchain would be the transparent records to discharge accountability to endowers (wāqif) and the Muslim public. This is both the purpose and value context of the blockchain. To achieve that purpose, and to protect sensitive data, access to read those records should be given to users that fulfil certain criteria. Therefore, the private permissioned network is the preferred model. The nodes are known and verified servers or computers of different departments within the waqf organization and of its partners.

Since the initial development, the actors and their roles and responsibilities should be identified and outlined. Similarly, the holders of decision control rights and decision management rights should be determined. Ideally, these two responsibilities are held by different actors. The actors are organized in a structural hierarchy. Typically, the CIO will have the final decision, but some autonomy may be given to the development team in flexible choices. Nonetheless, the degree of decision-making centralization should depend on the IT decision-making structure chosen by the waqf institution. Network participants have read access rights, but not write or commit rights. There is typically no hierarchy among participants.

Table 2

Framework for the Governance of Blockchain of a Waqf Institution

<table>
<tr><td></td><td colspan="2">Dimension</td><td colspan="3">Layers</td></tr>
<tr><td></td><td>Label</td><td>Definition</td><td>Off-chain community</td><td>Off-chain development</td><td>On-chain protocol</td></tr>
<tr><td rowspan="4">Cycle of formation/design → operation → evolve/crisis</td><td>Formation and context</td><td>The purpose, ideology, and use case underlying the development of the blockchain infrastructure.</td><td colspan="3">• Defining the purpose of the chain
• Defining the basic design, model, and governance protocols
• Defining the value context (purpose, strategy, mission, business requirements of the blockchain infrastructure)
• Defining the main actors during initial development (supervisors, developers, users)</td></tr>
<tr><td>Actors</td><td>Entities involved in the decision-making process of the blockchain throughout its entire lifecycle.</td><td></td><td></td><td></td></tr>
<tr><td>Actors and their roles</td><td>Stakeholders and agents that can affect or be affected by the blockchain system.</td><td>• Defining internal and external system roles (e.g., investors, leaders, regulators, standard setters, observers, etc.)
• Defining the roles of system actors
• Defining the structural hierarchy among these roles</td><td>• Defining infrastructure development roles (e.g., validators, users, nodes, developers, etc.)
• Defining the roles of infrastructure development actors
• Defining the structural hierarchy among these roles</td><td>• Defining the participants of the chain (e.g., funders, endowers, public users)
• Defining the roles of participants
• Defining the structural hierarchy among these roles</td></tr>
<tr><td>Rights, rules, and responsibilities</td><td>The rights and responsibilities of the actors in their various forms, as well as the rules established in the system, e.g., access rights/rules, decision rights/rules, development rights/rules, and voting and validation rights/rules. Rights, rules, and responsibilities may either be endogenous (those set by the community/internal stakeholders for self-governance) or exogenous (those set by external authorities, e.g., standard setters and legal authority). This dimension also defines the accountable persons for a given responsibility.</td><td>• Defining the rights, rules, and responsibilities of system actors, e.g., rules for membership/entry, access to data, decision making and voting on the general policy of the blockchain, etc.
• Defining actors with decision management rights and decision control rights to ensure accountability</td><td>• Defining the rights, rules, and responsibilities of infrastructure development actors, e.g., rules for software developers, quality assurance, etc.
• Defining actors with decision management rights and decision control rights to ensure accountability</td><td>Defining the rights, rules, and responsibilities of participants of the chain, e.g., what data are accessible, whether they can provide input, etc.</td></tr>
</table>

Table 2 to be continued

	Incentives	Pecuniary and non-pecuniary rewards given to actors as motivation.	Determining the incentives for system roles and their sources	• Determining the incentives for infrastructure development roles and their sources • Determining whether developers are hired in-house or outsourced	Determining the incentives for network participants
	Membership and participation*	Management of membership and conditions for the participation of actors in the blockchain. In other words, whether a blockchain is public or private, and permissioned or permissionless.	• Determining the actors who can take on system roles • Determining whether there are process or rules for the membership of system roles	• Determining the actors who can take on infrastructure development roles • Determining whether there are process or rules for the membership of infrastructure development roles • Training and instruction on blockchain development and underlying philosophy of the system • Determining the division of tasks	• Determining who can participate in the network • Determining the requirements and processes for new network participants
	Means of governance/ decision making	Actions, methods, and processes that enable decision making.			
	Technical (on-chain)	Methods and processes embedded in the system ("on-chain governance") that enable governance decisions, e.g., smart contracts and blockchain network protocols.	• Determining the processes on how system decisions are made and implemented • Determining which governance mechanisms should be automatized on the blockchain • Determining how disputes are resolved • Ensuring that the system complies with exogenous rules	• Determining the processes of making infrastructure development decisions • Determining how both system and infrastructure development decisions are executed and implemented on the blockchain • Determining how certain governance mechanisms are automatized • Determining how the system resolves disputes • Ensuring the compliance of the system with exogenous rules	• Determining the consensus mechanism (if applicable) • Determining the technical protocols embedded on the network
	Social (off-chain)	Methods and processes managed and implemented outside of the system ("off-chain governance") that enable governance decisions, e.g., collaboration, meeting, and agreements.	• Determining how system decisions are made off-chain • Communication between system actors, especially internal ones. • Communicating with external authorities and ensuring that their rules are implemented	• Determining how infrastructure development decisions are made off-chain • Communication between infrastructure development actors • Determining how system and infrastructure development decisions are executed and implemented on the blockchain • Determining how the blockchain complies with exogenous rules	• Determining how network participants communicate with each other • Determining how network participants communicate with and provide feedback to actors in the other layers

Table 2 to be continued

	Communication*	Formal and informal means of communication among actors, with or without communication tools or other media.	• Determining the coordination and communication system and or tools among system actors	• Determining the coordination and communication system and or tools among infrastructure development actors	• Determining the coordination and communication system and or tools among network participants
	Aspects**	Three main areas of decision making: business, legal and regulatory, and technology.			
	Business	Decisions concerning business, encompassing value context, creation, and capture	• Identifying the value context of the blockchain—the mission, strategy, and goal of the infrastructure • Determining value creation: core activities of the blockchain and to split funding between actors to incentivize them • Determining value capture: how to capitalize on the created value and generate revenue streams from it	-	-
	Legal and regulatory	Decisions concerning compliance with regulatory requirements and standards	• Determining which rules, laws, and standards to follow, whether those that concern blockchain specifically or the information managed by the blockchain, e.g., data protection acts • Determining how to comply with these rules • Creating legal agreements for actors and network participants	-	-
	Technological	Decisions concerning the architecture and implementation, software monitoring, and coordination systems		• Deciding the architecture, implementation, and data of the blockchain system, e.g., voting mechanisms, enforcement, on-chain governance mechanisms, and other technical choices • Deciding how the software is developed, updated, tested, debugged, and monitored • Deciding how development is coordinated among actors	-

Notes. * These dimensions are an important aspect of an open network, but not as much in a closed blockchain, simply because members of the latter are known and verified. Access rights for internal and external stakeholders shall depend on the criteria set by the organization. Communication can also be determined by company policy. ** These decisions can be made by the off-chain community (i.e., top management) alone—as in the case of a business or IT monarchy—or in collaboration with development and business team leaders—as in the cases of a federal system, IT duopoly, or feudal system. For simplification purposes, business and legal decisions are restricted to the off-chain community layer, while technological decisions to the off-chain development layer. In reality, these decisions may be made across the layers and at the individual, organizational, national, or international level, depending on the context.
Sources: Pelt et al. (2020) and Laatikainen et al. (2021), with modifications.

In a private permissioned blockchain, the actors are given pecuniary (e.g., salary) and non-pecuniary (e.g., paid vacation) incentives for their services. Because incentives are tied to the roles, the appointment of actors should be made carefully. Attention should be given to the experience and capability of the actors. For network participants, the incentive is non-pecuniary in the form of read rights. At the same time, accessing rights should be a privilege, in the sense that only participants who have fulfilled certain criteria can earn those rights. At the very least, the users shall provide their identification. This can mitigate any unwanted events initiated by anonymous participants.

Governance is implemented via technical and social means. On-chain governance protocols coded into the blockchain are determined by system actors with input from developers. It is important that these protocols comply with rules and standards concerning blockchain, waqf administration, data management, privacy, and other pertinent aspects. For example, laws governing waqf should be accounted for. These protocols are then implemented into the system by the development team. Off-chain governance also aids the development of on-chain protocols and software. Informal meetings together with a formal decision process between actors can facilitate better software design, update, maintenance, and monitoring, though perfect consensus may be unrealistic (van Deventer et al., 2018).

The decisions revolve around three main areas. Business decisions concern the identification of value and positioning the blockchain to capture this value. In a waqf institution, blockchain is likely used to discharge accountability and enhance transparency. Therefore, value capture comes in a non-pecuniary form: rather than generating revenue, it is a cost center. This is similar to other IT solutions. It is possible to generate some revenue if access rights are subscription-based or require a one-time payment. Charging access fees may also inhibit negative user behavior (Bchir & Willinger, 2013). But the public may perceive this fee negatively.

Legal and regulatory decisions surround the acts, rules, and standards that the blockchain must adhere to. It is important to identify these during the design and operation stages. This aspect also concerns the choice of jurisdiction for incorporation, though this is irrelevant for waqf institutions, as they are under state jurisdiction. Legal agreements, non-disclosure agreements, and contracts should be created and signed by the actors and network participants. These agreements typically specify the roles and responsibilities of the actors, as well as the legal consequences for breaching the terms of contract. For network participants, they include end-user license agreement (EULA) and information on how their data are used, stored, and managed by the system.

Finally, technological decisions refer to the technical choices regarding the blockchain: which model to use; what mechanism to employ; whether to construct a new infrastructure or use a hard fork of a permissionless public blockchain; how software updates and debugging are implemented; and what coordinating tool to use. All three areas of decision making are enabled by technical and social means of governance. In fact, it is appropriate to say that all aspects of the blockchain are governed by the two means. On-chain and off-chain governance regulate the processes on the blockchain, including membership, responsibilities, and accountability of actors, and other decisions.

These dimensions are continuously made throughout the lifecycle of the blockchain. Certain decisions are made during the design stage and executed during the operation stage. In the event of an emergent issue, feedback, or necessary improvement, the blockchain may enter a crisis or evolve stage. If the issues cannot be resolved, the blockchain may become non-operational. This could happen, for example, because the waqf institution does not have the financial resources and or expertise to maintain the system. In contrast, if the issue is resolved, the system "evolves", essentially improving—whether in terms of design, usability, or functionality—through software updates. In a waqf institution, decisions on the governance of blockchain remain centralized throughout its lifecycle stages, though with some degree of autonomy for development leaders and their teams.

Illustration of the Blockchain Governance Framework: Finterra's Waqf Chain

In this section, the proposed framework is applied to a blockchain-based waqf institution, Finterra, and its WAQF Chain. The process of waqf administration, from proposal to termination, is executed on a blockchain infrastructure, and so the firm implements both governance of and by blockchain. Data for this case study were collected from the company's website (finterra.org and mywaqf.com), documents (e.g., White Paper), blog, video presentations, and interviews, in addition to secondary sources such as scholarly and news articles. They were then categorized according to the dimensions of the framework.

Formation and Context

Finterra is a financial technology firm established in 2017 with offices in Asia, the Middle East, Europe, and the United States. The firm specializes in employing advanced IT solutions for project development, fund raising, and investment structuring. It is an ISO270001 and ISO20000 certified company, and it has received a Shariah compliance certificate from a Shariah advisory organization. It currently has 700 thousand digital wallet subscribers (Finterra, 2022).

Finterra has developed a proprietary blockchain solution named Gallactic Blockchain. The architecture has been developed to support open-source development with a full ecosystem. It can also interact with other blockchains such as Ethereum. The WAQF Chain is built on top of the Gallactic Blockchain. The core objective of the WAQF Chain is to unlock the potential of waqf assets in a secure, transparent, and efficient environment (Finterra, 2018). In 2019, pilot projects for the Waqf Chain have been successfully launched in Malaysia, Turkey, Oman, Tanzania, Kenya, and South Africa (Islamic Finance News, 2020).

The waqf administration process on the WAQF Chain can be summarized as follows (Ahmad, 2018; Finterra, 2018, November 7, 2019; Rich Management, 2018). First, the waqf board identifies a viable waqf project or asset and applies to the relevant SIRC to license it as a mutawallī. The board then drafts a prospectus that details the administrator, endowment period, asset, expected benefits, and other information related to the waqf project. Other entities, for example a registered non-government organization (NGO), university, or financial institution, may also propose a waqf campaign on the blockchain. Second, an independent external auditor reviews the prospectus, and revisions are made based on the auditor's recommendation. Third, following auditor approval, the waqf board and auditor shall jointly appoint a fund manager, who then produces and publishes a project portfolio to the WAQF Chain. Fourth, pre-qualified contributors may choose either one of four investment vehicles (cash waqf, muḍārabah investment, qarḍ ḥasan, or sukuk) when contributing to the project. The donations are directly deposited to a trust account with the firm's partnering banks. At the end of the fundraising deadline, the funds will be released to the fund manager only if the soft target is reached. Otherwise, they are returned to the contributors. Fifth, upon meeting the soft target and fulfilment of due diligence, the smart contracts for each project are triggered automatically. The smart contracts will create project-specific ERC777 tokens (FIN) to represent their indivisible stake in the project. If the contributions are in the form of loan, investment, or sukuk, the tokens represent their credit or returns according to their share in the project. Sixth, the fund manager appoints a contractor to construct or develop the waqf asset. Once completed, the asset will be transferred to an asset manager. Seventh, the waqf project is completed. Contributors can continuously track the development of the project on the WAQF Chain. The project owners are required to submit periodic reports or risk being blacklisted. Contributors can comment, make inquiries, or provide feedback in the comment section of the project. They can also rate the project on a scale of one to five. This entire process is summarized in Figure 1. The blockchain governance framework of the WAQF Chain is summarized in Appendix 1.

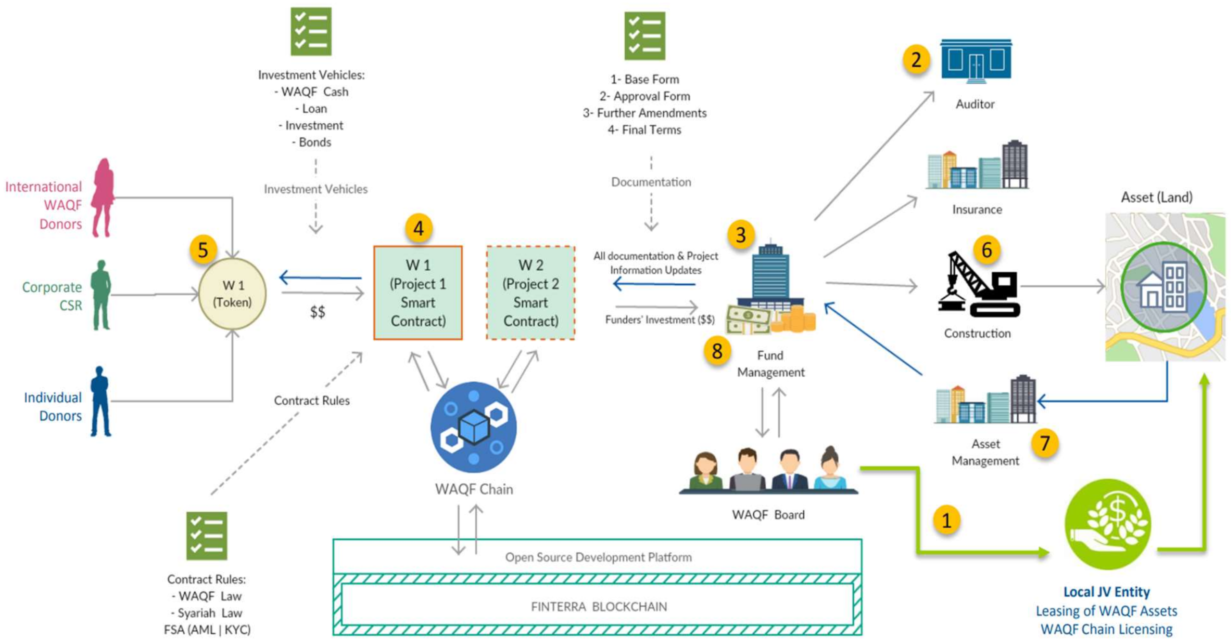

Figure 1. The Finterra WAQF Chain.
Source: Ahmad (2018).

Conclusion

In this paper, we have proposed a governance of blockchain framework for waqf institutions in Malaysia based on the IT governance dimensions and blockchain governance dimensions proposed in the literature. The framework comprises three dimensions, eight sub-dimensions, three layers, and three stages. This framework has been designed in a generic manner so as to allow its adoption by various types of organizations, not necessarily waqf institutions.

The contributions of this study are threefold. First, we designed a governance of blockchain framework for waqf institutions. Second, the framework is intended for closed networks, whereas frameworks proposed in the extant literature mostly target open networks and cryptocurrencies. Third, we have demonstrated the usefulness of the framework by applying it on the infrastructure of a blockchain-based waqf organization. Fourth, this study is a response to calls for research on governance of blockchain (van de Pol et al., 2018), how the governance framework may be applied to a closed blockchain (Pelt et al., 2020) and how it is implemented in a waqf institution (Abojeib & Habib, 2019).

Future works can improve this framework by collecting the inputs of waqf and blockchain experts. The framework should also be evaluated by blockchain experts. By involving IT managers or experts affiliated with waqf institutions, it is possible to come up with a more robust governance framework. Additionally, it allows the design of a feasible framework that can be easily implemented by waqf institutions, which typically have little expertise and experience in IT solutions. Researchers can perhaps work closely with SIRCs as waqf administrators and IT experts to build a blockchain infrastructure from the ground up. This endeavor allows the development of a governance of blockchain framework that satisfies the laws, rules, and standards related to waqf administration and financial technology in Malaysia.

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Appendix

Table 1. Summary of governance of blockchain in Finterra's WAQF Chain.

Dimension		Layers		
Label		Off-chain community	Off-chain development	On-chain protocol
Formation and context		The purpose and value context of the WAQF Chain is to provide a secure, transparent, and efficient environment, where stakeholders can see and review all vital documentations of waqf projects. It is a private permissioned model. The main actors include the waqf board, fund manager, asset manager, external auditor, insurer, contractor, and contributor.		
Actors	Actors and their roles	• Internal system actors include advisors, c-level executives (founder and co-founder, chairman, directors), head of units, senior managers, senior business analysts, and community manager. • External system actors include the central bank, financial services authority, banks, Islamic finance organizations, universities, cyber security organizations, and state waqf boards. • Advisors provide oversight of the operations, managers handle day-to-day operations, and external actors either act as partners or monitors. The hierarchy is similar to a typical organizational structure.	• Infrastructure development actors include senior project managers, senior blockchain developers, software development managers, blockchain and smart contract developers, and their respective teams. • Each team has its own roles, such as blockchain, software, or smart contract development. • The hierarchy is similar to a typical organizational structure.	• Participants are pre-qualified contributors. • They can provide contributions, comment on, and rate available waqf projects. • There is no structural hierarchy among participants.
Actors	Rights, rules, and responsibilities	• System actors are responsible for setting rules for the blockchain, waqf projects, project owners, and contributors. For example, the project owners must submit periodical progress report, or else they risk being blacklisted. • Decision management rights are held by the management team. It is unclear who holds decision control rights. Accountability is partly ensured through the external auditors, insurers, and regulators, but internal monitors are not clearly identified.	• Infrastructure development actors are responsible for the development of the blockchain and its software and applications. • Decision management rights are held by the development team. It is unclear who holds decision control rights.	• Participants can see and review all real-world documentations of the waqf projects. They can also provide feedback to the projects.
Actors	Incentives	• Pecuniary incentives sourced from firm revenue. • Non-pecuniary incentives in the form of benefits and access.	• Pecuniary incentives sourced from firm revenue. • Non-pecuniary incentives in the form of benefits and access.	• Pecuniary incentives from project returns (if the contract is based on investment or sukuk). • Non-pecuniary incentives in the form of access rights.
Actors	Membership and participation*	• Qualified managers hired by the top managers. • Advisors renowned for their expertise in waqf and blockchain. • Reliable financial partners. • State waqf boards.	• Qualified personnel hired by the top managers.	• Pre-qualified contributors who have complied with KYC and anti-money laundering (AML) principles. • Their ability to contribute is determined by an assigned credit score.

Table 1. to be continued

Means of governance/decision making	Technical (on-chain)	• Automatization and smart contract enforcement are determined based on applicable rules, standards, and business model of the WAQF Chain.	• Decisions of smart actors, with inputs from the development team, are implemented on the WAQF Chain.	• Tampering of contributions, stakeholder voting, and special terms is not possible as they are enforced by blockchain consensus through smart contracts. • Smart contracts are used to enforce contribution, special terms, the distribution of tokens, delivery of funds to project owners, stakeholder voting, and distribution of proceeds (if any).
	Social (off-chain)	• KYC and AML principles are implemented to ensure the goodwill of contributors. • Feasibility of waqf projects is evaluated by an independent external auditor. • Insurers hedge against such risks as fund manager insolvency. • Advisors and management maintain close communication with regulators, standard setters, and state waqf board.	• Development team communicate via formal and informal means.	• Contributors provide feedback to project owners in the comment section and rate the project.
	Communication*	• Formal and informal means.	• Formal and informal means.	• Comment section and other informal means.
Aspects**	Business	• Secure, transparent, and efficient environment, where stakeholders can see and review all vital documentations of waqf projects.	-	-
	Legal and regulatory	• Adherence to rules regarding waqf, data protection, and other relevant standards.	-	-
	Technological		• Smart contract is developed based on the ERC-777 standard. • Tokens are created and distributed using smart contracts to represent stake in each project. • WAQF Chain is constructed on the Gallactic infrastructure and can interact with networks within and without the infrastructure.	-

Notes. * These dimensions are an important aspect of an open network, but not as much in a closed blockchain, simply because members of the latter are known and verified. Access rights for internal and external stakeholders shall depend on the criteria set by the organization. Communication can also be determined by company policy. ** These decisions can be made by the off-chain community (i.e., top management) alone—as in the case of a business or IT monarchy—or in collaboration with development and business team leaders—as in the cases of a federal system, IT duopoly, or feudal system. For simplification purposes, business and legal decisions are restricted to the off-chain community layer, while technological decisions to the off-chain development layer. In reality, these decisions may be made across the layers and at the individual, organizational, national, or international level, depending on the context.

Sources: Pelt et al. (2020) and Laatikainen et al. (2021), with modifications.