Review of Blockchain Technology in Managing Waqf (Endowment)

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ABSTRACT

Waqf in Islam has historically been a vital institution in fulfilling religious needs and social welfare. Its effectiveness in medieval and modern Islam is evident. Yet, this institution is seemingly not without inefficiencies. Agency problem and idle, even dilapidated assets are commonplace, besides inancial constraints and poor human resources are also cited as key impediments. Thus, public trust and contribution are becoming low due to the opacity of the accounting and accountability system. As such, scholars propose the adoption of blockchain technology to mitigate these issues. This paper aims to review the waqf and its types, as well as blockchain technology and its models. The review makes clear that implementation of blockchain technology in managing waqf endowment is pertinent by using a smart contract. The article raises important issues in addition to its caveats pertaining to waqf based on blockchain, which offers solutions in the current problems for its effective implementation for waqf management. This study contributes to the field of waqf endowment as it highlights the use of blockchain technology in managing waqf, which could be useful for Mutawalli (trustee) of waqf towards the sustainability of Islamic social finance.

Keywords: blockchain technology, waqf management, Islamic social finance.

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ABSTRACT

Waqf in Islam has historically been a vital institution in fulfilling religious needs and social welfare. Its effectiveness in medieval and modern Islam is evident. Yet, this institution is seemingly not without inefficiencies. Agency problem and idle, even dilapidated assets are commonplace, besides inancial constraints and poor human resources are also cited as key impediments. Thus, public trust and contribution are becoming low due to the opacity of the accounting and accountability system. As such, scholars propose the adoption of blockchain technology to mitigate these issues. This paper aims to review the waqf and its types, as well as blockchain technology and its models. The review makes clear that implementation of blockchain technology in managing waqf endowment is pertinent by using a smart contract. The article raises important issues in addition to its caveats pertaining to waqf based on blockchain, which offers solutions in the current problems for its effective implementation for waqf management. This study contributes to the field of waqf endowment as it highlights the use of blockchain technology in managing waqf, which could be useful for Mutawalli (trustee) of waqf towards the sustainability of Islamic social finance.

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I. INTRODUCTION

Together with zakat and donations, waqf is regarded as the main instrument of charity in Islam. Its practice dates to the early years of Islam—though some claim that its concept has been somewhat practiced by the Hellenes, Romans, and Byzantines, among others (Çizakça,

2000; Singer, 2008). Waqf is a popular solution for poverty alleviation (Sadeq, 2002; Yahya, 2008) and micro financing (Abdullah & Ismail, 2017; Shaikh, Ismail, & Mohd Shafiai, 2017), and less notably as a conservation mechanism (Khalfan & Ogura, 2012; Yaakob et al., 2017), in past and modern-day Islam. Certainly, this trend has become even more manifest since the renaissance of the Islamic spirit post-colonialism, as indicated by the prodigious volume of research on the subject.

Of course, this institution is not without critics. It was reported that the database of Islamic Religious Council on Waqf assets are not sufficient, which detail and important information are not available. This affects the process of developing *waqf* lands. Lack of professional and technical expertise in developing Waqf asset, there are also lack of professional resources and expertise in the aspect planning and developing of *waqf* land thus causing many inefficiencies in their management.

Kuran's contention illustrates the two fundamental threats to proper governance: expropriation by controlling shareholders or managers (waqf: *mutawallī*), or by the state (Lamoureaux, 2009). However, Kuran's concern about the agency problem should not be conflated with Islamic law—by no means does the dishonesty of an administrator is an indication of its shortcoming. Rather, this issue must be dealt by both jurists and state alike by designing control mechanisms and laws that deter managers from favoring their own interests.

In 1826, Ottoman Turkey established *Evkaf-ı Humayun Nezareti* to centralize waqf administration and introduce accountability and accounting principles, while Egypt instituted *Diwān al-Awqāf* to centralize the control and

accounting of waqf entities. Both served as check-and-balance mechanisms to deter waqf administrators from unethical practices. Yet, at the same time, these policies were inspired by political and economic motivations, as waqf assets were flourished with revenues (Melčák, 2010; Yayla, 2011). An illustrative example was the attempts by soviet colonialists in Turkestan to reform waqf and transfer its administration, and accordingly revenues, to the state. One such bid was the enactment of a Central Waqf Administration (GVU) to contest the jurisdiction of the the Sharīʿah court, resulting in a turf war between both (Pianciola & Sartori, 2007). Regardless, state intervention has continued to the present day in the form of Ministries or Departments of *Awqāf* in Islamic nations, including Turkey, Egypt, Palestine, Kuwait, Malaysia, Brunei, and Indonesia, and in a few non-Muslim-majority countries like Singapore. It is important to note that the state should not be so powerful so as to expropriate the rights of waqf properties. The cases of *Maghrib* and *Mashriq* at once illustrate the imperativeness of check-and-balances in waqf governance between private administrators and state supervision to allow better upholding of the waqf terms.

Moving to the allegations of Landes et al. (2012), limited allocational flexibility is not a familiar feature of most waqf institutions. Only certain subsets, like *al-waqf al-khāṣṣ* (specific waqf) and *al-waqf al-ahlī* (family waqf), possess this peculiarity. In most cases, waqfs are targeted for social or religious purposes, often with a socioeconomic slant, for instance the poor and needy. Other times, such qualifications would be absent, and so the waqf object becomes a public good. Mosques, public fountains, water supplies, hospitals are commonly endowed without specific beneficiaries (Layish, 2008). Entire villages or cities were likewise made mortmain, such as the case of Sarajevo, whose facilities—mosque, *madrasah*, library, *ḥammām* (public bath)—are the waqfs of Isa-beg Ishaković and Gazi Huzrev Beg (al-Arnāʾūṭ, 2005; Smolo, 2019).

Even for family waqfs, the usufruct will be redeemed to the public—or poor relatives of the founder, if extant—once the named beneficiaries

are extinct (Abbasi, 2012; Ibn Qudāmah, 1992). This form of waqf, incidentally, constitutes only but a small part of waqfs. In fifteenth- and sixteenth-century Edirne, charitable waqf made up 80 percent of the endowments of the rich, lending the conclusion that family waqf was used only minorly for safeguarding purposes; in eighteenth-century Aleppo, it was only 40 percent of total waqf, the remainder of which was either charitable or mixed (Gerber, 1983, and Öztürk, 1995, in Çizakça, 2000). Moreover, any circumvention of the inheritance law was blocked by legal reforms. The codification of the Egyptian Waqf Law 1946 and Lebanese Waqf Law 1947, as well as the judicial verdict of equating waqf to bequest, limiting it to only one-third of total inheritance, were some attempts to close the loophole (Layish, 1997). Of course, there are recorded instances where the sons were named as beneficiaries of the family waqf, while the daughters were excluded. But such practices were absent during the times of the Prophet and his Companions. Jurists therefore decree that family waqf should be apportioned equally among the founder's children or in harmony to inheritance fractions (Abbasi, 2012).[1]

History therefore chronicles the organically changing administration of waqf and its institutions. This is of course an established case, considering that the interpretation of Islamic law itself is a subject of continual change and reform (Brown, 2014). Legal maxims such as *lā yunkar taghayyur al-aḥkām bi taghayyur al-azmān* and *al-aṣl fī al-muʿāmalah al-ibāḥah* also illustrate the necessity to revise and adapt to the social, technological, political, or similar customs prevailing in a society, so long as they remain within the boundaries of Sharīʿah. The first maxim declares that the rule of law may adjust to the change of time, place, condition, etc., whereas the second maintains that transactions in Islam

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[1] It should be mentioned here that Islamic inheritance law is compulsory only in the absence of agreement between the heirs. If they instead decide to apportion the inheritance according to mutually agreed terms, *takharruj*, then the inheritance law can be neglected in favor of this arrangement (al-Ḥaṣrī, 1992; al-Ṣabūnī, 1995). However, this argument does not apply to waqf because the apportionment was made by the founder before his death.

are fundamentally permissible in the absence of a proof (*dalīl*) that denies their legitimacy.

Nevertheless, the arguments of the above critics cannot be rejected outright; doing so would only injure the long-term effectiveness and sustainability of waqf institutions. Certainly, there are evidences for unproductive, mismanaged, misappropriated, expropriated, or neglected waqf properties. The reasons for these are various— conflicts, colonialism, poor legal protection, financial constraints, individual or state expropriation, or unqualified *mutawallī* (Abd Mutalib & Maamor, 2016; Gamon & Tagoranao, 2018; Ismail, Salim, & Hanafiah, 2015; Khalfan & Ogura, 2012; Moh'd, Mohammad, & Saiti, 2017; Mohamad, 2018; Musaee, Muhammad Abbas, Kamal Mujan, & Sidik, 2014; Noordin, Haron, & Kassim, 2017; Shatzmiller, 2001; Sulaiman & Zakari, 2019; Zilli, 2018).

To this point, modern scholars, waqf administrators, social and for-profit entrepreneurs, and other such stakeholders have continuously looked for new ways to further enhance the effectiveness of waqf assets. Traditional administration cannot be expected to remain efficient in this technologically advanced era. Furthermore, the ever-intensifying scrutiny of the public eye and wealth of information on traditional and new media increase the pressure on *mutawallī* to properly discharge their accountability and report the impact of the waqf assets. Otherwise, public trust on waqf institutions will be low, which in turn leads to low contribution and loss of effectiveness (Abd Jalil, Yahya, & Pitchay, 2019; Abdul Shukor et al., 2019; M. Ahmad, 2019; Alias, 2014).

Accountability, transparency, and socioeconomic and socioreligious impacts are thus important subjects for waqf. These have lent to the proliferation of research and recommendations on waqf accountability principles (Masruki & Shafii, 2013; Nahar & Yaacob, 2011; Siswantoro, Rosdiana, & Fathurahman, 2018), waqf performance indicators (Masruki, Mohd Hanefah, Aryani, & Bunyamin, 2019; Noordin et al., 2017), and novel or improved waqf concepts e.g. waqf bank (Ab Aziz, Yusof, Johari, Ramli, & Sabri, 2014; Gabil, Bensaid, Tayachi, & Jamaldeen, 2020; Mohammad, 2011), waqf share (Abdel Mohsin, 2013; Suhaimi, Ab Rahman, & Marican, 2014), waqf-funded *takāful* (Mikail, Ahmad, & Adekunle, 2017; Wan Ahmad & Ab Rahman, 2011), cooperation-waqf model (Pitchay, Mohd Thas Thaker, Mydin, Azhar, & Abdul Latiff, 2018), waqf-*iṣtiṣnāʿ* (Noor & Yunus, 2014), waqf-*muzāraʿah* (Moh'd, Omar Mohammed, & Saiti, 2017), waqf-*mushārakah mutanāqiṣah* (Md Zabri & Mohammed, 2018), and so forth, limited only by Sharīʿah and imagination.

Among these innovations is a new waqf channel that is gaining tract, no doubt due to the glut of cryptocurrencies over the past decade: blockchain technology (Abojeib & Habib, 2019; A. Ahmad & Habib, 2019; Elasrag, 2019; Rashid, 2018). It is generally lauded for its innate transparency and traceability because any changes, contributions, or expenditures made in a blockchain would be recorded and distributed to its participants—a decentralized ledger. It is usually said to be tamper-proof, frustrating any deliberate modification of records (Alam, Gupta, & Zameni, 2019; Salmon & Myers, 2019). This review will take a closer inspection to waqf and provides a brief description of blockchain. Accordingly, it will explore the possibility of transacting waqf on a blockchain.

II. TYPES OF WAQF

Waqf in *fiqh* nomenclature is the relinquishment of private goods (*mawqūf*)—movable, immovable, liquid, illiquid, productive, unproductive—and the transference of their usufruct, benefits, rights, or all three at once, to specific beneficiaries (*mawqūf ʿalayh*) named by the founder (*wāqif*) in a clear and implicit or explicit expression of offer (*ṣīghah*). Those four elements form the integral components of waqf, the absence of any of which will render invalid the contract and its legal consequences.

While the Sharīʿah itself makes no distinction about the categories of waqf, in practice academics and states have done so. These distinctions may be made according to at least five perspectives (Table 1).

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Table 1: Typical Classification of Waqf

Beneficiary	Mawqūf (endowed assets)	Motive	Mutawallī (trustee)	Temporality
Family	Fixed	Charity	Individual	Permanent
Khayri	Movable	Wealth preservation	Institution	Temporary
Mushtarak	Rights	Succession planning		
		Protection from abuse and expropriation Unlawful confiscation		
		Political gain		

Based on Table 1, by no means are these divisions and their respective constituents exhaustive. Waqf can be classified by its beneficiaries, Mawqūf, motive, mutawalli and temporality. Details of each basis are discussed as follows:

2.1 Beneficiary of Waqf

Sorted by beneficiaries, there are three main categories of waqf. *First* is *al-waqf al-ahlī*, *al-dhurrī*, or *al-awlād*, which is the endowment of funds or assets to family members. The designated recipients are of variety, though most often are children and grandchildren. Rarely, siblings, poor family members, or non-legal heirs, who cannot receive any inheritance, such as adopted children, are appointed as beneficiaries (Layish, 1997, 2008). The founder of this waqf generally aims to ensure effective succession planning and prevent prodigality of wealth upon his passing (Mohamad, 2018).

The *second* is *al-waqf al-khayrī* or *al-waqf lillāh*, which is for public causes or religious purposes, such as endowments targeted to orphans, students, the poor and destitute, and the handicapped. It may take the form of public institutions e.g. mosques, cemeteries, hospitals, and schools; public rights e.g. irrigation rights and roads; or benefits e.g. allowances and social assistances. *Al-waqf al-khayrī* is waqf in its most basic form. The *third* is *al-waqf al-mushtarak* (Alias, 2014; Ihsan & Hameed 2011), which is an amalgamation of the first two purposes: the benefits, rights, or usufruct of the waqf assets are shared between public and private beneficiaries. The proportion for each is to the discretion of the founder.

2.2 Mawqūf (Type of Endowed Assets)

Waqf may also be classified according to the type of endowed assets. The *first* is fixed assets, such as lands, farms, buildings, or other such properties. These are conventional waqf assets permitted by all legal schools. The *second* is movable assets, such as vehicles, currency, books, and so on. Here, there are some controversies, though jurists largely allow their endowment (Abdel Mohsin et al., 2016). The *third* is rights or usufructs, like irrigation rights and patents. All three groups may either be cost-incurring or revenue-generating. For the former are all properties that do not generate income but require constant upkeep, such as mosques and cemeteries; the latter are those to the contrary, such as rental buildings and farmlands. Typically, a founder would endow both at the same time so that the latter sustains the former.

2.3 Motive of Waqf

According to motive, one may group waqf into social or religious charity, wealth preservation, succession planning, protection from abuse and expropriation, unlawful confiscation, and political gain. Such motives are dedicated to the beneficiaries of waqf to whom may either be

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specified (*khāṣṣ*) or not (*ʿāmm*). These motives have been alluded to previously.

2.4 Mutawallī (Trustee) of Waqf

The *mutawalli (trustee), acting as an administrator of waqf* may either be an individual or institution. In the early days of Islam and before the establishment of state waqf supervisory agencies, a founder would typically entrust his waqf to certain individuals. Often, he would also name the replacement for the first *mutawallī*. Though in no rare occasions, the founder may appoint himself the *mutawallī*, so that he may enjoy the benefits or usufruct of the property. After his passing, the role will be assumed by a *mutawallī* specified by the founder or appointed by an Islamic judge (*qāḍī*). This lenience is the stance of Ḥanafī jurists (Abbasi, 2012; Layish, 1997). Alternatively, Shāfiʿī and Ḥanbalī scholars only allow the founder's self-appointment if he expresses so in his declaration (*ṣīghah*), while Mālikī jurists completely deny its permissibility (al-Qarāfī, 1994; al-Shayrāzī, 1976; Ibn Qudāmah, 1992). Institutional (including corporate) *mutawallī* is more prevalent today. In Malaysia, the sole *mutawallī* is the State Islamic Council, but it may concede certain waqf assets to authorized institutions. Or it may also partner with other institutions to manage waqf assets or projects. For example, Waqf Annur Corporation Berhad, under Johor Corporation (JCorp.) was granted the status of *mutawallī* by the Johor State Islamic Council (Majlis Agama Islam Johor, "MAIJ").

2.5 Temporality of Waqf Assets

Waqf generally has three inherent features: irrevocability, perpetuity, and inalienability. However, most Mālikī scholars and a few jurists from other schools permit temporal waqf. Mālikī jurists hold that the declarator, who is the donor of waqf may limit the waqf to a certain period, after which the property returns to his or his heir's possession (Al-Dardīr, 1995; Jafri & Mohd Noor, 2019). Waqf, therefore, can temporally be classed into perpetual or temporary.

The perpetuity of waqf assets is also a subject of lengthy debate among scholars. Typically, this revolves around the permissibility of cash waqf. This is discoursed below due to its current preponderance.

Another easy and flexible type of waqf is widely used known as cash waqf. It had been legitimized by the Ottoman courts in the fifteenth century before becoming ubiquitous within the Empire in the following century. But its implementation before and after that period, including the modern times, has faced serious objections (Mandaville, 1979). Oppositions mostly come from conservative scholars, who hold that the object of waqf (*mawqūf*) should be physically perpetual, as in the case of land and building. This the view of some Shāfiʿī, Ḥanbalī, and Ḥanafī jurists (al-ʿImādī, 1997; al-Sharbīnī, 2000; al-Shayrāzī, 1976). Accordingly, certain Muslim communities that adhere to those schools hold that belief, hence the illiquidity of their waqfs. Nevertheless, its practice has been widely legitimized in most Islamic states.

Another source of its unpopularity is the low awareness, and even less knowledge, of Muslims about cash waqf. This poor awareness likely stems from their misconception of waqf—that it is only for perpetual assets and strictly for religious or social causes (Rahaman, Fahmi, & Faisol, 2011). Adeyemi, Ismail, and Hassan (2016) hypothesizes that a community's poor understanding of a phenomenon may lend to their low awareness about it, much less its implementation. Certainly, they found empirical evidence that Malaysian Muslims exhibited poor awareness of cash waqf due to the lack of understanding and promotion, as well as the influence of social norms. Further promotion of cash waqf and the introduction of convenient contribution channels, such as monthly salary deductions, collection agents, and online payments, can increase contributions from Muslims. The success stories of the Waqf Fund Scheme and Waqf Share of the Penang State Religious Council (MAINPP) and Selangor Waqf Corporation (PWS) demonstrate the effectiveness of these approaches (Sanusi & Mohd Shafiai, 2015; Suhaimi et al., 2014).

III. BLOCKCHAIN TECHNOLOGY

The inflating price of Bitcoin over the past decade and subsequent mushrooming of alternative cryptocurrencies have sparked the rising popularity of blockchain technology. Evidently, research on the subject seems to take off since the mid-2010s (Fosso Wamba, Kala Kamdjoug, Epie Bawack, & Keogh, 2019). Proposals for its use case covers a diverse industries, such as logistics and supply chain (Abeyratne & Monfared, 2016; Tieman & Darun, 2017), construction (Li, Greenwood, & Kassem, 2019), healthcare (Mettler, 2016), automotive (Fraga-Lamas & Fernández-Caramés, 2019), and oil and gas (Lu, Huang, Azimi, & Guo, 2019). It is especially regarded as a disruptive financial technology (FinTech) that can potentially transform the commercial and finance spheres (Fanning & Centers, 2016).

3.1 Mechanism and Characteristics of Blockchain

Blockchain is simply a decentralized network of nodes—servers, laptops, computers connected to the blockchain—that verify, record, and store data blocks that are interlinked by chains. Each block contains multiple transactions records. Each record is identified with a hash, a fixed-length alphanumeric string generated from a string of characters using a mathematical function. This hash details the specific record for each transaction, including sender, recipient, other participants, date, time, and other such details as coded into the blockchain algorithm (Brito & Castillo, 2013; Salmon & Myers, 2019). After the block has been forged, it is also "stamped" with a hash, which connects it to the preceding block. This is the "chain". This hash also stores the transaction hashes recorded inside the block. Each block is added to the chain subsequent to the verification of the network participants of its authenticity, which is proven using a consensus mechanism[2] (Zīle & Strazdiņa, 2018). This entire process continues indefinitely, and theoretically there is no limit to the number of blocks on the network.

Transaction on the blockchain is carried out using public and private keys (asymmetric-key cryptography) that are owned by all participating nodes. The private key is used to encrypt information, effectively "signing" the transaction. The key is hashed to generate a public key, which the counterparty then uses to authenticate that (a) this transaction request indeed comes from the original sender and (b) the content has not been tampered with. Conversely, it is possible to encrypt information using one's public key; it can then only be decrypted using that person's private key. A public key may also be hashed to generate an address, which is not unlike a house address or bank account number. The private key must be kept confidential and safely; if misappropriated, it can be used to sign fraudulent transactions; if lost, the user will lose all digital assets associated to that key. Recovering the key is computationally infeasible (Yaga, Mell, Roby, & Scarfone, 2019; Zheng, Xie, Dai, Chen, & Wang, 2017).

The entire database is recorded on nodes and is regularly updated. Blockchain allows the nodes to transact with one another even with the absence of trust and an intermediary, hence its attribute as a trustless, low-cost peer-to-peer (P2P) network (Christidis & Devetsikiotis, 2016). Because the network essentially exists on several distributed nodes in various locations, there is no central authority or point of failure, so the risk of losing the entire database is minimized (Alam et al.,

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[2] There are numerous mechanisms/algorithms, though the most prevalent are proof-of-work (PoW) and proof-of-stake (PoS). In PoW, the requesting node is required to solve a computational problem, which is then verified by the network; correct solutions will reward the node with a coin. This is known as mining. In PoS, instead of solving a puzzle, a node stakes its coins to ensure its chance of being selected as the one to forge the block, which rewards it with coin. This is a transaction fee, not mining. Coins are rewarded to disincentivize dishonest nodes. In a closed network, where nodes are known and authorized, they are unnecessary. Some blockchains use tokens to transact (see note 3). The transaction is then authenticated by validator nodes, and the tokens will exchange hands (Bach, Mihaljevic, & Zagar, 2018; Christidis & Devetsikiotis, 2016).

2019; Raval, 2016). But by the same token, transactions are irreversible, rendering payments made to the wrong address as vanished, unable to be recovered. Frauds, equally, cannot be reversed, unlike in conventional bank transactions. The records stored in the network are open to the public and can be accessed in a matter of seconds. For this reason, it is most familiar with the description of a decentralized, distributed ledger.

Blockchain is considered immutable and secure because any alteration to a block would require the rebuilding and rehashing of the subsequent blocks (Hileman & Rauchs, 2017). For instance, slightly modifying the information, even a character, contained in the seventh block of a 10-block network would produce a new hash for the altered block. This will cause the block to disconnect from the original eighth block, since the latter identifies the original seventh block by its hash. Effectively, modifying the seventh block transforms the network into a seven-block chain. To cover this clandestine deed, one must update the remaining three blocks so that they generate new hashes that can continue this new chain. If he fails to do so, or because the majority of the nodes in the network have verified the original chain to be the true chain that connects to the genesis block (the first block in a chain), this altered seventh block becomes an extinct or orphan block, and this new chain ends there (Decker & Wattenhofer, 2013). There are now two forks in the blockchain network, one leading to the now abandoned seventh block, and the other is the consensually agreed correct path. Without the collusion from the majority of the nodes—an expensive and resource-intensive undertaking—any attempts to alter information in a blockchain is effectively unfeasible (Bonneau, 2019).

The advantages of using blockchains can be summarized into the following points:

- Traceability, auditability, and transparency of data and transactions, every one of which are "stamped" and verified.
- Public-private key enables participants to sign and authenticate transactions, preventing tampering or fraudulent requests.

- Transactions can be carried out without any intermediaries, and they will be automatically registered into the blockchain. Both cost and time can be minimized.
- It has no central point of failure because the database is constantly distributed to and verified with participating P2P nodes.
- No central authority also means that no one entity has the power to shut, erase, alter, or add any information to the network. But this also means that transactions are irreversible; lost or stolen private keys (and accordingly digital assets) cannot be recovered.
- Information stored in the network is secure and immutable from deliberate alterations.
- Any forks introduced into the chain are automatically corrected into a mutually accepted chain.

3.2 Types of Blockchain

The narrative thus far, however, pertains mostly to public permissionless blockchain, implemented in the very familiar cases of Bitcoin and Ethereum. However, the scenarios discussed above may not necessarily be applicable to closed models. The differences between the models primarily lie with the authority to read, write or commit information into the blockchain, though the general mechanism is about identical (Table 2).

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			Read	Write	Commit	Immutability	Centralized	Efficiency
Block-chain 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	Restricted to 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

*Notes: *Requires significant investment either in mining hardware (proof-of-work model) or cryptocurrency itself (proof-of-stake model).*

Read: right to access the network and see transactions; *Write*: right to generate transactions and send them to the network; *Commit*: right to update or commit transactions to the network (by adding a block to the blockchain)

Sources: Hileman and Rauchs (2017); Zheng et al. (2017)

Referring to Table 2, the permissibility for anyone to read blockchain records is only in a public network, as in the case of Bitcoin. One may also write into its blockchain, but this must be verified with a consensus algorithm. Malicious nodes may also force commit a record if it has sufficient resources, affording it higher chances to self-validate transactions, but this is an extremely costly endeavor (Bonneau, 2019). Honest behavior in this chain is promoted with the rewarding of coins, more specifically payment coins (or cryptocurrencies).[3] On the Ethereum

blockchain, for instance, the rewards would be Ether (ETH).

In lieu of coins, some models typically issue security or utility tokens.[4] The former represents the underlying external (off-chain) asset owned by the node, not unlike a share or a deed. For example, a company may crowdfund for a certain project, with the promise of sharing the profits with investors. They may issue security tokens to do so. These can be traded on the secondary market. Since there are no intermediaries, transactions can be completed quickly. Utility tokens, on the other hand, are akin to loyalty points or amusement park tickets: they are without any intrinsic value and cannot be used as currency outside of the store or theme park. Holders may use them to redeem a product or service offered by the issuer (Doe-Bruce, 2019; Liu & Wang, 2019; Oliveira et al., 2018). It bears mentioning that tokens are not a necessary feature of blockchains. Private network often operates without any tokens, verifying each transaction based on certain algorithms and protocols (Jeong, Youn, Jho, & Shin, 2020). In this case, the blockchain merely acts as a distributed ledger database.

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[3] Currency (coin) and token are dissimilar. Currency is a native feature of a blockchain that is used to incentivize the blockchain participants and used as a medium of exchange, much like conventional currency. Token, alternatively, is created on top of a blockchain; it is created and governed by a smart contract, to be used only within a blockchain network (Massey, Dalal, & Dakshinamoorthy, 2017; Oliveira, Zavolokina, Bauer, & Schwabe, 2018). On the Ethereum blockchain, for instance, the currency is Ether, while its token is that which is created, traded, or gifted only on the Ethereum platform e.g. Vechain.

[4] There are also other token archetypes: cryptocurrency, equity, funding, consensus, work, voting, asset, and payment. See Oliveira et al. (2018).

In the public permissioned model, writing is only for authorized nodes, while commitment can be carried out by either all or part of them. For closed systems, certain actions may only be carried out by a specific party. Transparency and auditability of a closed blockchain is an enduring issue, especially because the participants, especially organizations or corporations, are legally and morally required to uphold confidentiality. Even if sensitive information is withheld, it is still possible to reveal or reasonably estimate a participant's identity through his transaction patterns or other methods (Biryukov, Khovratovich, & Pustogarov, 2014; Meiklejohn et al., 2013). To mitigate this issue, some academics e.g. Kosba, Miller, Shi, Wen, and Papamanthou (2016) suggest the use of public blockchains with zero-knowledge proof to enable the validator to verify a transaction without the requirement to disclose any sensitive information.

Security for closed models come within and without the blockchain, such as legal contracts and threats, but immutability may not entirely apply. The risk of collusion is still possible, especially if the participating nodes are small and the validators cooperate in the scheme (Hileman & Rauchs, 2017; Schrepel, 2019).

3.3 Blockchain Smart Contracts

Smart contracts are lines of codes embedded into the blockchain algorithm that are "deployed using cryptographically signed transactions on the blockchain network" (Yaga et al., 2019, p. 32). It functions as an if-else statement, that is, the fulfilment of a condition will immediately trigger the resulting action. Theoretically, they may supplement or fully substitute traditional legal contracts (Alam et al., 2019; Raval, 2016). Smart contracts can also be used to create tokens (Oliveira et al., 2018).

To illustrate its execution: suppose the smart contract holds the condition that the release of a sum of payment to the seller is subject to the arrival of the item. Sequel to its confirmation by the buyer, the smart contract automatically executes the consequent action. In this instance, the services of a third party are rendered unnecessary, and the transaction can be executed quickly at minimum cost. In actual practice, smart contracts would be even more complex, encompassing terms and conditions that involve multiple parties.

By their own nature, smart contracts are deterministic, that is, a similar output will always be produced for the same input. But it may also be non-deterministic if it requires off-chain information from external parties, a service termed oracle (or data feed). Because it is incorporated into the blockchain, it is possible for all authorized nodes (or anyone if it is a public blockchain) to inspect its code in detail. Similarly, it is possible to trace all operations of the contract because it is recorded on the blockchain (Christidis & Devetsikiotis, 2016).

IV. BLOCKCHAIN FOR WAQF MANAGEMENT

There are some Sharīʿah disputes surrounding cryptocurrencies, principally due to the ambiguity of its category—is it a currency or an asset (*māl*)? Some scholars consider them *ḥarām* as a currency due to (a) their volatile value, creating elements of speculation and gambling; and (b) the fact that they are not issued by the state. Others deny their permissibility as an asset because they have no intrinsic value. Conversely, some allow their use as currency seeing as (a) fluctuation of value is also present in fiat money, and (b) it is accepted by the contracting parties as a medium of exchange (Alam et al., 2019; Beik, Zaenal, & Rizkiningsih, 2019; Zubaidi & Abdullah, 2017). It bears mentioning that conventional law systems also face the predicament of classifying and regulating cryptocurrencies (Salmon & Myers, 2019).

Regardless, blockchain is a neutral technology. Much like a pen, it is but a tool. Proper implementation of a blockchain, accounting carefully for the elimination of usury, *gharar*, *maysir*, and incorporating elements of transparency and accountability, would certainly not be illegal in Islam. For reason of prudency (*iḥtiyāṭ*), cryptocurrencies should be avoided. Additionally, since the intention to develop a

blockchain is to crowdfund, not merely recording, the enterprise waqf model cannot be implemented. This leaves two models: (a) a public permissioned or (b) private permissioned blockchain. In a waqf blockchain, the network can grant a token to the founder as proof of his contribution, akin to waqf deeds.

There have been several proposals for the development of waqf chain. Before discussing them, it is best to illustrate an implemented example with FINTERRA's Waqf Chain. This platform is built on top the company's Gallactic Blockchain, which can interact with external platforms like Ethereum (FINTERRA, 2018b).

The chain has several stakeholders, including a waqf board, fund manager (e.g. an Islamic bank), insurer, auditor, constructor, asset manager, and contributors. The entire process involves several steps:

- The board identifies a viable waqf asset (or project) and requests its concession from the *mutawallī* e.g. State Islamic Council. The board then drafts the prospectus, detailing the specificities of the project, such as investment period, administrator, property, expected returns, and so forth.
- The prospectus is reviewed by an external auditor.
- After its approval, both the board and auditor appoint a fund manager, who then produces a project portfolio and publishes it to the blockchain.
- Participants contribute to the project using either one of four instruments: cash waqf, *qarḍ ḥasan*, sukuk, or *muḍārabah*. For the last two, the contributors will earn investment returns.
- When the crowdfunding goal has been met and after all due diligence requirements are satisfied, the smart contracts (according to the respective instrument and project) are automatically initiated.
- The smart contracts will create project-specific utility tokens (FIN) to the contributors as representation for their stake in the project.
- The fund manager appoints a contractor to develop the waqf asset.

- Once completed, the asset is transferred to the asset manager.
- Proceeds from sukuk and *muḍārabah* will be distributed to investors.

During the entire process, the insurers hedge such risks as fund manager insolvency and project delivery risks.

The contributors themselves are pre-qualified to ascertain that the principles of Know Your Customer (KYC) and Anti Money Laundering (AML) have been met. They are also assigned a certain credit score to determine their capacity to contribute to the project. Participants are only allowed to contribute sequel to their success in this screening.

The FIN tokens can only be used within the Waqf Chain network. Participants that intend to contribute to the project may do so by exchanging their cryptocurrencies, for example Bitcoin (BTC) or ETH, to FIN. This way, as well, FIN can be traded in the secondary market i.e. cryptocurrency exchange platform. Transacting FIN to a given project will trigger the execution of the smart contract peculiar to that project, subject to the satisfaction of all conditions and due diligences (FINTERRA, 2018a; Management, 2018).

Other proposals for waqf-blockchain does not deviate much from this system. (These are not exhaustive). Abdel Mohsin and Muneeza (2019) conceptualizes a WaqfCoin as a token that represents the underlying waqf asset. This token is issued by a company listed on a waqf market through an Initial Coin Offering (ICO), and it may be traded in the secondary market. Beik et al. (2019) suggests three models: waqf-blockchain, waqf-crowd coin, and waqf-cryptocurrency. The first model only records the journey of the fund, and distribution is made off-chain. The second is identical to FINTERRA's model. The third is to donate cryptocurrencies produced through proof-of-stake algorithms (as they are more energy-efficient) toward waqf. This concept has been applied in conventional charity crowdfunding by such organizations as UNICEF, Cudo Donate, and Charity Mine. Unfortunately,

the employment of this system for waqf rests on the *fiqh* ruling of cryptocurrencies.

V.   CONCLUSION AND RECOMMENDATIONS

This paper has reviewed an overview of waqf, blockchain technology and the integration of waqf into the blockchain ecosystem. Persistent issues in the management of waqf assets and institutions, especially misappropriation and neglect of properties, must be resolved to garner waqf donors' trust with mutawalli (trustee). One solution to this problem is through the application of blockchain technology using smart contract, enabling traceability, transparency, and compliance of waqf transactions and activities. FINTERRA has implemented waqf into a blockchain network, while others have suggested identical and dissimilar systems. Imagination, resources and Sharīʿah are amongst boundaries of developing innovative waqf blockchains. Indeed, it is essential to outline numerous crucial points and caveats as follows:

First, it is important not to see any one technological concept as the magical solution for every issue. New and immature solutions are often seen as an infallible answer, especially to those unfamiliar with them. Therefore, frequent exposure is called for the positive aspects of a solution and ignorance to its weaknesses will leave the impression that it is unflawed. This is never the case.

Second, not all blockchain is equal. Transparency, security and immutability of information differ from a blockchain to another. Closed permissioned platforms, for instance, could allow collusion due to the small number of participants and validators. Further, information may also be opaque to some nodes, let alone the public external of the blockchain, because authorization is in the hands of a single or multiple nodes. Public trust in the waqf institution thus, cannot effectively be elevated if this is the case. Ignoring collusion, in an entirely honest closed blockchain, there is still the trade-off dilemma between security and transparency.

Third, to a certain extent, the use of smart contracts is congruent with the spirit of Islam of facilitation (*taysīr*). They are written logically and precisely so as to remove non-deterministic executions (Christidis & Devetsikiotis, 2016; Mohamed & Ali, 2018). Additionally, its inalterability, not even by the author (Alharby & Van Moorsel, 2017), satisfies the Sharīʿah requirement of fixed contract terms. Still, this could also pose problems if the contract is later deemed as contravening the Sharīʿah, which necessitates the coding of a new smart contract. Moreover, the contracts are written in a programming language, which cannot be readily understood by non-specialists. Even experts have noted the difficulty in translating legal jargon into deterministic, unambiguous codes (Mik, 2017).

Fourth, under- or unqualified waqf managers are regarded as a key obstacle in waqf administration, and this problem may be enhanced with the adoption of new technology. This issue is not confined to them; other parties may also be unfamiliar with blockchain and its myriad concepts and nomenclatures. For those reasons, mutawalli (trustee), along with other stakeholders—lawyers, jurists, regulators, auditors, fund managers, insurers, users, and the public—must be made aware and educated on the subject. Additionally, the system must be accessible. Convenience afforded by a user-friendly and useful platform is correlated to the inclination of Muslims to make waqf donations (Mohd Thas Thaker, Mohd Thas Thaker, & Pitchay, 2018).

Fifth, while blockchain itself is neutral and *mubāḥ* (permissible), the transactions, contracts, and other activities taking place on the platform are not necessarily so. Regulators and Islamic scholars, are constantly playing catch-up to the rapidly advancing blockchain technology. Islamic scholars should therefore, be more cognizant of the specificities of these activities. Additionally, practitioners must involve them in every step of development to ensure their compliance with Sharīʿah, perhaps via a Sharīʿah committee not unlike that in Islamic financial institutions. Its function will be to ensure the compliance of the

real crowdfunded project as well as the digital transactions. Its scope is thus comprehensive.

Sixth, the effectiveness of a blockchain is conditional on the integrity and morals of the human actors themselves. Any wrong input will perfectly return an inaccurate or wrong output. Here, it is apt to invoke the adage of "garbage in, garbage out".

Despite these caveats, there is much to be hopeful for with regards to waqf blockchain using smart contract. With a proper execution, it may very well fulfil its promise of transforming the Islamic social finance worldwide.

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REFERENCES

1. Ab Aziz, M. R., Yusof, M. A., Johari, F., Ramli, A., & Sabri, H. (2014). The Relief of Higher Education Loan through Islamic Waqf Bank. *Asian Social Science, 10*(22). doi:10.5539/ass.v10n22p175.

2. Abbasi, M. Z. (2012). The Classical Islamic Law of Waqf: A Concise Introduction. *Arab Law Quarterly, 26*(2), 121-153. Retrieved from www.jstor.org/stable/23234650

3. Abd Jalil, M. I., Yahya, S., & Pitchay, A. A. (2019). Building committed Waqif: the role of information disclosure. *Journal of Islamic Accounting and Business Research, 10*(2), 185-215. doi:10.1108/jiabr-05-2016-0058

4. Abd Mutalib, H., & Maamor, S. (2016). Utilization of Waqf Property: Analyzing an Institutional Mutawalli Challenges in Management Practices. *International Journal of Economics and Financial Issues, 6*, 36-41.

5. Abdel Mohsin, M. I. (2013). Financing through cash-waqf: a revitalization to finance different needs. *International Journal of Islamic and Middle Eastern Finance and Management, 6*(4), 304-321. doi:10.1108/ IMEFM-08-2013-0094.

6. Abdel Mohsin, M. I., Dafterdar, H., Cizakca, M., Alhabshi, S. O., Razak, S. H. A., Sadr, S. K., . . . Obaidullah, M. (2016). Legal Framework of the Institution of Waqf. In *Financing the Development of Old Waqf Properties: Classical Principles and Innovative Practices around the World* (pp. 1-12). New York: Palgrave Macmillan US.

7. Abdel Mohsin, M. I., & Muneeza, A. (2019). Integrating waqf crowdfunding into the blockchain. In U. A. Oseni & S. N. Ali (Eds.), *Fintech in Islamic Finance Theory and Practice* (pp. 266-279). London: Routledge.

8. Abdul Shukor, S., Johari, F., Abd Wahab, K., Kefeli @ Zulkefli, Z., Ahmad, N., Haji Alias, M., . . . Abu-Hussin Mohd, F. (2019). Trust on awqaf institutions: evidence from Malaysia. *Journal of Islamic Marketing, 10*(2), 511-524. doi:10.1108/JIMA-05-2017-0054.

9. Abdullah, R., & Ismail, A. G. (2017). Taking stock of the waqf-based Islamic microfinance model. *International Journal of Social Economics, 44*(8), 1018-1031. doi:10.1108/ ijse-06-2015-0176

10. Abeyratne, S. A., & Monfared, R. P. (2016). Blockchain ready manufacturing supply chain using distributed ledger. *International Journal of Research in Engineering and Technology, 5*(9), 1-10.

11. Abojeib, M., & Habib, F. (2019). Blockchain for Islamic Social Responsibility Institutions. In A. Rafay (Ed.), *FinTech as a Disruptive Technology for Financial Institutions* (pp. 221-240). Hershey: IGI Global.

12. Adeyemi, A. A., Ismail, N. A., & Hassan, S. S. B. (2016). An Empirical Investigation of the Determinants of Cash Waqf Awareness in Malaysia. *Intellectual Discourse, 24*, 501-520. Retrieved from https://journals. iium.edu.my/intdiscourse/index.php/islam/ article/view/931.

13. Ahmad, A., & Habib, F. (2019). Using Blockchain and Smart Contracts for Waqf Institutions. In M. Anshari, M. N. Almunawar, & M. Masri (Eds.), *Financial*

Technology and Disruptive Innovation in ASEAN (pp. 225-244). Hershey: IGI Global.

14. Ahmad, M. (2019). An empirical study of the challenges facing zakat and waqf institutions in Northern Nigeria. *ISRA International Journal of Islamic Finance, 11*(2), 338-356. doi:10.1108/ijif-04-2018-0044

15. Al-Arnā'ūṭ, M. (2005). *Dawr al-Waqf fī Nushū' al-Mudun al-Jadīdah fī al-Būsnah (Sīrāyīfū Namūdhajan). Awqāf, 8*, 47-57. Retrieved from https://docs.google.com/viewer?url=https://www.muslim-library.com/dl/books/ar5727.pdf .

16. Al-Bukhārī, M. i. I. (1993). *Ṣaḥīḥ al-Bukhārī*. Bayrūt: Dār Ibn Kathīr.

17. Al-Dardīr, A. i. M. (1995). *al-Sharḥ al-Ṣaghīr*. Bayrūt: Dār al-Kutub al-ʿIlmiyyah.

18. Al-Ḥaṣrī, A. (1992). *a-Tarikāt wa al-Waṣāyā wa al-Qaḍāyā al-Mutaʿalliqah fī al-Fiqh al-Islāmī al-Muqāran*. Bayrūt: Dār al-Jayl.

19. Al-ʿImādī, M. i. M. (1997). *Risālah fī Jawāz Waqf al-Nuqūd*. Bayrūt: Dār Ibn Ḥazm.

20. Al-Qarāfī, A. i. I. (1994). *al-Dhakhīrah*. Bayrūt: Dār al-Gharb al-Islāmī.

21. Al-Ṣabūnī, M. ʿ. (1995). *a-Mawārith fī al-Sharīʿah al-Islāmiyyah fī Dhaw' al-Kitāb wa al-Sunnah*. Bayrūt: Dār al-Kutub al-ʿIlmiyyah.

22. Al-Sharbīnī, M. i. M. (2000). *Mughnī al-Muḥtāj ilā Maʿrifah Maʿānī Alfāẓ al-Minhāj*. Bayrūt: Dār al-Kutub al-ʿIlmiyyah.

23. Al-Shayrāzī, I. i. ʿ. (1976). *al-Muhadhdhab*. al-Qāhirah: Muṣṭafā Ḥalabī.

24. Alam, N., Gupta, L., & Zameni, A. (2019). *Fintech and Islamic Finance: Digitalization, Development and Disruption*. London: Palgrave Macmillan.

25. Alharby, M., & Van Moorsel, A. (2017). Blockchain-based smart contracts: A systematic mapping study. *arXiv preprint arXiv:1710.06372*.doi:10.5121/csit.2017.71011.

26. Alias, T. A. (2014). The gift economy: waqf in the Islamic world today. In M. K. Hassan & M. K. Lewis (Eds.), *Handbook on Islam and Economic Life* (pp. 475-495). Cheltenham: Edward Elgar Publishing.

27. Bach, L. M., Mihaljevic, B., & Zagar, M. (2018, 21-25 May 2018). *Comparative analysis of blockchain consensus algorithms*. Paper presented at the 2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO).

28. Beik, I. S., Zaenal, M. H., & Rizkiningsih, P. (2019). Waqf Led Halal Cryptocurrency Model. In M. M. S. Billah (Ed.), *Halal Cryptocurrency Management* (pp. 285-298). Cham: Springer International Publishing.

29. Biryukov, A., Khovratovich, D., & Pustogarov, I. (2014). *Deanonymisation of Clients in Bitcoin P2P Network*. Paper presented at the Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security, Scottsdale, Arizona, USA. https://doi.org/10.1145/2660267.2660379.

30. Bonneau, J. (2019). *Hostile Blockchain Takeovers (Short Paper)*, Berlin, Heidelberg.

31. Brito, J., & Castillo, A. (2013). *Bitcoin: A Primer for Policymakers*. Arlington: Mercatus Center.

32. Brown, J. A. C. (2014). *Misquoting Muhammad: The Challenge and Choices of Interpreting the Prophet's Legacy*. London, UK: Oneworld Publications.

33. Christidis, K., & Devetsikiotis, M. (2016). Blockchains and Smart Contracts for the Internet of Things. *IEEE Access, 4*, 2292-2303.doi:10.1109/ACCESS.2016.2566339.

34. Çizakça, M. (1995). Cash waqfs of Bursa, 1555-1823. *Journal of the Economic and Social History of the Orient, 38*(3), 313-354.

35. Çizakça, M. (2000). *A History of Philanthropic Foundations: The Islamic World from the Seventh Century to the Present*. Istanbul: Boğaziçi University Press.

36. Decker, C., & Wattenhofer, R. (2013, 9-11 Sept. 2013). *Information propagation in the Bitcoin network*. Paper presented at the IEEE P2P 2013 Proceedings.

37. Doe-Bruce, O. (2019). Blockchain and Alternative Sources of Financing. In S. Goutte, K. Guesmi, & S. Saadi (Eds.), *Cryptofinance and Mechanisms of Exchange: The Making of Virtual Currency* (pp. 91-111). Cham: Springer International Publishing.

Review of Blockchain Technology in Managing Waqf (Endowment)

38. Elasrag, H. (2019). *Blockchains for Islamic finance: Obstacles & Challenges*. Retrieved fromhttps://EconPapers.repec.org/RePEc:pra:mprapa:92676.

39. Fanning, K., & Centers, D. P. (2016). Blockchain and Its Coming Impact on Financial Services. *Journal of Corporate Accounting & Finance, 27*(5), 53-57. doi:10.1002/jcaf.22179

40. FINTERRA. (2018a). *Social Solution for Blockchain*. Retrieved from Singapore: https://cdn.finterra.org/FINTERRA_WHITE PAPER.pdf.

41. FINTERRA. (2018b). *WAQF Chain the socio economic solutions*. Retrieved from https://24zoll3xswnf3vtql2lanwdx-wpengine.netdna-ssl.com/wp-content/uploads/2019/01/WAQF-Blockchain-Social-Economic-V-03.1.pdf.

42. Fosso Wamba, S., Kala Kamdjoug, J. R., Epie Bawack, R., & Keogh, J. G. (2019). Bitcoin, Blockchain and Fintech: a systematic review and case studies in the supply chain. *Production Planning & Control, 31*(2-3), 115-142.doi:10.1080/09537287.2019.1631460

43. Fraga-Lamas, P., & Fernández-Caramés, T. M. (2019). A review on blockchain technologies for an advanced and cyber-resilient automotive industry. *IEEE Access, 7*, 17578-17598.

44. Gabil, H., Bensaid, B., Tayachi, T., & Jamaldeen, F. (2020). The Need for Shari'ah-Compliant Awqāf Banks. *Journal of Risk and Financial Management, 13*(4), 76. Retrieved from https://www.mdpi.com/1911-8074/13/4/76.

45. Gamon, A. D., & Tagoranao, M. S. (2018). The Role of Waqf Properties in the Development of the Islāmic Institutions in the Philippines: Issues and Challenges. *Intellectual Discourse, 26*(2), 1191–1212. Retrieved from https://journals.iium.edu.my/intdiscourse/index.php/islam/article/view/1263.

46. Gaudiosi, M. (1988). The Influence of the Islamic Law of Waqf on the Development of Trust in England: the Case of Merton College. *University of Pennsylvania Law Review, 136*(4), 1231-1261.

47. Hileman, G., & Rauchs, M. (2017). *Global blockchain benchmarking study*. Cambridge: Cambridge Centre for Alternative Finance.

48. Ibn al-Ḥajjāj, M. (n.d.). *Ṣaḥīḥ Muslim*. al-Qāhirah: Dār al-Iḥyā' al-Kutub al-ʿArabiyyah.

49. Ibn Qudāmah, M. (1992). *Al-Mughnī* (Vol. 8). al-Qāhirah: Ḥijr.

50. Ihsan, H., & Hameed , S. H. M. I. (2011). Waqf accounting and management in Indonesian waqf institutions. *Humanomics, 27*(4), 252-269. doi:10.1108/08288661111181305.

51. Ismail, C. Z., Salim, N. J., & Hanafiah, N. J. A. (2015). Administration and Management of Waqf Land in Malaysia: Issues and Solutions. *Mediterranean Journal of Social Sciences*. doi:10.5901/mjss.2015.v6n4s2p613

52. Jafri, F. A., & Mohd Noor, A. (2019). Temporary Waqf Model for Islamic Private Retirement Scheme in Malaysia - A Proposal. *Journal of Islamic Finance, 8*(1), 023-035. Retrieved from https://journals.iium.edu.my/iiibf-journal/index.php/jif/article/view/329.

53. Jeong, B.-G., Youn, T.-Y., Jho, N.-S., & Shin, S. U. (2020). Blockchain-Based Data Sharing and Trading Model for the Connected Car. *Sensors (Basel, Switzerland), 20*(11), 3141. doi:10.3390/s20113141

54. Khalfan, K. A., & Ogura, N. (2012). The Contribution of IslamicWaqfto Managing the Conservation of Buildings in the Historic Stone Town of Zanzibar. *International Journal of Cultural Property, 19*(2), 153-174. doi:10.1017/s0940739112000112

55. Kosba, A., Miller, A., Shi, E., Wen, Z., & Papamanthou, C. (2016, 22-26 May 2016). *Hawk: The Blockchain Model of Cryptography and Privacy-Preserving Smart Contracts*. Paper presented at the 2016 IEEE Symposium on Security and Privacy (SP).

56. Kuran, T. (2001). The Provision of Public Goods under Islamic Law: Origins, Impact, and Limitations of the Waqf System. *Law & Society Review, 35*(4), 841-898. doi:10.2307/3185418.

57. Kuran, T. (2012). *The Long Divergence: How Islamic Law Held Back the Middle East*. Princeton: Princeton University Press.

58. Lamoureaux, N. (2009). Scylla or Charybdis? Historical Reflections on Two Basic Problems of Corporate Governance. *Business History Review, 83*, 9-34.

59. Landes, D. S., Mokyr, J., & Baumol, W. J. (2012). *The Invention of Enterprise: Entrepreneurship from Ancient Mesopotamia to Modern Times*. Princeton: Princeton University Press.

60. Layish, A. (1997). The Family Waqf and the Sharʿī Law of Succession in Modern Times. *Islamic Law and Society, 4*(3), 352-388. Retrieved from www.jstor.org/stable/3399366.

61. Layish, A. (2008). Waqfs of Awlād al-Nās in Aleppo in the Late Mamlūk Period as Reflected in a Family Archive. *Journal of the Economic and Social History of the Orient, 51*(2), 287-326. doi:10.1163/156852008x307456.

62. Li, J., Greenwood, D., & Kassem, M. (2019). Blockchain in the built environment and construction industry: A systematic review, conceptual models and practical use cases. *Automation in Construction, 102*, 288-307.

63. Liu, C., & Wang, H. (2019). Crypto Tokens and Token Offerings: An Introduction. In S. Goutte, K. Guesmi, & S. Saadi (Eds.), *Cryptofinance and Mechanisms of Exchange: The Making of Virtual Currency* (pp. 125-144). Cham: Springer International Publishing.

64. Lu, H., Huang, K., Azimi, M., & Guo, L. (2019). Blockchain Technology in the Oil and Gas Industry: A Review of Applications, Opportunities, Challenges, and Risks. *IEEE Access, 7*, 41426-41444. doi:10.1109/ACCESS.2019.2907695.

65. Management, R. (Producer). (2018). The Finterra WAQF Chain with Hamid Rashid, Founder and CEO Finterra @Finterra2u. [Video file] Retrieved from youtube.com/watch?v=XipYn2ATt7Q.

66. Mandaville, J. E. (1979). Usurious Piety: The Cash Waqf Controversy in the Ottoman Empire. *International Journal of Middle East Studies, 10*(3), 289-308. Retrieved from www.jstor.org/stable/162140

67. Masruki, R., Mohd Hanefah, M., Aryani, D. N., & Bunyamin. (2019). Performance measurements of socio-economic impact for waqf (endowment) institutions. *International Journal of Innovation, Creativity and Change, 7*(6), 1-16.

68. Masruki, R., & Shafii, Z. (2013). The development of Waqf accounting in enhancing accountability. *Middle-East Journal of Scientific Research, 13*, 1-6. doi:10.5829/idosi.mejsr.2013.13.1873

69. Massey, R., Dalal, D., & Dakshinamoorthy, A. (2017). *Initial coin offering: A new paradigm*. Retrieved from Deloitte: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-cons-new-paradigm.pdf.

70. McChesney, R. D. (2014). *Waqf in Central Asia: Four Hundred Years in the History of a Muslim Shrine, 1480-1889*: Princeton University Press.

71. Md Zabri, M. Z., & Mohammed, M. O. (2018). Qualitative validation of a financially affordable Islamic home financing model. *ISRA International Journal of Islamic Finance, 10*(2), 143-161. doi:10.1108/ijif-08-2017-0023.

72. Meiklejohn, S., Pomarole, M., Jordan, G., Levchenko, K., McCoy, D., M. Voelker, G., & Savage, S. (2013). *A fistful of bitcoins: characterizing payments among men with no names*. Paper presented at the Proceedings of the 2013 conference on Internet measurement conference, Barcelona, Spain. https://doi.org/10.1145/2504730.2504747.

73. Melčák, M. (2010). The development of Dīwān al-awqāf in Egypt in the 19th century: Regulations of 1837 and 1851. *Oriental Archives, 78*(1), 1-34.

74. Mettler, M. (2016, 14-16 Sept. 2016). *Blockchain technology in healthcare: The revolution starts here*. Paper presented at the 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom).

Review of Blockchain Technology in Managing Waqf (Endowment)

75. Mik, E. (2017). Smart contracts: terminology, technical limitations and real world complexity. *Law, Innovation and Technology, 9*(2), 269-300. doi:10.1080/17579961.2017.1378468.

76. Mikail, S. A., Ahmad, M. A. J., & Adekunle, S. S. (2017). Utilisation of zakāh and waqf fund in micro-takāful models in Malaysia: an exploratory study. *ISRA International Journal of Islamic Finance, 9*(1), 100-105. doi:10.1108/ijif-07-2017-010

77. Moh'd, I. S., Mohammad, M. O., & Saiti, B. (2017). The Role of Waqf and Trust Commission (WTC) in Zanzibar : Problems and Prospects. *Journal of Islamic Economics Banking and Finance, 13*(1), 96-107. doi:10.12816/0051157

78. Moh'd, I. S., Omar Mohammed, M., & Saiti, B. (2017). The problems facing agricultural sector in Zanzibar and the prospects of Waqf-Muzar'ah-supply chain model. *Humanomics, 33*(2), 189-210. doi:10.1108/h-02-2017-0033

79. Mohamad, N. A. (2018). A Study on the Socio-Economic Roles of Waqf Ahli (Family Waqf) in Promoting Family Security and a Sustainable Family Economy. *IIUM Law Journal, 26*(1), 141. doi:10.31436/iiumlj.v26i1.383.

80. Mohamed, H., & Ali, H. (2018). *Blockchain, Fintech, and Islamic Finance: Building the Future in the New Islamic Digital Economy.* Berlin: Walter De Gruyter.

81. Mohammad, M. T. S. (2011). Towards an Islamic Social (Waqf) Bank. *International Journal of Trade, Economics and Finance*, 381-386. doi:10.7763/IJTEF.2011.V2.135

82. Mohd Thas Thaker, M. A., Mohd Thas Thaker, H., & Pitchay, A. A. (2018). Modeling crowdfunders' behavioral intention to adopt the crowdfunding-waqf model (CWM) in Malaysia. *International Journal of Islamic and Middle Eastern Finance and Management, 11*(2), 231-249. doi:10.1108/imefm-06-2017-0157.

83. Musaee, A. H. M., Muhammad Abbas, E., Kamal Mujan, W., & Sidik, R. (2014). Waqf Land in the West Bank and Investment Current State of Affairs. *Asian Social Science, 10*(14). doi:10.5539/ass.v10n14p23

84. Nahar, H. S., & Yaacob, H. (2011). Accountability in the sacred context. *Journal of Islamic Accounting and Business Research, 2*(2), 87-113. doi:10.1108/17590811111170520.

85. Noor, A. b. M., & Yunus, S. b. M. (2014). Application of the Build, Operate, Transfer (bot) Contract as a Means of Financing Development of Waqf Land: Malaysian Experience. *Arab Law Quarterly, 28*(2), 136. doi:https://doi.org/10.1163/15730255-12341281

86. Noordin, N. H., Haron, S. N., & Kassim, S. (2017). Developing a comprehensive performance measurement system for waqf institutions. *International Journal of Social Economics, 44*(7), 921-936. doi:10.1108/ijse-09-2015-0257.

87. Oliveira, L., Zavolokina, L., Bauer, I., & Schwabe, G. (2018). *To Token or not to Token: Tools for Understanding Blockchain Tokens.* Paper presented at the International Conference of Information Systems (ICIS 2018), San Francisco, USA. https://www.zora.uzh.ch/id/eprint/157908/.

88. Pianciola, N., & Sartori, P. (2007). Waqfin Turkestan: the colonial legacy and the fate of an Islamic institution in early Soviet Central Asia, 1917–1924. *Central Asian Survey, 26*(4), 475-498. doi:10.1080/02634930802017929.

89. Pitchay, A. A., Mohd Thas Thaker, M. A., Mydin, A. A., Azhar, Z., & Abdul Latiff, A. R. (2018). Cooperative-waqf model: a proposal to develop idle waqf lands in Malaysia. *ISRA International Journal of Islamic Finance, 10*(2), 225-236. doi:10.1108/ijif-07-2017-0012.

90. Rahaman, C. M. S., Fahmi, G. M., & Faisol, I. M. (2011). Economics of Cash Waqf management in Malaysia: A proposed Cash Waqf model for practitioners and future researchers. *African Journal of Business Management, 5*.

91. Rashid, S. K. (2018). Potential of Waqf in Contemporary World. *journal of king*

Abdulaziz University Islamic Economics, 31(2), 53-69. doi:10.4197/Islec.31-2.4

92. Raval, S. (2016). *Decentralized Applications: Harnessing Bitcoin's Blockchain Technology.* Newton: O'Reilly Media.

93. Rothstein, B. O., & Broms, R. (2013). Governing religion: the long-term effects of sacred financing. *Journal of Institutional Economics, 9*(4), 469-490. doi:10.1017/S1744137413000271.

94. Sadeq, A. M. (2002). Waqf, perpetual charity and poverty alleviation. *International Journal of Social Economics, 29*(1/2), 135-151. doi:10.1108/03068290210413038.

95. Salmon, J., & Myers, G. (2019). *Blockchain and Associated Legal Issues for Emerging Markets.* Retrieved from https://openknowledge.worldbank.org/handle/10986/31202.

96. Sanusi, S., & Mohd Shafiai, M. H. (2015). The Management of Cash Waqf: Toward Socio-Economic Development of Muslims in Malaysia. *Jurnal Pengurusan (UKM Journal of Management); Vol 43 (2015), 43.* Retrieved from http://ejournal.ukm.my/pengurusan/article/view/11117.

97. Schrepel, T. (2019). Collusion by Blockchain and Smart Contracts. *Harvard Journal of Law and Technology, 33.* doi:https://dx.doi.org/10.2139/ssrn.3315182.

98. Shaikh, S. A., Ismail, A. G., & Mohd Shafiai, M. H. (2017). Application of waqf for social and development finance. *ISRA International Journal of Islamic Finance, 9*(1), 5-14. doi:10.1108/ijif-07-2017-002

99. Shatzmiller, M. (2001). Islamic Institutions and Property Rights: The Case of the 'Public Good' Waqf. *Journal of the Economic and Social History of the Orient, 44*(1), 44-74. Retrieved from www.jstor.org/stable/3632558.

100. Singer, A. (2008). *Charity in Islamic Societies.* Cambridge: Cambridge University Press.

101. Siswantoro, D., Rosdiana, H., & Fathurahman, H. (2018). Reconstructing accountability of the cash waqf (endowment) institution in Indonesia. *Managerial Finance, 44*(5), 624-644. doi:10.1108/ mf-05-2017-0188.

102. Smolo, E. (2019). The Role of Waqf (Endowment) in Economic Development of Bosnia and Herzegovina: A Historical Overview and Future Prospects. In K. M. Ali, M. K. Hassan, & A. e. E. S. Ali (Eds.), *Revitalization of Waqf for Socio-Economic Development, Volume I* (pp. 85-105). Cham: Springer International Publishing.

103. Suhaimi, F. M., Ab Rahman, A., & Marican, S. (2014). The role of share waqf in the socio-economic development of the Muslim community: The Malaysian experience. *Humanomics, 30*(3), 227-254. doi:10.1108/h-12-2012-0025.

104. Sulaiman, M., & Zakari, M. A. (2019). Financial sustainability of state waqf institutions (SWIs) in Malaysia. *Journal of Islamic Accounting and Business Research, 10*(2), 236-258. doi:10.1108/jiabr-05-2016-0054.

105. Tieman, M., & Darun, M. R. (2017). Leveraging blockchain technology for halal supply chains. *Islam and Civilisational Renewal, 274*(5750), 1-4.

106. Wan Ahmad, W. M., & Ab Rahman, A. (2011). The Concept of Waqf and its Application in an Islamic Insurance Product: The Malaysian Experience. *Arab Law Quarterly, 25*(2), 203-219. doi:10.1163/157302511x553994

107. Yaakob, A., Mahzir, N., Supaat, D., Zakaria, M. Z., Wook, I., & Mustafa, M. (2017). Waqf as a Means of Forest Conservation: Alternative for Malaysia. *Advanced Science Letters, 23*, 4860-4864. doi:10.1166/asl.2017.8928.

108. Yaga, D., Mell, P., Roby, N., & Scarfone, K. (2019). Blockchain technology overview. *arXiv preprint arXiv:1906.11078.* doi:10.6028/NIST.IR.8202

109. Yahya, S. S. (2008). Financing social infrastructure and addressing poverty through wakf endowments: experience from Kenya and Tanzania. *Environment and Urbanization, 20*(2), 427-444. doi:10.1177/0956247808096121.

110. Yayla, H. E. (2011). Operating regimes of the government: Accounting and accountability changes in the Sultan Süleyman Waqf of the Ottoman Empire (The 1826 Experience).

Review of Blockchain Technology in Managing Waqf (Endowment)

Accounting History, 16(1), 5-34. doi:10.1177/
1032373210389320.

111. Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang,
     H. (2017). *An Overview of Blockchain
     Technology: Architecture, Consensus, and
     Future Trends.* Paper presented at the 2017
     IEEE International Congress on Big Data
     (BigData Congress).

112. Zīle, K., & Strazdiņa, R. (2018). Blockchain
     Use Cases and Their Feasibility. *Applied
     Computer Systems, 23*(1), 12-20. doi:10.
     2478/acss-2018-0002.

113. Zilli, I. A. (2018). Waqf 'Ala Al-'Awlād A Case
     of Colonial Intervention in India. *Intellectual
     Discourse, 26*(2), 989–1005. Retrieved from
     https://journals.iium.edu.my/intdiscourse/i
     ndex.php/islam/article/view/1253.

114. Zubaidi, I., & Abdullah, A. (2017). Developing
     a Digital Currency from an Islamic
     Perspective: Case of Blockchain Technology.
     International Business Research, 10, 79.
     doi:10.5539/ibr.v10n11p79.