

| Research Article |

Blockchain-Based Digitalization of Zakat and Waqf for Sustainable Infrastructure and Economic Development: A Conceptual Model for Indonesia.

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Abstract: Officially recorded zakat in Indonesia remains far below its estimated potential: in 2023 zakat recorded on the balance sheets of official institutions was IDR 4.05 trillion (within a total collection of zakat, infaq, sadaqah and other social funds of IDR 32.32 trillion), against an estimated potential of IDR 327.6 trillion, while cumulative cash waqf stood at about IDR 2.23 trillion against an estimated potential of IDR 130–180 trillion. Informal giving explains part of this gap, but limited transparency in formal institutions is also widely documented. Drawing on trust and agency theory, this study develops a conceptual model of blockchain-based zakat and waqf digitalization for Indonesia, informed by the Design Science Research Methodology. A structured corpus of literature, regulations, fatwas and official reports was analysed through qualitative content analysis. The resulting Blockchain Zakat–Waqf for Sustainable Development (BZW-SD) model has four functional layers (stakeholders, digital collection, a permissioned consortium ledger with five *smart contracts*, and milestone-based disbursement verified by a multi-party oracle) and a cross-cutting governance layer. Funds remain in rupiah in Islamic bank accounts; the ledger records only metadata and hashes, and no tradable token is issued. Zakat is directed to the productive empowerment of recipients (SDG 8) and waqf to productive and social assets (SDG 9), so the model sidesteps, rather than resolves, the debate on zakat for infrastructure. The model is demonstrated through pseudocode and an illustrative case and evaluated against six design criteria. Its novelty lies in integrating zakat, infaq/sadaqah and waqf in one ledger with encoded statutory limits and an indicator-based SDG mapping. Six theory-based propositions are offered for empirical testing.

Keywords: Sharia compliance by design; Design Science Research; Islamic social finance; *smart contract*; SDGs



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Introduction

Zakat and waqf are the two main pillars of Islamic social finance and have historically played a major role in the development of civilization. During the height of the Ottoman Empire, waqf institutions financed roads, bridges, waterways, hospitals, and schools without relying on the state treasury (Çizakça, 2000). Zakat, as a redistributive religious obligation, serves to reduce poverty and inequality (Ahmed, 2004; al-Qaradawi, 1999). Within the framework of modern development, both instruments are considered aligned with the *Sustainable Development Goals* (SDGs), particularly poverty alleviation, inclusive economic growth, and infrastructure development (Abdullah, 2018; United Nations, 2015).

Indonesia, the country with the largest Muslim population in the world, has substantial Islamic social finance potential, but the official figures need to be read with care. The most widely cited estimate of national zakat potential, IDR 327.6 trillion, was produced by the BAZNAS Center of Strategic Studies using its Zakat Potential Mapping Indicator for 2020. It aggregates corporate zakat (IDR 144.5 trillion), zakat on income and services (IDR 139.07 trillion), zakat on savings (IDR 58.76 trillion), agricultural zakat (IDR 19.79 trillion) and livestock zakat (IDR 9.52 trillion) (Pusat Kajian Strategis BAZNAS, 2021). Against this estimate, the National Zakat Management Report records a 2023 collection of IDR 32.32 trillion. This figure, however, covers all zakat, infaq, sadaqah and other religious social funds (ZIS-DSKL). Zakat recorded on the balance sheets of official zakat institutions amounted to only IDR 4.05 trillion (zakat mal IDR 3.66 trillion and zakat fitrah IDR 0.38 trillion), while IDR 21.99 trillion (68.02% of the total) was reported as off-balance-sheet collection (Badan Amil Zakat Nasional [BAZNAS], 2024). Even if all off-balance-sheet collection were zakat, recorded zakat would be at most about IDR 26 trillion, or roughly 8% of the estimated potential.

The picture for waqf is similar, with one additional caveat. Cash waqf figures reported by the Indonesian Waqf Board (BWI) are cumulative stocks, not annual flows. Cumulative cash waqf had reached about IDR 2.23 trillion, of which IDR 840 billion was placed in Cash Waqf Linked Sukuk (CWLS), against a national potential that BWI estimates at between IDR 130 and 180 trillion (Saptono, 2023). Even this generous comparison of a multi-year stock with a single year's potential implies a realization rate below 2%. Waqf land also remains dominated by traditional uses: of 440,512 registered parcels, 72% are used for mosques and prayer rooms, 14.5% for schools and pesantren, and 4.3% for cemeteries (Saptono, 2023).

The potential–realization gap should not be read as direct evidence of a trust deficit. A large share of zakat in Indonesia is paid informally, directly to recipients, to mosque committees, or to unregistered bodies; BAZNAS estimates that more than 85% of zakat realization flows outside official zakat institutions (Pusat Kajian Strategis BAZNAS, 2021). Such giving is real but unrecorded, so the measured gap partly reflects a recording gap rather than a giving gap. Nevertheless, survey and qualitative studies consistently show that perceived transparency, accountability, and the ability

to see how funds are used shape whether payers choose official institutions over direct giving (Bin-Nashwan et al., 2020; Kasri & Yuniar, 2021; Zulfikri et al., 2022). The same holds for cash waqf, where trust is a significant determinant of online waqf intention (Kasri & Chaerunnisa, 2022). The working assumption of this study is therefore deliberately limited: limited transparency is *one* of several reasons why funds stay outside the formal system, alongside giving habits, literacy and regulation, and a design that makes fund flows verifiable may help shift part of informal giving into channels that can be recorded, audited and directed to development goals.

At the same time, Indonesia faces a substantial infrastructure financing gap. The National Medium-Term Development Plan (RPJMN) 2020–2024 estimated infrastructure investment needs at IDR 6,445 trillion, of which only about 37% could be financed from central and regional government budgets, 21% from state-owned enterprises and the remaining 42% had to come from the private sector and other sources (Republik Indonesia, 2020). The need is particularly acute for basic social infrastructure such as schools, health facilities, clean water and sanitation in underdeveloped regions. Islamic social finance has already been used to fill part of this gap. Returns on CWLS, through which cash waqf is placed in sovereign sukuk, have financed health facilities such as a retina and glaucoma centre, as well as scholarships and agricultural programmes (Rochaniah & Faizah, 2025; Kirana, 2025). Waqf, with its perpetual principal and continuously flowing benefits, is conceptually well suited to financing long-term assets (Kahf, 2003; Shaikh et al., 2017).

Blockchain technology is frequently proposed as a response to these problems of trust and traceability. A blockchain is a distributed ledger that records transactions in an append-only, traceable form that is difficult for any single party to alter (Nakamoto, 2008; Zheng et al., 2017). Through *smart contracts*, transaction rules can be written in code that executes automatically when specified conditions are met (Szabo, 1997; Buterin, 2014). In Islamic finance these characteristics are considered consistent with the principles of trustworthiness (*amanah*), justice and the avoidance of *gharar* (Mohamed & Ali, 2019; Rabbani et al., 2020). A growing literature examines FinTech and blockchain in Islamic finance generally (Hasan et al., 2020; Oseni & Ali, 2019) and, more recently, in zakat and waqf specifically, as reviewed in the next section.

Building on that review, this study addresses three research questions. *First*, Which design requirements for a blockchain-based zakat–waqf system follow from the documented problems of zakat and waqf management in Indonesia? *Second*, How can a blockchain architecture integrate zakat, infaq/sadaqah and waqf flows in a way that is technically feasible and compatible with Indonesian regulation? *Third*, To what extent does the resulting model satisfy Sharia requirements and the design criteria, and through which pathways can it contribute to SDG 8 and SDG 9? The theoretical contribution is an integrated, theory-grounded model with testable propositions; the practical contribution is a reference architecture for regulators and managing institutions.

Literature Review and Theoretical Foundation

State of the Art: Blockchain for Zakat and Waqf

Table 1 summarizes the studies and platforms identified through the literature search described in the Method section. Three strands are visible. The first consists of conceptual models proposing blockchain and *smart contracts* for zakat institutions (Zulfikri et al., 2021; Nazeri & Mohd Nor, 2023) or waqf asset management (Setiawan & Nurzaman, 2022; Mutmainah et al., 2021). The second consists of adoption studies that test intention to use blockchain-based zakat systems with TAM, UTAUT or related models (Zulfikri et al., 2023; Afifah et al., 2025; Juniati & Widiastuti, 2026). The third consists of industry platforms, notably Finterra's WAQF Chain, which uses blockchain to crowdfund waqf (Naoual, 2022), and Blossom Finance's SmartSukuk, which issued a micro-sukuk for an Indonesian Islamic microfinance cooperative on the public Ethereum network in 2019 (Blossom Finance, 2019).

Table 1: State of the art of blockchain-based zakat and waqf studies and platforms

Study / platform	Context and method	Main components	Limitations relative to this study
Zulfikri et al. (2021)	Indonesia (BAZNAS); conceptual	Blockchain and <i>smart contracts</i> to track zakat from payer to recipient to enhance trust	Zakat only; no waqf; no encoded Sharia rules; no technical or regulatory specification
Mutmainah et al. (2021)	Indonesia; literature review	Blockchain and crowdfunding for waqf fundraising	No architecture; focuses on enabling conditions and literacy
Setiawan & Nurzaman (2022)	Indonesia; qualitative, secondary data	Decentralized recording of waqf assets with <i>smart contracts</i>	Waqf assets only; link to fiat payments and impact indicators not addressed
Zulfikri et al. (2022)	Indonesia; qualitative interviews	Trust drivers (reputation, distribution satisfaction, service quality, transparency) and blockchain	Explains trust; no system design
Naoual (2022) on Finterra WAQF Chain	Malaysia/global; case description	Blockchain crowdfunding of waqf, investment and peer-to-peer lending	Platform-specific and token-oriented; compatibility with Indonesian payment and crypto rules not examined
Blossom Finance (2019)	Indonesia; industry pilot	Micro-sukuk issued on the public Ethereum network for a BMT	Commercial sukuk, not zakat or waqf; public chain
Zulfikri et al. (2023)	Indonesia; conceptual, TAM	Adoption framework for zakat institutions	Adoption, not design
Nazeri & Mohd Nor (2023)	Malaysia; conceptual	Blockchain zakat management system	Zakat only; state-based Malaysian setting
Khairi et al. (2024)	Malaysia and Indonesia; content analysis	Strategies and applications for zakat collection and distribution	Descriptive; no integrated model

Study / platform	Context and method	Main components	Limitations relative to this study
Afifah et al. (2025); Juniati & Widiastuti (2026)	Indonesia; surveys (TRUTAUT, UTAUT), mixed methods	Determinants of intention to adopt blockchain for zakat; trust in e-zakat is significant	Demand-side adoption; no architecture
This study (BZW-SD)	Indonesia; conceptual model informed by DSRM	Integrated zakat–infaq–waqf ledger; fiat-anchored, no token; five <i>smart contracts</i> with statutory limits; multi-party oracle; SDG indicator mapping; theory-based propositions	Not yet validated empirically or by experts (see Limitations)

Three gaps emerge from this review. First, existing models treat zakat or waqf in isolation; none integrates both, together with infaq/sadaqah, in a single ledger that keeps their juristic regimes separate. Second, none specifies how fiat payments made through Indonesian channels are linked to the ledger, or how the design complies with the prohibition of crypto as a means of payment. Third, Sharia rules are generally invoked as principles rather than translated into executable rules, and statutory limits such as the amil share and the nazhir share are not encoded. Fourth, although trust is the central motivation of nearly all studies, conceptual models rarely derive testable propositions from an explicit theory.

Theoretical Foundation: Trust Theory and Agency Theory

This study draws on two complementary theories. Trust theory defines trust as the willingness of one party to be vulnerable to the actions of another, based on perceptions of the other's ability, benevolence and integrity (Mayer et al., 1995). When parties cannot observe each other directly, trust also rests on *institution-based* mechanisms, especially structural assurance: the belief that guarantees, rules and verifiable records make a good outcome likely (McKnight et al., 1998). A payer who gives zakat to an institution cannot observe how the funds are used; a ledger that lets the payer verify the flow of funds, and that enforces Sharia rules by design, functions as structural assurance and as an observable signal of integrity.

Agency theory views the relationship between payers or donors (principals) and the amil or nazhir (agents) as one in which the agent has more information than the principal, creating monitoring and bonding costs (Jensen & Meckling, 1976). Payers respond to information asymmetry either by incurring monitoring costs or by bypassing the agent, which in the Indonesian context means direct, informal giving. Blockchain can reduce monitoring costs by making records shared and tamper-evident, and *smart contracts* can act as bonding mechanisms that constrain the agent's discretion, for example by capping the amil share or releasing project funds only after verified milestones. The same logic applies within the chain of disbursement: staged release of productive zakat capital limits moral hazard on the part of recipients.

Finally, the concept of *compliance by design* comes from the regulatory technology (RegTech) literature, where regulatory requirements are embedded in the technical infrastructure so that compliance is monitored continuously and violations are prevented *ex ante* rather than detected *ex post*. This study applies the concept to Sharia requirements, referred to below as *Sharia compliance by design*. Together, the two theories and this design principle provide the basis for the propositions developed in the Results section.

Method

Research Approach and Design

This study adopts a qualitative approach with a conceptual research design. Jaakkola (2020) distinguishes four types of conceptual articles, namely *theory synthesis*, *theory adaptation*, *typology*, and *model*. This study falls into the *model* type, i.e., an article that builds a framework to explain relationships between concepts and to predict how a system works. This approach was chosen because the application of blockchain to zakat and waqf in Indonesia is still limited, so adequate empirical data for quantitative testing are not yet available.

The study is positioned as *conceptual model development informed by* the Design Science Research Methodology (DSRM) of Peffers et al. (2007), which is grounded in the design science paradigm of Hevner et al. (2004). DSRM comprises six activities: problem identification, definition of solution objectives, design and development, demonstration, evaluation, and communication. The first three activities are carried out in full. Demonstration is carried out in a limited, non-technical form through *smart contract* pseudocode (Box 1) and an illustrative numerical case (Table 5), rather than through a working prototype. Evaluation is an *ex ante* conceptual evaluation conducted by the authors against explicit criteria (Table 6); it does not replace external validation by experts or users, which is left to further research. This positioning is stated explicitly to avoid overclaiming the use of DSRM.

Data Sources and Literature Search Protocol

The research data are secondary data in four groups: (1) scholarly literature; (2) regulations, namely Law No. 23 of 2011 on Zakat Management, Law No. 41 of 2004 on Waqf, Government Regulation No. 42 of 2006, BWI Regulation No. 1 of 2020 on the management and development of waqf assets, BAZNAS Regulation No. 1 of 2016, Law No. 27 of 2022 on Personal Data Protection, Law No. 4 of 2023 on the Development and Strengthening of the Financial Sector, and the relevant Bank Indonesia and OJK regulations (Republik Indonesia, 2004, 2006, 2011b, 2022, 2023; BAZNAS, 2016; Badan Wakaf Indonesia [BWI], 2020); (3) fatwas, namely MUI fatwas on cash waqf (2002), the use of zakat for *istitsmar* (No. 4 of 2003), *amil* zakat (No. 8 of 2011) and the use of zakat, infaq, sadaqah and waqf for clean water and sanitation (No. 001/MUNAS-IX/MUI/2015); DSN-MUI Fatwas No. 116/2017 on Sharia electronic money, No. 117/2018 on information technology-based financing services and No.

140/2021 on waqf of insurance and investment benefits; and the 2021 decision of the Seventh Ijtima Ulama of the MUI Fatwa Commission on cryptocurrency (Majelis Ulama Indonesia [MUI], 2002, 2003, 2011, 2015, 2021; Dewan Syariah Nasional Majelis Ulama Indonesia [DSN-MUI], 2017, 2018, 2021); and (4) official data and reports of BAZNAS, BWI and the Ministry of National Development Planning (Bappenas).

Scholarly literature was retrieved through a structured search following a simplified version of the PRISMA 2020 reporting logic (Page et al., 2021). Table 2 summarizes the protocol. Regulations and fatwas were retrieved purposively from official repositories, and institutional data were taken only from primary publications of the issuing institution.

Table 2: Literature search protocol and final corpus

Element	Specification
Databases	Scopus-indexed publisher platforms (Emerald Insight, Springer, Elsevier, MDPI), Google Scholar, and the Garuda portal for SINTA-accredited Indonesian journals
Search strings	("blockchain" OR "distributed ledger" OR "smart contract") AND ("zakat" OR "waqf" OR "wakaf" OR "Islamic social finance"); supplementary strings on "cash waqf linked sukuk", "digital zakat", "trust" AND "zakat", and "blockchain oracle"
Time range	2017–2025 for blockchain-related studies; no restriction for foundational works on zakat, waqf, trust, agency and design science
Inclusion criteria	Peer-reviewed articles, book chapters and scholarly books in English or Indonesian that propose, evaluate or explain blockchain use in zakat or waqf, or that provide evidence on trust, transparency or infrastructure finance in Islamic social finance
Exclusion criteria	Non-scholarly opinion pieces; studies on cryptocurrency trading or pricing only; duplicates; documents without accessible full text or abstract sufficient for coding
Screening	Titles and abstracts screened against the criteria, followed by full-text reading of retained documents; backward citation search of retained studies
Final corpus	73 documents analysed: 45 scholarly works (17 of them published in 2021–2026), 13 regulations, 8 fatwas or fatwa decisions, and 7 institutional reports, official datasets or industry sources. Methodological references (e.g., on DSRM and content analysis) are cited separately and not counted in the corpus

Research Stages and Analysis Procedure

- 1. Problem identification.** Mapping the documented problems of zakat and waqf management from official data and the literature, distinguishing problems that a ledger can plausibly address from those it cannot (e.g., informal giving habits).
- 2. Definition of solution objectives.** Deriving six design criteria from the problems through an explicit problem–criterion linkage (Table 6).
- 3. Literature synthesis.** Qualitative content analysis of the corpus (Elo & Kyngäs, 2008). Coding combined a deductive codebook with inductive codes. The deductive codebook had five top-level categories derived from the DSRM design elements: (a) problems and evidence, (b) actors and roles, (c) technical mechanisms (ledger type, consensus, *smart contracts*, oracles, data storage), (d) Sharia and legal rules (with sub-codes for zakat recipients, amil share, waqf

principal, nazhir share, contracts, data protection), and (e) impact indicators. Inductive codes were added when a recurring theme did not fit the codebook, for example *informal giving* and *token status*. Coding was performed in a spreadsheet codebook that recorded, for each coded segment, the document, the code, a verbatim excerpt and the model component it informed, creating an audit trail.

4. **Model design.** Developing a layered conceptual model covering actors, technology architecture, *smart contract* design, separate fund and data flows, and cross-cutting governance.
5. **Demonstration and conceptual evaluation.** Demonstrating the model through pseudocode and an illustrative numerical case, and evaluating it through three lenses: (a) logical consistency among components, (b) conformity with Sharia principles, regulation and *maqāṣid al-sharī'ah*, and (c) fulfilment of the six design criteria, rated as *full*, *partial* or *not yet* with supporting arguments (Table 6). The results were then formulated into theory-based propositions.

Trustworthiness of the Synthesis and Methodological Limitations

The credibility and trustworthiness of the synthesis (Lincoln & Guba, 1985) were supported by source triangulation, i.e., by comparing evidence from academic literature, regulations, fatwas and institutional data; by using primary institutional sources for all quantitative claims; by the audit trail of the coding; and by peer debriefing among the authors on disputed codes. Triangulation establishes the credibility of the synthesis, not the validity of the model itself. Model validity requires external validation, which this study has not yet undertaken. The model is therefore presented together with propositions that can be tested through expert validation (e.g., a Delphi study or focus group with Sharia, IT and institutional experts), the *Analytic Network Process* (ANP), surveys, or a system *prototype*.

Results and Discussion

Problems of Zakat and Waqf Management and Design Requirements (RQ1)

The synthesis yields six problems that form the basis of the model design (Table 3). Each is supported by primary data or by peer-reviewed evidence specific to zakat and waqf, and each is paired with the ledger feature that is relevant to it. The table also shows what a ledger cannot do: it cannot by itself change informal giving habits or raise literacy.

Table 3: Problems in zakat and waqf management, evidence and relevant features

Problem	Evidence and sources	Relevant feature
(1) Low recorded collection and large informal channel	Recorded zakat IDR 4.05 trillion on balance sheet in 2023; IDR 21.99 trillion off balance sheet (BAZNAS, 2024); >85% of zakat realization outside official institutions (Pusat Kajian Strategis BAZNAS, 2021); cumulative cash waqf IDR 2.23 trillion vs. potential IDR 130–180 trillion (Saptono, 2023)	Convenient digital payment with a verifiable receipt; recording of off-balance-sheet collection by collection units
(2) Trust deficit among payers and donors	Trust and transparency affect zakat compliance and online cash waqf intention (Bin-Nashwan et al., 2020; Kasri & Yuniar, 2021; Kasri & Chaerunnisa, 2022); payers bypass institutions they perceive as opaque (Zulfikri et al., 2022)	Tamper-evident shared ledger; public dashboard; encoded Sharia rules as structural assurance
(3) Limited traceability of distribution and duplicate recipients	Payers cite lack of disclosure on fund use as a reason for direct giving (Zulfikri et al., 2022); low CWLS take-up linked to transparency concerns (Rochaniah & Faizah, 2025)	Fund-level traceability from receipt to disbursement; recipient matching across institutions
(4) Fragmented recording and reporting	702 zakat institutions report separately; 36 did not submit 2023 reports (BAZNAS, 2024); most collection is recorded outside institutional balance sheets	Single shared ledger with automatic reconciliation between institutions and banks
(5) Sensitive recipient data held in scattered systems	Recipient data are personal data protected under Law No. 27 of 2022; matching across institutions requires sharing such data	Off-chain encrypted storage, pseudonymous identifiers and hashes on chain; private data collections
(6) Underproductive waqf and weak evidence of development impact	72% of waqf land used for mosques and prayer rooms (Saptono, 2023); impact of zakat programmes requires field instruments such as CIBEST (Beik & Arsyianti, 2016)	Milestone-based project financing; on-chain output indicators linked to off-chain outcome surveys

These findings are in line with Casino et al. (2019) and Kshetri (2018), who show that the main advantage of blockchain lies in lowering verification costs and building trust among parties who cannot observe each other. In the context of zakat and waqf, one of the core problems, alongside giving habits, literacy and regulation, is the lack of a mechanism that assures payers and donors that their trust (*amanah*) is properly fulfilled.

From these problems, six design criteria are derived: (1) **transparency**, meaning that transactions can be examined by authorized parties and summaries are public (problems 1 and 2); (2) **traceability**, meaning that each fund can be followed from receipt to disbursement (problem 3); (3) **efficiency**, meaning that reconciliation and disbursement time are reduced (problem 4); (4) **Sharia compliance**, meaning that encodable juristic and statutory rules are enforced automatically and the rest are routed to the Sharia Supervisory Board (problems 2 and 6); (5) **data protection**, meaning that the identity of zakat recipients (*mustahik*) is protected in line with Law No. 27 of 2022 (problem 5); and (6) **measurability of impact**, meaning that contributions to SDG 8 and SDG 9 can be monitored with official indicators (problem 6). Table 6 makes the linkage from problem to criterion to model component explicit.

The BZW-SD Model: Blockchain Zakat–Waqf for Sustainable Development (RQ2)

The BZW-SD model consists of four functional layers and one governance layer that cuts across all of them (Figure 1). The figure separates two flows that are often conflated in the literature: the **fund flow**, in which money moves in rupiah through Islamic banks, and the **data flow**, in which records of those movements are written to the ledger.

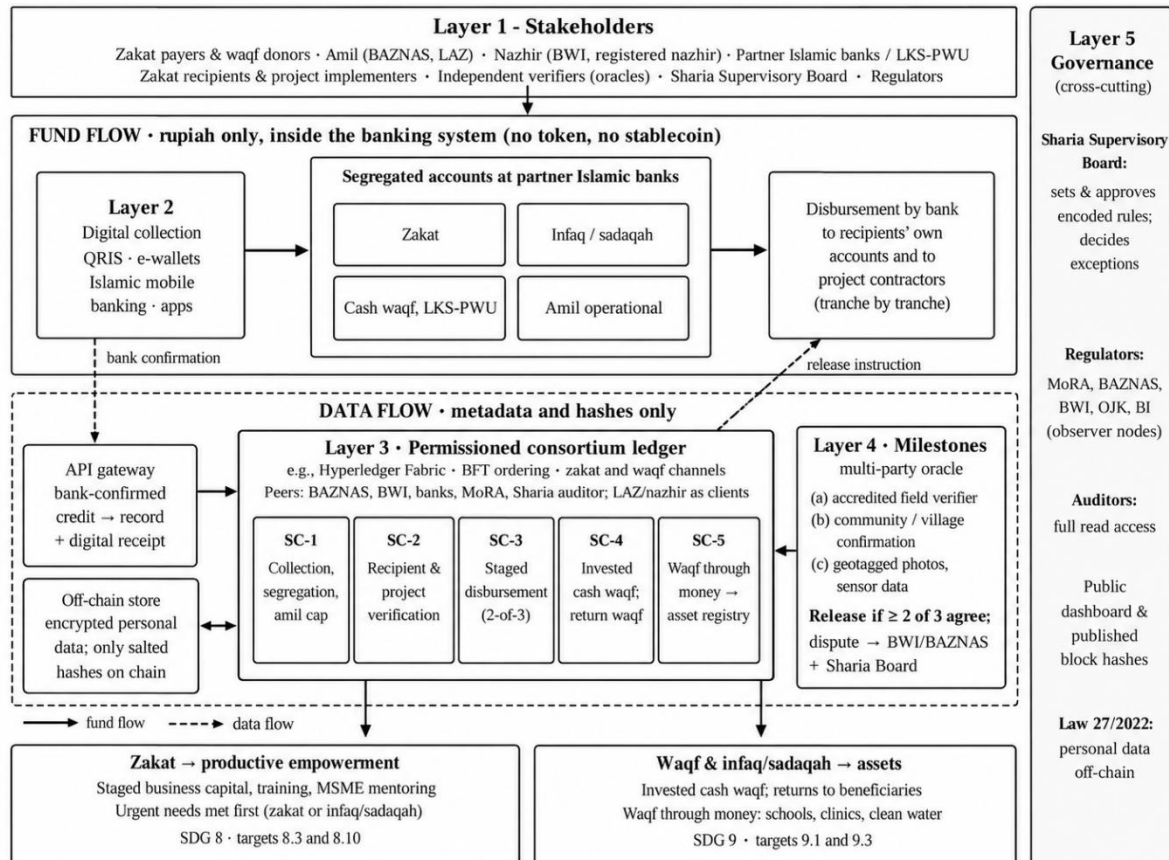


Figure 1: Architecture of the Blockchain Zakat–Waqf for Sustainable Development (BZW-SD) Model. Source: authors' design (2025).

Layer 1: Stakeholders. This layer consists of zakat payers and waqf donors as fund providers; zakat administrators (*amil*: BAZNAS and licensed zakat institutions, LAZ) and waqf managers (*nazhir*: BWI and registered nazhir) as managers; zakat recipients and project implementers as beneficiaries; partner Islamic banks, including those designated as Islamic Financial Institutions Receiving Cash Waqf (LKS-PWU); the Sharia Supervisory Board as the guarantor of compliance; independent verifiers who act as oracles; and regulators, namely the Ministry of Religious Affairs, BAZNAS, BWI, the Financial Services Authority (OJK) and Bank Indonesia.

Layer 2: Digital collection and the fiat–ledger link. Payers and donors use existing channels such as QRIS, e-wallets, Islamic mobile banking and institutional applications, which fall under Bank Indonesia's payment system regulation (Bank Indonesia, 2020) and, for Sharia electronic money, DSN-MUI Fatwa No. 116/DSN-

MUI/IX/2017 (DSN-MUI, 2017). Funds never leave the banking system and are never converted into a token or stablecoin. They are credited in rupiah to segregated accounts in partner Islamic banks: a zakat account, an infaq/sadaqah account, a cash waqf account at an LKS-PWU and an amil operational account. When the bank confirms a credit, an application programming interface (API) gateway writes a transaction record to the ledger containing the amount, fund type, the payer's declared intention (*niyyah*) and contract (*akad*), a timestamp, the bank reference and a pseudonymous payer identifier. The ledger therefore records metadata and hashes, not money. This design keeps the model within Law No. 7 of 2011 on Currency (Republik Indonesia, 2011a) and Bank Indonesia's prohibition on processing virtual currency as a means of payment (Bank Indonesia, 2016), and it avoids the 2021 Ijtima Ulama finding that cryptocurrency is impermissible as currency (MUI, 2021). The payer receives a non-transferable digital receipt that carries a transaction code; this receipt is a record, not an asset, and cannot be traded. Traceability is therefore end-to-end *within the formal system*, from bank credit to disbursement to the recipient's or contractor's account, but not beyond: how a recipient spends cash after disbursement is outside the ledger.

Layer 3: Permissioned consortium ledger and smart contracts. The model uses a permissioned consortium ledger, for which Hyperledger Fabric is a suitable reference platform because it supports organization-level identities, configurable endorsement policies, separate channels and private data collections (Androulaki et al., 2018). Peer nodes are operated by a limited set of organizations: BAZNAS (national, with provincial clusters), BWI, partner Islamic banks, the Ministry of Religious Affairs and an independent Sharia audit organization; OJK and Bank Indonesia may hold read-only observer nodes. The hundreds of LAZ and registered nazhir do not each run a node; they connect as client organizations through certified gateways with write rights limited to their own transactions, and large LAZ can be admitted as peers later. Zakat and waqf use separate channels so that their data and rules remain separate. Ordering uses a Byzantine fault-tolerant consensus protocol, which tolerates a minority of faulty or malicious ordering nodes. Because a permissioned network with few organizations is more exposed to collusion than a public blockchain, the claim that records are difficult to manipulate rests on three safeguards rather than on the ledger alone: endorsement policies that require signatures from organizations with different interests (e.g., the amil, the bank and the auditor for each disbursement); periodic publication of block hashes on the public dashboard so that any later alteration becomes detectable; and external audit. The design choice is justified by the personal nature of recipient data, the need for regulator access and the lower energy use and higher throughput of permissioned ledgers (Xu et al., 2019; Wang et al., 2019). This layer runs five *smart contracts* (Table 4).

Layer 4: Milestone-based disbursement and the oracle. Funds for waqf projects and productive zakat capital are released in stages. A blockchain guarantees the integrity of data once recorded but not the truth of the data entered, which is the oracle

problem (Caldarelli, 2020). The model therefore treats the oracle as a designed institution rather than a single data feed. Each milestone requires attestations from at least two of three independent sources: (a) an accredited field verifier, such as a public accounting firm or a university partner appointed by BWI or BAZNAS and paid a fixed fee from the operational budget, not from the project; (b) a representative of the beneficiary community or village government confirming through a mobile application; and (c) geotagged, time-stamped photographs or sensor data, such as water-meter readings. Verifiers' identities and attestations are recorded on chain, so their track record is visible. Verifiers who submit false reports are removed from the accredited list and are liable under their service contracts, and a random sample of milestones is re-audited each year. Disputed attestations freeze the tranche and are escalated to a dispute committee of BWI or BAZNAS and the Sharia Supervisory Board.

Layer 5: Governance (cross-cutting). Governance is not a final output but spans all layers. The Sharia Supervisory Board determines which rules are encoded, approves any change to the *smart contracts* and decides cases that cannot be decided automatically; regulators set data standards and access rights; and auditors have read access to the full ledger. A public dashboard shows aggregate collection, distribution and project progress. Personal data protection follows Law No. 27 of 2022 (Republik Indonesia, 2022): recipients' personal data are stored *off-chain* in encrypted databases controlled by the responsible institution, while the ledger stores only pseudonymous identifiers and salted hashes, and data shared between institutions travel through private data collections with access control. Deleting the off-chain record and its salt leaves an unlinkable hash on the ledger, which accommodates the right to erasure. Zero-knowledge proofs can be considered later for proving eligibility without revealing data. Payers and donors can trace their own funds using the transaction code on their receipt.

Table 4: *Smart contract design in the BZW-SD model*

<i>Smart contract</i>	<i>Function</i>	<i>Encoded rule and legal or juristic basis</i>
SC-1 Collection, segregation and amil share	Records each bank-confirmed payment and assigns it to one of four ledgers: zakat, infaq/sadaqah, cash waqf, or waqf through money (project-specific). Computes the amil share and blocks allocations above the cap.	Zakat, infaq/sadaqah and waqf are never commingled; contract and intention are recorded as declared by the payer. Amil share from zakat $\leq 12.5\%$ (one-eighth) and operational use of infaq/sadaqah $\leq 20\%$ (BAZNAS, 2016; MUI, 2011)
SC-2 Recipient and project verification	Checks prospective zakat recipients against a verified registry: the national integrated social-economic data (DTKS, being consolidated into DTSEN) and BAZNAS recipient records; checks projects against an approved waqf project list.	Zakat only for the eight <i>asnaf</i> (Q.S. al-Tawbah: 60), operationalized as rules (e.g., <i>fakir/miskin</i> : household in the bottom welfare deciles of DTSEN or below the BAZNAS <i>had kifayah</i> threshold; <i>gharimin</i> : documented debt for basic needs). Recipients already funded for the same need in the same period are flagged; ambiguous cases go to manual review

Smart contract	Function	Encoded rule and legal or juristic basis
SC-3 Staged disbursement	Releases tranches after the multi-party oracle has confirmed a milestone; records ownership of productive zakat capital in the recipient's name from the moment of approval.	<i>Amanah</i> and avoidance of <i>gharar</i> ; <i>tamlik</i> and prompt distribution safeguarded as explained in the next section (MUI, 2003)
SC-4 Invested cash waqf	For cash waqf invested through an LKS-PWU (e.g., Sharia deposits or CWLS): restricts placement to an approved list of instruments, keeps the principal on a separate ledger, and splits net returns.	Principal preserved (<i>habs al-aşl</i>): placement only in insured or guaranteed instruments (BWI, 2020; Republik Indonesia, 2006). Nazhir share $\leq 10\%$ of net returns (Law No. 41 of 2004, Art. 12); at least 50% to beneficiaries (<i>mauquf 'alaih</i>) (BWI, 2020)
SC-5 Waqf through money for assets	For money donated to build a specific asset (school, clinic, water facility): releases funds by milestone and, on completion, registers the asset in the waqf asset registry.	The donated money is converted into a perpetual physical asset; the asset, not the cash, becomes the preserved principal, and its benefits are dedicated (<i>tasbīl al-manfa'ah</i>) as pledged

Demonstration: Pseudocode and an Illustrative Case

Box 1 shows simplified pseudocode for SC-1 and SC-3. It illustrates that the rules most suitable for automation are deterministic: fund segregation, the *amil cap* and the requirement of two independent attestations before release.

Box 1: Simplified pseudocode for SC-1 and SC-3

```

contract SC1_Collection:
  on bankCredit(ref, amount, fundType, akad, payerId):
    require fundType in {ZAKAT, INFAQ, CASH_WAQF, WAQF_PROJECT}
    require bankOracle.confirms(ref, amount)
    ledger[fundType].append(ref, amount, akad, hash(payerId))
    issueReceipt(payerId, txCode) # non-transferable record
  on allocateAmil(period, amount):
    cap = 0.125 * ledger[ZAKAT].sumCollected(period)
    require amil[period] + amount <= cap # else revert

contract SC3_Disbursement:
  on approve(projectOrRecipient, total, milestones):
    require SC2.verified(projectOrRecipient)
    entitlement[projectOrRecipient] = total # tamlik recorded
  on attest(milestone, verifierId, evidenceHash):
    require verifierId in accreditedVerifiers
    attestations[milestone].add(verifierId, evidenceHash)
  on release(milestone):
    require attestations[milestone].distinctSources() >= 2
    require not disputed(milestone)
    instructBank(pay, tranche(milestone)) # fiat transfer by bank

```

Table 5 presents an illustrative case with hypothetical figures. It is not an empirical observation but a walk-through that shows how the contracts interact and where human judgement remains.

Table 5: Illustrative case (hypothetical figures)

Flow	Walk-through
Waqf through money: a village clean-water facility (SC-5, SC-3)	Target IDR 300 million raised from 1,200 donors through QRIS; each donation is recorded by SC-1 on the project ledger. Three milestones: (1) design, permits and drilling contract, 30%; (2) well, pump and storage completed, 40%; (3) distribution network completed and water-quality test passed, 30%. Tranche 2 is released only after the field verifier's report, the village head's confirmation and geotagged photographs agree. On completion the facility is registered as a waqf asset and its operating costs are covered by user contributions agreed with the community.
Productive zakat (SC-2, SC-3, infaq support)	IDR 200 million is approved for 40 verified recipients (IDR 5 million each), recorded as owned by each recipient on approval. Capital is released in two tranches of IDR 2.5 million tied to the business plan and mentoring. Any urgent consumptive need identified at assessment is met immediately from the infaq/sadaqah ledger, so that staging does not delay basic needs.
Amil share (SC-1)	If zakat collected in the period is IDR 1,000 million, SC-1 rejects any allocation that would push the amil share above IDR 125 million (12.5%).
Invested cash waqf (SC-4)	IDR 1,000 million placed in a CWLS series with a 6.5% annual return yields IDR 65 million. SC-4 caps the nazhir share at IDR 6.5 million (10%), allocates at least IDR 32.5 million (50%) to beneficiaries, and assigns the remainder to reinvestment. The principal is repaid by the government at maturity; the contract does not, and cannot, guarantee it.

Separating the Roles of Zakat and Waqf: A Sharia Compliance Analysis (RQ3)

One of the most important design decisions in this model is the strict separation of zakat, infaq/sadaqah and waqf flows. This decision rests on the different juristic characteristics of the instruments.

Zakat has specifically designated recipients set out in Q.S. al-Tawbah verse 60, namely the eight *asnaf*. The use of zakat to build public infrastructure remains debated. The majority of classical scholars restrict *fī sabīlillāh* to its narrower meaning, while a number of contemporary scholars extend it to include the general public interest (al-Qaradawi, 1999). Indonesian practice has taken a middle position. MUI Fatwa No. 001/MUNAS-IX/MUI/2015 permits zakat to be used for clean water and sanitation facilities provided that the facilities benefit zakat recipients, while allowing infaq, sadaqah and waqf to be used for such facilities more broadly (MUI, 2015). The model follows the more cautious course: it directs zakat to the economic empowerment of zakat recipients, such as business capital, training and mentoring for micro, small and medium enterprises (MSMEs), and routes public facilities through waqf and infaq/sadaqah. In this way it sidesteps the debate rather than resolving it. Productive zakat is grounded in MUI Fatwa No. 4 of 2003, which permits zakat to be used for *istitsmar* subject to conditions, including that the urgent needs of recipients are met first and that the activity is Sharia-compliant and managed by trustworthy and competent institutions (MUI, 2003). Its impact can be measured using the CIBEST model (Beik & Arsyianti, 2016).

Staged disbursement of productive zakat (SC-3) raises two further juristic questions: prompt distribution (*al-fawriyyah*) and transfer of ownership (*tamlik*). The

model addresses them in three ways. First, the payer's obligation is discharged when the amil, acting on behalf of recipients, receives the zakat; the amil then holds the funds as a trust (*amanah*), which is the ordinary position of any amil between collection and distribution. Second, ownership is transferred at approval: the full allocation is recorded on the ledger as belonging to the named recipient, and the staged release is a capital-management arrangement agreed with the recipient as part of mentoring, not retention by the amil. Third, the conditions of MUI Fatwa No. 4 of 2003 are observed by meeting urgent consumptive needs immediately (from zakat or from the infaq/sadaqah ledger) and by limiting staging to the business plan horizon. Whether a ledger entitlement is sufficient for *tamlík* where the recipient does not yet have physical control of the funds is a question that the model flags for a specific fatwa.

Waqf, by contrast, offers broader flexibility of purpose as long as it is consistent with the donor's pledge and does not contravene Sharia (Republik Indonesia, 2004). Cash waqf, declared permissible by the MUI in 2002 (MUI, 2002), takes two distinct forms that the original version of the model conflated. In *invested cash waqf* (SC-4), the money itself is the principal; it is placed through an LKS-PWU and only the returns are distributed. A *smart contract* cannot prevent an investment loss, so principal preservation is ensured institutionally: BWI Regulation No. 1 of 2020 requires cash waqf to be managed in instruments that are covered by deposit insurance or Sharia insurance, makes the nazhir responsible for the principal where such cover is absent, and limits the nazhir share to 10% of net returns (BWI, 2020; Republik Indonesia, 2004, 2006). The contract enforces these rules by restricting placements to approved instruments and splitting returns, while placement in CWLS adds a sovereign guarantee of the principal. In *waqf through money* (SC-5), the money is spent to create a physical asset such as a school, clinic or water facility; the asset becomes the perpetual principal and its benefits are dedicated to the community, which is how waqf has historically financed infrastructure (Kahf, 2003; Shaikh et al., 2017). DSN-MUI Fatwa No. 140/DSN-MUI/VIII/2021 on waqf of insurance and investment benefits opens an additional inflow channel that SC-1 can record (DSN-MUI, 2021).

With this separation, *smart contracts* function as a mechanism of *Sharia compliance by design*, adapting the compliance-by-design principle of the RegTech literature. deterministic juristic and statutory rules are embedded from the outset in code that prevents violations, rather than only being checked after transactions occur. This approach strengthens the role of the Sharia Supervisory Board rather than replacing it. The Board remains necessary to determine the rules to be encoded, review cases that cannot be decided automatically, and approve changes to the *smart contracts*. This is consistent with Rabbani et al. (2020) and Hasan et al. (2020), who emphasize that technology in Islamic finance must remain subject to Sharia governance and the objectives of *maqāṣid al-sharī'ah*.

Conceptual Evaluation Against the Design Criteria

Table 6 reports the results of the three-lens evaluation. It links each criterion to the problems in Table 3 and to the model components that address it, and rates the

degree of fulfilment. The ratings are the authors' ex ante assessment and should be read as hypotheses for external validation.

Table 6: Traceability matrix and conceptual evaluation of the design criteria

Design criterion	From problem	Model components	Fulfilment	Argument
(1) Transparency	1, 2	Layer 2 receipts; Layer 5 dashboard and published block hashes; observer nodes	Full	All transactions visible to authorized parties; aggregate data public; individual payers can trace their funds
(2) Traceability	3	SC-1, SC-3, SC-5; bank-ledger API	Partial	Traceable from bank credit to disbursement; recipients' subsequent spending and off-balance-sheet collection outside the ledger are not traceable
(3) Efficiency	4	Shared ledger; automatic reconciliation; SC-3	Partial	Reconciliation and reporting effort fall; implementation and operating costs have not been estimated
(4) Sharia compliance	2, 6	SC-1 to SC-5; Sharia Supervisory Board in Layer 5	Partial	Deterministic rules (segregation, asnaf screening, amil and nazhir caps, return split) are enforced; judgement-based matters and the <i>tamlík</i> question require the Board and a fatwa
(5) Data protection	5	Off-chain storage; pseudonymous IDs; salted hashes; private data collections	Full (by design)	Consistent with Law No. 27 of 2022 in design; legal assessment of implementation still required
(6) Measurability of impact	6	Output indicators on chain; outcome surveys (CIBEST) off chain; Table 7	Partial	Outputs are recorded automatically; outcomes and impact still require field data

The logical-consistency lens identified and resolved three inconsistencies in the initial design: the conflation of invested cash waqf with waqf through money (resolved by splitting SC-4 and SC-5), the absence of an allocation for infaq/sadaqah (resolved by a separate ledger used for urgent needs and public facilities), and the reliance on a single oracle (resolved by the multi-party attestation in Layer 4).

Contribution to SDG 8 and SDG 9

The BZW-SD model contributes to two SDGs through different pathways. Table 7 maps each pathway to the official targets and indicators of the global indicator framework (United Nations, 2017) as adopted in Indonesia's SDG indicator metadata (Kementerian PPN/Bappenas, 2020), and distinguishes the model-level *output* indicators that the ledger can record from the *outcome* indicators that require field data.

Table 7: Pathways of the model's contribution to the SDGs

SDG target	Official indicator	Instrument and mechanism	Output indicators recorded on chain	Outcome indicators (off chain)
8.3 Promote policies that support productive activities, entrepreneurship and MSME growth	8.3.1 Proportion of informal employment in total employment	Productive zakat: staged business capital and mentoring	Number of recipients financed; capital disbursed; tranche completion rate	Business income and formalization; CIBEST welfare quadrant; graduation from recipient to payer
8.10 Strengthen the capacity of domestic financial institutions to expand access to financial services	8.10.2 Proportion of adults with an account at a bank or other financial institution or mobile-money provider	Disbursement only to recipients' own accounts at partner Islamic banks	Number of recipients receiving funds into their own accounts	Account use after programme exit (survey)
9.1 Develop quality, reliable, sustainable and resilient infrastructure, with equitable access for all	9.1.1 Rural population within 2 km of an all-season road (official indicator; the model contributes mainly to social infrastructure that this indicator does not capture)	Waqf through money and returns on invested cash waqf for schools, clinics and water facilities	Number and value of completed waqf assets; milestones verified	Population served; facility use (field verification)
9.3 Increase access of small-scale enterprises to financial services, including affordable credit	9.3.2 Proportion of small-scale industries with a loan or line of credit	Cash waqf placed in Islamic microfinance (Haneef et al., 2015)	Financing volume; number of enterprises financed; repayment rate	Enterprise survival and growth

This mapping is consistent with Abdullah (2018), who demonstrates the alignment between waqf, the SDGs and *maqāṣid al-sharī'ah*, and with Rabbani et al. (2021), who emphasize the role of Islamic FinTech in economic recovery and resilience. The advantage of the model is that output indicators are produced automatically from recorded transactions rather than compiled manually; outcomes and impact, however, still require instruments such as CIBEST collected in the field, and the ledger can only link to those data, not generate them.

Implementation Challenges

Despite its promise, the implementation of this model faces several challenges.

1. **Regulation.** There is not yet a specific regulation on distributed ledger technology in zakat and waqf management. The model must operate within Law No. 4 of 2023 on the Development and Strengthening of the Financial Sector (Republik Indonesia, 2023), OJK Regulation No. 3 of 2024 on financial sector technological innovation (Otoritas Jasa Keuangan, 2024), Bank Indonesia's payment system regulation and the prohibition on virtual currency as a means of payment (Bank Indonesia, 2016, 2020), and Law No. 27 of 2022 on Personal

Data Protection. Bills amending Law No. 23 of 2011 and Law No. 41 of 2004 are both listed in the DPR's 2025–2029 National Legislation Programme (Dewan Perwakilan Rakyat Republik Indonesia [DPR RI], 2024), which provides an opportunity to accommodate digital recording.

2. **Fatwa readiness.** A fatwa is needed that specifically governs the validity of zakat and waqf contracts and records executed through *smart contracts*, including whether a recorded entitlement satisfies *tamlik*. DSN-MUI Fatwa No. 117/2018 on information technology-based financing services provides a precedent for Sharia rules on digital platforms (DSN-MUI, 2018).
3. **Institutional capacity.** Many zakat administrators and waqf managers, especially in the regions, do not yet have adequate technological capacity, which is why the model connects them as clients through gateways rather than as nodes.
4. **User adoption and digital literacy.** Adoption depends on effort expectancy, facilitating conditions and trust in e-zakat systems (Afifah et al., 2025; Juniati & Widiastuti, 2026), and waqf literacy remains low (Mutmainah et al., 2021). Recipients with limited digital access must still be able to receive funds and confirm milestones through assisted channels.
5. **The oracle problem.** Even with multi-party attestation, the ledger cannot detect collusion among all verifiers; random re-audits and sanctions reduce but do not eliminate this risk (Caldarelli, 2020).
6. **Cost and interoperability.** Building a consortium network requires initial investment, common data standards among more than 700 zakat institutions and many nazhir, and integration with the systems of partner banks; these costs have not yet been estimated.

Conceptual Propositions

The propositions are derived from trust theory and agency theory and are summarized in Figure 2. The constructs are defined so that they can be measured: **ledger-based transparency** (LT), the extent to which payers and donors can verify fund flows through the receipt and dashboard; **perceived Sharia compliance assurance** (SCA), the extent to which they believe Sharia rules are enforced by design; **institutional trust** (TR), assessed through ability, benevolence and integrity items (Mayer et al., 1995); **formal channel intention and collection** (FC), the intention to pay or donate through official institutions and the corresponding recorded collection; **agency costs** (AC), measured by reconciliation time, audit effort and disbursement lead time; **targeting accuracy** (TA), measured by inclusion and exclusion errors and duplicate recipients; **recipient welfare** (RW), measured by CIBEST quadrants and business income; and **waqf infrastructure financing** (WI), measured by the value of completed waqf assets. Habit of direct giving (HDG) and digital literacy (DL) are proposed moderators.

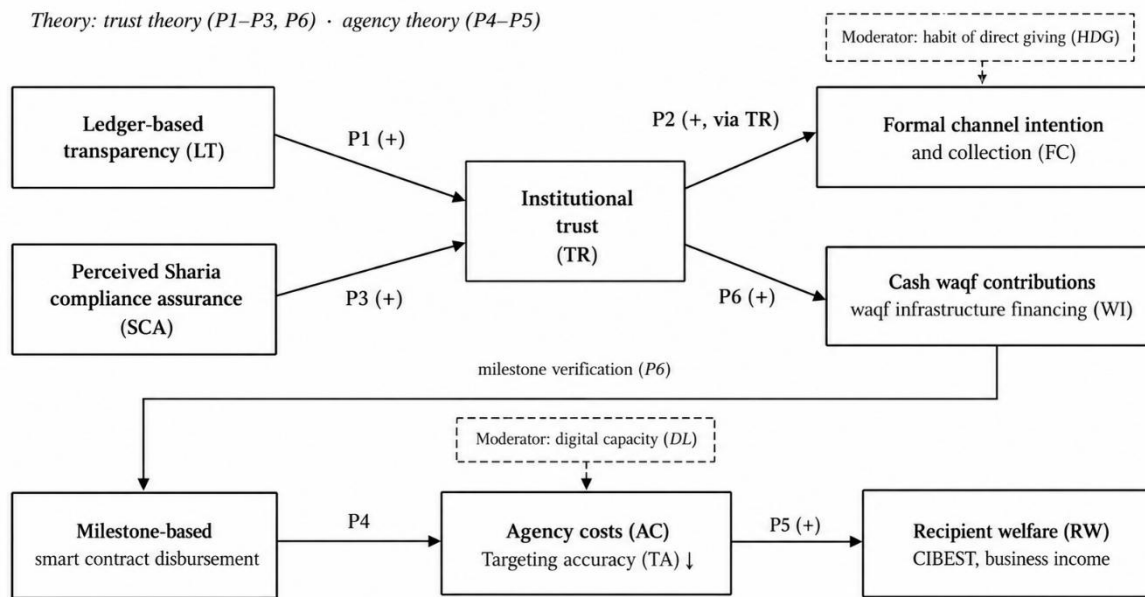


Figure 2: Propositional framework of the BZW-SD model. Source: authors' design (2025).

- P1:** Ledger-based transparency has a positive effect on institutional trust. *Rationale:* verifiable records act as structural assurance and as signals of integrity when payers cannot observe institutions directly (McKnight et al., 1998; Mayer et al., 1995); disclosure and transparency are central drivers of trust in zakat institutions (Zulfikri et al., 2022).
- P2:** Institutional trust mediates the effect of ledger-based transparency on formal channel intention and collection, and this effect is weaker among payers with a strong habit of direct giving. *Rationale:* trust predicts digital zakat payment and online cash waqf (Kasri & Yuniar, 2021; Kasri & Chaerunnisa, 2022), while the large informal channel (Pusat Kajian Strategis BAZNAS, 2021) implies that habit competes with institutional channels. The proposition is specific to the model because it concerns the shift from unrecorded to recorded giving.
- P3:** Perceived Sharia compliance assurance has a positive effect on institutional trust over and above ledger-based transparency. *Rationale:* in religious giving, integrity includes conformity with Sharia; making rules such as fund segregation and the amil cap verifiable adds an assurance that transparency about amounts alone does not provide (Bin-Nashwan et al., 2020). This replaces the earlier, near-tautological claim that encoding rules increases compliance with those rules.
- P4:** Milestone-based *smart contract* disbursement reduces agency costs and improves targeting accuracy relative to manual processes, and the effect is stronger in institutions with higher digital capacity. *Rationale:* shared, tamper-evident records reduce monitoring costs and automated constraints act as bonding mechanisms (Jensen & Meckling, 1976; Casino et al., 2019); cross-institution recipient matching addresses duplication (Zulfikri et al., 2021).

5. **P5:** Productive zakat delivered through staged capital and mentoring under the model has a positive effect on recipient welfare. *Rationale:* staging with verified milestones limits moral hazard among recipients (Jensen & Meckling, 1976), and productive zakat combined with mentoring has been associated with welfare improvement measured by CIBEST (Beik & Arsyianti, 2016; Ascarya et al., 2022).
6. **P6:** Institutional trust and milestone verification increase cash waqf and waqf-through-money contributions, which in turn increase waqf infrastructure financing. *Rationale:* trust determines cash waqf intention (Kasri & Chaerunnisa, 2022), and low trust and transparency are cited as reasons for the limited take-up of CWLS (Rochaniah & Faizah, 2025); verification of project progress reduces the perceived risk of contributing to long-term assets (Mohd Thas Thaker et al., 2018).

Conclusion and Recommendations

This study set out to answer three research questions. Regarding **RQ1**, the synthesis of primary data and the literature identified six problems: low recorded collection alongside a large informal channel, a trust deficit, limited traceability of distribution, fragmented recording, scattered sensitive recipient data, and underproductive waqf with weak impact evidence. From these, six design criteria were derived. The study does not claim that a trust deficit is the sole cause of the potential-realization gap; informal giving, literacy and regulation also play a role.

Regarding **RQ2**, the BZW-SD model integrates zakat, infaq/sadaqah and waqf in four functional layers and a cross-cutting governance layer. Funds remain in rupiah in segregated Islamic bank accounts; a permissioned consortium ledger records metadata and hashes; five *smart contracts* enforce segregation, recipient verification, staged disbursement, invested cash waqf rules and waqf-through-money asset creation; and a multi-party oracle verifies milestones. Regarding **RQ3**, the model satisfies the transparency and data protection criteria by design and the traceability, efficiency, Sharia compliance and impact measurability criteria partially. It directs zakat to productive empowerment (SDG 8) and waqf and infaq/sadaqah to productive and social assets (SDG 9), thereby sidestepping the juristic debate over the use of zakat for infrastructure, and it encodes statutory limits such as the *amil* share and the *nazhir* share.

Relative to existing blockchain zakat and waqf models, the novel contribution of this study lies in (a) the integration of zakat, infaq/sadaqah and waqf in one ledger that preserves their separate juristic regimes; (b) a fiat-anchored, token-free design that is compatible with Indonesian payment and crypto regulation; (c) the translation of Sharia and statutory rules into executable *smart contract* logic; and (d) six propositions derived from trust and agency theory. Practically, the study recommends the following steps:

1. **For regulators** (the Ministry of Religious Affairs, BAZNAS, BWI, OJK and Bank Indonesia): use the planned amendments of the Zakat Management Law and the

Waqf Law to provide for digital recording and distributed ledgers, and develop shared data standards and recipient identifiers.

2. **For DSN-MUI:** issue a fatwa on the validity of zakat and waqf contracts and records executed through *smart contracts*, including the status of recorded entitlements for *tamlik*.
3. **For managing institutions:** begin with a pilot built on existing schemes, for example tracking the returns of a CWLS series or a single BWI productive waqf or National Cash Waqf Movement project, such as a clean-water facility or a village clinic, before scaling up.
4. **For researchers:** validate the model with experts through a Delphi study or focus groups, build a prototype, estimate implementation costs, and test propositions P1–P6 through surveys of payers and donors and field studies of recipients.

This study has several limitations. First, the model is conceptual and has not been tested empirically or technically. Second, it has not been validated by external experts; the evaluation in Table 6 is the authors' own assessment. Third, implementation and operating costs have not been estimated, so the efficiency claim remains provisional. Fourth, user and institutional adoption are discussed but not modelled. Fifth, the regulatory analysis is specific to Indonesia. Finally, estimates of zakat and waqf potential are drawn from institutional publications and may change as calculation methodologies are updated.

References

Journal Articles and Conference Proceedings

- Abdullah, M. (2018). Waqf, Sustainable Development Goals (SDGs) and maqasid al-shariah. *International Journal of Social Economics*, 45(1), 158–172.
<https://doi.org/10.1108/IJSE-10-2016-0295>
- Afifah, K., Abu-Hussin, M. F., & Zafar, M. B. (2025). Transforming Islamic social finance: Determinants of blockchain technology adoption for zakat payment. *Journal of Islamic Accounting and Business Research*. Advance online publication.
<https://doi.org/10.1108/JIABR-08-2024-0283>
- Androulaki, E., Barger, A., Bortnikov, V., Cachin, C., Christidis, K., De Caro, A., Enyeart, D., Ferris, C., Laventman, G., Manevich, Y., Muralidharan, S., Murthy, C., Nguyen, B., Sethi, M., Singh, G., Smith, K., Sorniotti, A., Stathakopoulou, C., Vukolić, M., ... Yellick, J. (2018). Hyperledger Fabric: A distributed operating system for permissioned blockchains. In *Proceedings of the Thirteenth EuroSys Conference* (Article 30). ACM. <https://doi.org/10.1145/3190508.3190538>
- Ascarya, A., Hosen, M. N., & Rahmawati, S. (2022). Designing simple productive waqf models for Indonesia. *Journal of Islamic Accounting and Business Research*, 13(3), 380–401. <https://doi.org/10.1108/ijoes-07-2020-0101>

- Beik, I. S., & Arsyianti, L. D. (2016). Measuring zakat impact on poverty and welfare using CIBEST model. *Journal of Islamic Monetary Economics and Finance*, 1(2), 141–160. <https://doi.org/10.21098/jimf.v1i2.524>
- Bin-Nashwan, S. A., Abdul-Jabbar, H., Aziz, S. A., & Viswanathan, K. K. (2020). A socio-economic model of zakah compliance. *International Journal of Sociology and Social Policy*, 40(3/4), 304–320. <https://doi.org/10.1108/ijssp-11-2019-0240>
- Caldarelli, G. (2020). Understanding the blockchain oracle problem: A call for action. *Information*, 11(11), 509. <https://doi.org/10.3390/info11110509>
- Casino, F., Dasaklis, T. K., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*, 36, 55–81. <https://doi.org/10.1016/j.tele.2018.11.006>
- Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107–115. <https://doi.org/10.1111/j.1365-2648.2007.04569.x>
- Haneef, M. A., Pramanik, A. H., Mohammed, M. O., Amin, M. F. B., & Muhammad, A. D. (2015). Integration of waqf-Islamic microfinance model for poverty reduction: The case of Bangladesh. *International Journal of Islamic and Middle Eastern Finance and Management*, 8(2), 246–270. <https://doi.org/10.1108/imefm-03-2014-0029>
- Hasan, R., Hassan, M. K., & Aliyu, S. (2020). Fintech and Islamic finance: Literature review and research agenda. *International Journal of Islamic Economics and Finance*, 3(1), 75–94. <https://doi.org/10.18196/ijief.2122>
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105. <https://doi.org/10.2307/25148625>
- Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, 10(1–2), 18–26. <https://doi.org/10.1007/s13162-020-00161-0>
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305–360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
- Juniati, W., & Widiastuti, T. (2026). Intention to adopt blockchain technology for zakat management in Indonesia. *Journal of Islamic Marketing*, 17(2). <https://doi.org/10.1108/JIMA-12-2023-0384>
- Kasri, R. A., & Chaerunnisa, S. R. (2022). The role of knowledge, trust, and religiosity in explaining the online cash waqf amongst Muslim millennials. *Journal of Islamic Marketing*, 13(6), 1334–1350. <https://doi.org/10.1108/JIMA-04-2020-0101>
- Kasri, R. A., & Yuniar, A. M. (2021). Determinants of digital zakat payments: Lessons from Indonesian experience. *Journal of Islamic Accounting and Business Research*, 12(3), 362–379. <https://doi.org/10.1108/JIABR-08-2020-0258>

- Kirana, M. (2025). Evaluation of cash waqf linked sukuk as a tool for public infrastructure development. *PAPUA: International Journal of Sharia Business Management*, 2(2), 66–81. <https://doi.org/10.53491/papua.v2i2.1929>
- Kshetri, N. (2018). Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, 39, 80–89. <https://doi.org/10.1016/j.ijinfomgt.2017.12.005>
- Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review*, 20(3), 709–734. <https://doi.org/10.5465/amr.1995.9508080335>
- McKnight, D. H., Cummings, L. L., & Chervany, N. L. (1998). Initial trust formation in new organizational relationships. *Academy of Management Review*, 23(3), 473–490. <https://doi.org/10.5465/amr.1998.926622>
- Mohd Thas Thaker, M. A., Mohd Thas Thaker, H., & Allah Pitchay, 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. <https://doi.org/10.1108/imefm-06-2017-0157>
- Mutmainah, L., Nurwahidin, & Huda, N. (2021). Waqf blockchain in Indonesia: At a glance. *Al-Awqaf: Jurnal Wakaf dan Ekonomi Islam*, 14(1), 31–49. <https://doi.org/10.47411/al-awqaf.v14i1.129>
- Naoual, B. (2022). Blockchain application to waqf through Finterra's WAQF Chain platform. *Journal of Economics and Sustainable Development*, 5(1), 136–148.
- Nazeri, A. N. N., & Mohd Nor, S. (2023). The implementation of blockchain technology in the zakat management system: A conceptual research. *Journal of Information Systems and Digital Technologies*, 5(2), 287–300. <https://doi.org/10.31436/jisdtd.v5i2.419>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Peppers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3), 45–77. <https://doi.org/10.2753/MIS0742-1222240302>
- Rabbani, M. R., Bashar, A., Nawaz, N., Karim, S., Ali, M. A. M., Rahiman, H. U., & Alam, M. S. (2021). Exploring the role of Islamic fintech in combating the aftershocks of COVID-19: The open social innovation of the Islamic financial

- system. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(2), 136. <https://doi.org/10.3390/joitmc7020136>
- Rabbani, M. R., Khan, S., & Thalassinou, E. I. (2020). FinTech, blockchain and Islamic finance: An extensive literature review. *International Journal of Economics and Business Administration*, 8(2), 65–86. <https://doi.org/10.35808/ijeiba/444>
- Rochaniah, A. N., & Faizah, F. N. (2025). Cash waqf linked sukuk: Overcoming social disparities in Indonesia. *Journal of Islamic Economics Management and Business*, 7(2), 135–156. <https://doi.org/10.21580/jiemb.2025.7.2.26286>
- Setiawan, A., & Nurzaman, M. S. (2022). Application of blockchain and smart-contract on waqf asset management: Is it necessary? *El Dinar: Jurnal Keuangan dan Perbankan Syariah*, 10(2), 85–101. <https://doi.org/10.18860/ed.v10i2.15529>
- 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. <https://doi.org/10.1108/ijif-07-2017-002>
- Szabo, N. (1997). Formalizing and securing relationships on public networks. *First Monday*, 2(9). <https://doi.org/10.5210/fm.v2i9.548>
- Wang, S., Ouyang, L., Yuan, Y., Ni, X., Han, X., & Wang, F.-Y. (2019). Blockchain-enabled smart contracts: Architecture, applications, and future trends. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 49(11), 2266–2277. <https://doi.org/10.1109/TSMC.2019.2895123>
- Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017). An overview of blockchain technology: Architecture, consensus, and future trends. In *2017 IEEE International Congress on Big Data* (pp. 557–564). IEEE. <https://doi.org/10.1109/BigDataCongress.2017.85>
- Zulfikri, Z., Adam, A., Kassim, S., & Hassan, A. (2022). Trust enhancement in zakat institutions using blockchain technology: A qualitative approach. *European Journal of Islamic Finance*, 9(1). <https://doi.org/10.13135/2421-2172/6312>
- Zulfikri, Z., Kassim, S., & Abdullah Othman, A. H. (2023). A conceptual framework of the blockchain technology adoption for zakat institution in Indonesia. *European Journal of Islamic Finance*, 10(1), 16–23. <https://doi.org/10.13135/2421-2172/7221>
- Zulfikri, Z., Kassim, S. H., & Hawariyuni, W. (2021). Proposing blockchain technology based zakat management model to enhance muzakki's trust in zakat agencies: A conceptual study. *Journal of Accounting Research, Organization and Economics*, 4(2). <https://doi.org/10.24815/jaroe.v4i2.20467>

Books and Book Chapters

- al-Qaradawi, Y. (1999). *Fiqh az-zakah: A comparative study of zakah, regulations and philosophy in the light of Qur'an and Sunnah* (M. Kahf, Trans.). Dar Al Taqwa.

- Çizakça, M. (2000). *A history of philanthropic foundations: The Islamic world from the seventh century to the present*. Boğaziçi University Press.
- Khairi, K. F., Rafiki, A., Rahmadhani, S. N., & Ananda, R. F. (2024). Strategies and applications of blockchain technology of zakat collection and distribution in Malaysia and Indonesia. In A. Rafiki, V. Ramadani, L. P. Dana, & S. E. Hidayat (Eds.), *Strategic Islamic business and management* (pp. 19–33). Springer.
https://doi.org/10.1007/978-3-031-61778-2_2
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.
- Mohamed, H., & Ali, H. (2019). *Blockchain, fintech, and Islamic finance: Building the future in the new Islamic digital economy*. De Gruyter.
- Oseni, U. A., & Ali, S. N. (Eds.). (2019). *Fintech in Islamic finance: Theory and practice*. Routledge.
- Xu, X., Weber, I., & Staples, M. (2019). *Architecture for blockchain applications*. Springer.
<https://doi.org/10.1007/978-3-030-03035-3>

Websites and Online Sources

- Blossom Finance. (2019, October 16). *World's first primary sukuk issuance on blockchain closes* [Press release]. <https://blossomfinance.com/posts/worlds-first-primary-sukuk-issuance-on-blockchain-closes>
- Buterin, V. (2014). *A next-generation smart contract and decentralized application platform* [White paper]. Ethereum.
- Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*.
<https://bitcoin.org/bitcoin.pdf>

Documents (Laws, Regulations, Fatwas and Official Reports)

- Ahmed, H. (2004). *Role of zakah and awqaf in poverty alleviation* (Occasional Paper No. 8). Islamic Research and Training Institute, Islamic Development Bank.
- Badan Amil Zakat Nasional. (2016). *Peraturan Badan Amil Zakat Nasional Nomor 1 Tahun 2016 tentang Pedoman Penyusunan Rencana Kerja dan Anggaran Tahunan BAZNAS, BAZNAS Provinsi, dan BAZNAS Kabupaten/Kota* [BAZNAS Regulation No. 1 of 2016 on guidelines for annual work plans and budgets].
- Badan Amil Zakat Nasional. (2024). *Laporan pengelolaan zakat nasional tahun 2023* [National zakat management report 2023]. BAZNAS. <https://baznas.go.id/szn>
- Badan Wakaf Indonesia. (2020). *Peraturan Badan Wakaf Indonesia Nomor 01 Tahun 2020 tentang Pedoman Pengelolaan dan Pengembangan Harta Benda Wakaf* [BWI Regulation No. 1 of 2020 on guidelines for the management and development of waqf assets].

- Bank Indonesia. (2016). *Peraturan Bank Indonesia Nomor 18/40/PBI/2016 tentang Penyelenggaraan Pemrosesan Transaksi Pembayaran* [Regulation No. 18/40/PBI/2016 on payment transaction processing].
- Bank Indonesia. (2020). *Peraturan Bank Indonesia Nomor 22/23/PBI/2020 tentang Sistem Pembayaran* [Regulation No. 22/23/PBI/2020 on the payment system].
- Dewan Perwakilan Rakyat Republik Indonesia. (2024). *Program Legislasi Nasional Rancangan Undang-Undang Tahun 2025–2029* [National Legislation Programme 2025–2029]. DPR RI.
- Dewan Syariah Nasional Majelis Ulama Indonesia. (2017). *Fatwa No. 116/DSN-MUI/IX/2017 tentang Uang Elektronik Syariah* [Fatwa on Sharia electronic money].
- Dewan Syariah Nasional Majelis Ulama Indonesia. (2018). *Fatwa No. 117/DSN-MUI/II/2018 tentang Layanan Pembiayaan Berbasis Teknologi Informasi Berdasarkan Prinsip Syariah* [Fatwa on information technology-based financing services based on Sharia principles].
- Dewan Syariah Nasional Majelis Ulama Indonesia. (2021). *Fatwa No. 140/DSN-MUI/VIII/2021 tentang Wakaf Manfaat Asuransi dan Manfaat Investasi pada Asuransi Jiwa Syariah* [Fatwa on waqf of insurance and investment benefits in Sharia life insurance].
- Kahf, M. (2003). *The role of waqf in improving the ummah welfare* [Seminar paper]. International Seminar on Waqf as a Private Legal Body, Universitas Islam Sumatera Utara, Medan.
- Kementerian PPN/Bappenas. (2020). *Metadata indikator Tujuan Pembangunan Berkelanjutan (TPB) Indonesia: Pilar pembangunan ekonomi (Edisi II)* [Metadata of Indonesia's SDG indicators: Economic pillar]. Kementerian PPN/Bappenas.
- Majelis Ulama Indonesia. (2002). *Fatwa Komisi Fatwa MUI tentang Wakaf Uang* [Fatwa of the MUI Fatwa Commission on cash waqf] (May 11, 2002).
- Majelis Ulama Indonesia. (2003). *Fatwa MUI No. 4 Tahun 2003 tentang Penggunaan Dana Zakat untuk Istitsmar (Investasi)* [Fatwa on the use of zakat funds for istitsmar (investment)].
- Majelis Ulama Indonesia. (2011). *Fatwa MUI No. 8 Tahun 2011 tentang Amil Zakat* [Fatwa on amil zakat].
- Majelis Ulama Indonesia. (2015). *Fatwa MUI No. 001/MUNAS-IX/MUI/2015 tentang Pendayagunaan Harta Zakat, Infaq, Sedekah, dan Wakaf untuk Pembangunan Sarana Air Bersih dan Sanitasi bagi Masyarakat* [Fatwa on the use of zakat, infaq, sadaqah and waqf for clean water and sanitation facilities].

- Majelis Ulama Indonesia. (2021). *Keputusan Ijtima Ulama Komisi Fatwa se-Indonesia VII tahun 2021* [Decisions of the Seventh Ijtima Ulama of the Indonesian Fatwa Commissions], including the decision on cryptocurrency.
- Otoritas Jasa Keuangan. (2024). *Peraturan OJK Nomor 3 Tahun 2024 tentang Penyelenggaraan Inovasi Teknologi Sektor Keuangan* [OJK Regulation No. 3 of 2024 on financial sector technological innovation].
- Pusat Kajian Strategis BAZNAS. (2021). *Outlook zakat Indonesia 2021* [Indonesia zakat outlook 2021]. BAZNAS.
- Republik Indonesia. (2004). *Undang-Undang Nomor 41 Tahun 2004 tentang Wakaf* [Law No. 41 of 2004 on Waqf].
- Republik Indonesia. (2006). *Peraturan Pemerintah Nomor 42 Tahun 2006 tentang Pelaksanaan Undang-Undang Nomor 41 Tahun 2004 tentang Wakaf* [Government Regulation No. 42 of 2006 on the implementation of Law No. 41 of 2004 on Waqf].
- Republik Indonesia. (2011a). *Undang-Undang Nomor 7 Tahun 2011 tentang Mata Uang* [Law No. 7 of 2011 on Currency].
- Republik Indonesia. (2011b). *Undang-Undang Nomor 23 Tahun 2011 tentang Pengelolaan Zakat* [Law No. 23 of 2011 on Zakat Management].
- Republik Indonesia. (2020). *Peraturan Presiden Nomor 18 Tahun 2020 tentang Rencana Pembangunan Jangka Menengah Nasional 2020–2024* [Presidential Regulation No. 18 of 2020 on the National Medium-Term Development Plan 2020–2024].
- Republik Indonesia. (2022). *Undang-Undang Nomor 27 Tahun 2022 tentang Pelindungan Data Pribadi* [Law No. 27 of 2022 on Personal Data Protection].
- Republik Indonesia. (2023). *Undang-Undang Nomor 4 Tahun 2023 tentang Pengembangan dan Penguatan Sektor Keuangan* [Law No. 4 of 2023 on the Development and Strengthening of the Financial Sector].
- Saptono, I. T. (2023). *Perkembangan perwakafan nasional* [Developments in national waqf; presentation at the 2023 BWI National Coordination Meeting]. Badan Wakaf Indonesia. <https://bwi.go.id/storage/2023/12/Arahan-dan-Up-Date-Perwakafan-Rakornas-2023.pdf>
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development* (A/RES/70/1).
- United Nations. (2017). *Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development* (A/RES/71/313).

