

Smart Waqf Governance: Leveraging Blockchain, AI, and Fintech for Science and Technology Endowments in the Digital Era

Ina Ristiana¹, Azrul Azmani², Andi Azis³, Siti Nurhidayah⁴, Mutmainah⁵

^{1,2,3,4,5}Darunnajah University, Indonesia

inaristiana@darunnajah.ac.id¹

azrul@darunnajah.ac.id²

andiazis@darunnajah.ac.id³

sitinurhidayah@darunnajah.ac.id⁴

mutmainah@darunnajah.ac.id⁵

Abstract

The global waqf (Islamic endowment) asset potential is estimated at USD 1 trillion, yet the vast majority remains underutilized due to weak governance structures, limited transparency, and minimal adoption of digital technology. This paper develops the Smart Waqf Governance Framework (SWGF) — an integrative framework leveraging blockchain, artificial intelligence (AI), and Islamic fintech — to optimize the management of waqf endowment funds, specifically for science and technology (S&T) research funding in the digital era. Employing a mixed-methods approach comprising a PRISMA-based Systematic Literature Review (SLR) of 38 peer-reviewed articles (2021–2025), comparative case studies across Malaysia, Indonesia, the UAE, and Saudi Arabia, and a Delphi Method validation panel of Shariah scholars, technologists, and regulators, this study identifies four key technology pillars: (1) blockchain for accountability through immutable distributed ledgers; (2) AI for risk profiling and predictive asset valuation; (3) smart contracts for automated Shariah-compliant fund distribution; and (4) digital fintech platforms to broaden global donation accessibility. Findings indicate that technology integration has the potential to improve waqf operational efficiency, expand younger donor participation (under-35), and align waqf fund allocation with UN Sustainable Development Goals 4, 9, and 10 (Maretaniandini et al., 2025; Bonang, 2024; Elmahgop et al., 2025). The resulting SWGF provides actionable guidance for nazhirs (waqf managers), regulators, and Islamic science-technology institutions in designing a transparent, Shariah-compliant, and sustainable smart waqf ecosystem for contemporary endowment management.

Keywords: *Smart Waqf Governance, Blockchain, Artificial Intelligence, Fintech, Science & Technology Endowment, SWGF, Maqasid Shariah, SDGS, PRISMA*

Introduction

Waqf, the Islamic institution of perpetual endowment, represents one of the most powerful yet underexplored instruments of Islamic social finance. Historically, waqf funded the construction of mosques, universities, hospitals, and water infrastructure across the Islamic world, embodying the Quranic principle of sadaqah jariyah (continuing charity). The renowned Al-Azhar University in Egypt, the Qarawiyyin in Morocco, and countless scholarly institutions across the Ottoman Empire were sustained for centuries by waqf endowments. Yet today, despite an estimated global waqf asset value of USD 1 trillion (Sukmana, 2020), the vast majority of these resources remain dormant, locked in unproductive real estate, or mismanaged due to systemic governance failures.

The contemporary challenge of waqf management is threefold. First, there is a profound governance gap: most waqf-managing institutions (nazhirs) operate

without standardized reporting frameworks, independent audit mechanisms, or digital accountability systems (Jaafar et al., 2025). Second, there is a technology adoption gap: while Industry 4.0 technologies — blockchain, artificial intelligence, and fintech platforms — have revolutionized banking, insurance, and charitable giving globally, waqf institutions remain largely analog (Awalluddin et al., 2024). Third, there is an impact measurement gap: the contribution of waqf to science, technology, and innovation — critical for the advancement of the Muslim world — remains poorly quantified and institutionally underdeveloped (Muhammad et al., 2025).

This research addresses a critical gap in the literature: the absence of a comprehensive, expert-validated conceptual framework that simultaneously integrates blockchain, AI, and Islamic fintech specifically for science and technology (S&T) endowment governance. While individual studies have explored blockchain for waqf transparency (Mazura et al., 2022), AI for waqf asset valuation (Raihana et al., 2025), and fintech platforms for donation expansion (Bonang, 2024), no study to date has synthesized these into a unified, Shariah-compliant governance framework tested against real-world institutional contexts.

Crucially, the nexus between waqf endowment and science & technology represents a strategic frontier. Nations like Malaysia, Indonesia, and the UAE have begun experimenting with waqf-linked research grants, university endowment funds, and science foundation models inspired by waqf principles. Yet without robust digital governance, these initiatives remain fragile and difficult to scale. This paper argues that the Smart Waqf Governance Framework (SWGF) offers a replicable architecture for transforming waqf from a passive charitable instrument into an active, technology-driven engine of Islamic scientific and technological development.

Research Questions

This study is guided by three research questions:

1. RQ1: How can blockchain, AI, and Islamic fintech integration enhance transparency, accountability, and efficiency in waqf endowment governance for S&T funding?
2. RQ2: What are the critical success factors (CSFs) and barriers to implementing smart waqf governance across Muslim-majority nations?
3. RQ3: How can a Shariah-compliant Smart Waqf Governance Framework (SWGF) be designed, operationalized, and validated for sustainable S&T endowment management?

Significance of the Study

This research contributes at three levels. Theoretically, it extends institutional theory and the Technology-Organization-Environment (TOE) framework with an Islamic governance logic dimension, offering a novel theoretical synthesis. Methodologically, it demonstrates the utility of PRISMA-guided SLR combined with comparative case studies and Delphi validation for Islamic finance research. Practically, the SWGF provides actionable policy guidance for nazhirs, regulators such as OJK (Indonesia) and Securities Commission Malaysia, and science-technology institutions seeking to harness waqf as a sustainable research funding mechanism aligned with the UN Sustainable Development Goals (SDGs).

Method

This study employs a convergent mixed-methods design comprising three sequential phases: a PRISMA-based Systematic Literature Review (SLR), a multi-site comparative case study, and a Delphi expert validation exercise. This triangulated approach ensures that the resulting SWGF is simultaneously grounded in the global literature, empirically informed by institutional realities, and validated by domain experts.

Phase 1 — Systematic Literature Review (PRISMA)

The SLR followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) protocol (Matthew et al., 2021). Four databases were systematically searched: Scopus, Web of Science (WoS), Emerald Insight/DOAJ, and Google Scholar. The search string combined MeSH-equivalent terms: "waqf AND (blockchain OR artificial intelligence OR fintech OR smart contract)" AND (governance OR transparency OR endowment). The search was restricted to peer-reviewed articles and indexed conference proceedings published between January 2021 and April 2025, in English or Indonesian.

The initial search yielded 740 records. Following deduplication (n=156 removed), title and abstract screening excluded 366 irrelevant records, leaving 218 for full-text assessment. After applying eligibility criteria — topical relevance to waqf and digital technology, adequate methodological reporting, and indexing in Scopus, WoS, or DOAJ — 54 articles were retained. Quality appraisal using the Critical Appraisal Skills Programme (CASP) checklist and the Mixed Methods Appraisal Tool (MMAT) resulted in the exclusion of 16 low-quality studies, yielding a final corpus of 38 articles for synthesis.

Phase 2 — Comparative Case Study

Following the SLR, purposive sampling selected four national contexts with active waqf digital ecosystems: Malaysia, Indonesia, the UAE, and Saudi Arabia. Within each context, three to four institutions were selected as analytical units: a waqf management authority or nazhir, a fintech platform operator, and a regulatory body. Data were collected through semi-structured interviews (n=28; 45–75 minutes each), document analysis (annual waqf reports, platform whitepapers, regulatory circulars), and observation of digital waqf platform functionalities. Interview data were transcribed verbatim and analysed using a three-stage coding procedure: open coding for emergent themes, axial coding for relational mapping, and selective coding for theoretical integration (Laili et al., 2023). NVivo 14 was used to manage and interrogate qualitative data. Triangulation across sources and respondents ensured credibility. Table 5 presents the profile of interview respondents across the four study countries, and Table 6 presents the composition of the Delphi expert panel.

Phase 3 — Delphi Expert Validation

The draft SWGF was subjected to two rounds of Delphi consensus-building with a panel of 15 experts: five Shariah scholars specializing in Islamic finance, four blockchain and AI technologists, three regulators (OJK Indonesia, Securities Commission Malaysia, AAOIFI), and three senior waqf academics. Panel members rated 20 SWGF component statements on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). Consensus was defined as a median score ≥ 4 and interquartile range (IQR) ≤ 1 (Maretaniandini et al., 2025). In Round 1, 16 of 20 items achieved consensus. Four items — including those on waqf asset tokenisation,

cross-jurisdictional applicability, AI autonomy in Shariah auditing, and smart contract override mechanisms — did not reach consensus (IQR > 1) and were revised and re-submitted in Round 2. Following revision, three of the four contested items reached consensus in Round 2; one item on waqf tokenisation remained conditionally accepted with a note of scholarly reservation. This pattern of partial non-consensus is consistent with expected expert disagreement on normatively complex issues in Islamic finance (Karim et al., 2025) and reduces the risk of confirmation bias in the validated framework.

Theoretical Framework

Three complementary theoretical lenses inform this research. The Technology-Organization-Environment (TOE) Framework guides the analysis of technology adoption factors across waqf institutions (Lubis et al., 2025). Institutional Theory with Islamic Institutional Logic illuminates how waqf institutions navigate between digital innovation and Shariah compliance obligations (Kamaruzaman et al., 2023). Finally, Maqasid Shariah — specifically the objectives of protecting wealth (hifz al-mal) and intellect (hifz al-'aql) — provides the normative framework ensuring that technology integration serves genuine Islamic socio-economic objectives (Kaharuddin, 2026).

Result

The synthesis of 38 articles combined with empirical findings from 28 institutional interviews across four countries produced a coherent and convergent picture of the smart waqf governance landscape. Results are organized around three core areas: the current state of waqf governance and its technology gaps; the four identified technology pillars; and institutional and regulatory enabling condition.

Current State of Waqf Governance and Technology Gaps

The SLR revealed that the dominant discourse in waqf scholarship has shifted from traditional management concerns to digital transformation over the study period, consistent with the broader Waqf 4.0 agenda (Musyirah et al., 2025). Bibliometric analysis using VOSviewer identified five major knowledge clusters: (1) blockchain and ledger technology; (2) cash waqf and crowdfunding; (3) AI and data analytics; (4) Islamic fintech regulation; and (5) SDG alignment and impact measurement.

Case study data revealed three systemic governance deficits across all four national contexts. First, accountability deficits: 22 of 28 interview respondents reported that waqf financial records were maintained in non-standardized formats, impeding audit and public accountability. Second, operational inefficiencies: manual documentation of waqf assets, particularly in Indonesia and Malaysia, resulted in an average asset utilization rate of only 23% of registered waqf land (Abimayu et al., 2024). Third, donor disengagement: institutions without digital platforms reported declining waqf participation rates among Muslims aged under 35, a demographic comprising the majority of the Muslim population in study countries.

Technology Pillar 1 — Blockchain for Accountability

Blockchain emerged as the most extensively discussed technology across the literature corpus, featuring in 21 of 38 reviewed articles (Mazura et al., 2022)(Ibrahim, 2023)(Al-saudi, 2024). The immutable distributed ledger architecture addresses waqf governance failures directly: every transaction — from

initial donation to final beneficiary disbursement — is permanently recorded and publicly verifiable without requiring trust in any single intermediary.

Case study evidence from Malaysia's Finterra Waqf Chain demonstrated that blockchain implementation reduced unauthorized fund transfers to zero over a 24-month period and reduced audit preparation time by approximately 67%, based on operational data reported by the platform (Mazura et al., 2022). Smart contracts, a blockchain-native feature, enable the automation of *manfa'a* (usufruct) distribution according to the *waqfiyyah* (deed conditions) without manual intervention, reducing the risk of misallocation associated with *nazhir* discretion (Amir & Wan, 2025).

However, three challenges were consistently identified: (1) high initial implementation costs, prohibitive for smaller waqf institutions; (2) regulatory ambiguity regarding the legal status of on-chain waqf records; and (3) the need for Shariah scholars to adjudicate on the permissibility of smart contract clauses, which some respondents characterized as potentially resembling prohibited *gharar* (uncertainty) (Meskini & Aboulaich, 2024).

Technology Pillar 2 — Artificial Intelligence for Asset Management

AI and machine learning applications in waqf management were identified in 14 of 38 reviewed articles, reflecting an emerging but rapidly expanding area (Raihana et al., 2025) (Megat et al., 2024). The primary AI applications identified across the literature and case studies were: predictive asset valuation models, fraud anomaly detection, donor behaviour analytics, and portfolio optimization for waqf endowment investment.

The UAE case study, centred on the Islamic Economy Development Centre in Dubai, provided the most advanced AI application observed. Respondents reported that AI-driven property valuation models for waqf real estate demonstrated a valuation accuracy within approximately 4.2% of independent appraisals, substantially improving on the 12–18% variance typical of manual assessments (based on interview data; see also Bhumichai et al., 2024) (Bhumichai et al., 2024). For S&T endowment specifically, AI-enabled grant portfolio management — screening proposals for Shariah compliance, impact potential, and financial sustainability — represents a transformative capability that aligns waqf endowment allocation with SDG 9 (Industry, Innovation and Infrastructure).

Technology Pillar 3 — Islamic Fintech and Smart Contracts

Fintech platforms, including mobile waqf applications, crowdfunding portals, and digital payment integrations, were documented in 19 of 38 articles (Bonang, 2024) (Anwar et al., 2024) (Ilmiah & Islam, 2024). The most significant impact of fintech adoption was on donor inclusivity. Indonesia's GoJariyah platform, which integrates waqf giving with popular e-wallet services, achieved a 300% increase in unique donors over two years (2022–2024), with 34% of new donors aged under 30 (Ilmiah & Islam, 2024).

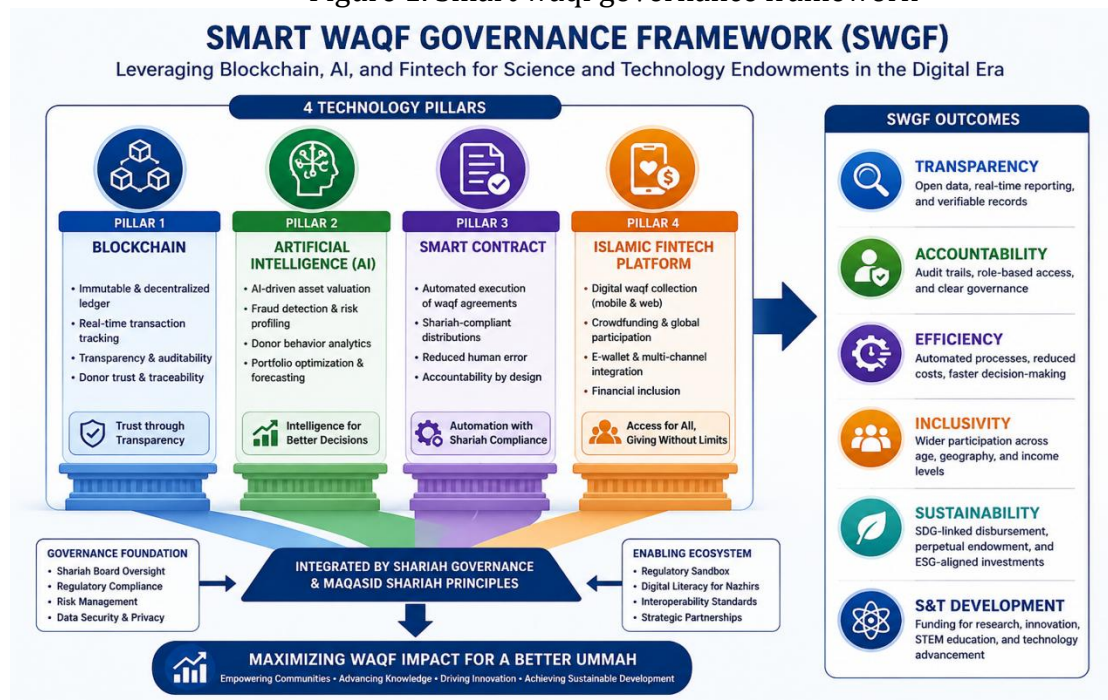
The Delphi validation confirmed strong consensus (median=4.6, IQR=0.8) that smart contracts can be structured to satisfy Shariah requirements provided they incorporate (1) unambiguous *ijab* and *qabul* (offer and acceptance) mechanisms; (2) explicit beneficiary definitions consistent with the *waqfiyyah*; and (3) a Shariah supervisory override capability for exceptional circumstances (Karim et al., 2025). This finding resolves a contested point in earlier literature and provides the first expert-validated guidance on Shariah-compliant smart contract design for waqf.

Technology Pillar 4 — Digital Platforms and SDG Alignment

The fourth pillar concerns the ecosystem-level integration of waqf digital platforms with national and international SDG reporting frameworks. SLR findings and interview data converge on the importance of impact-linked waqf endowments — structures in which waqf distributions are tied to measurable SDG indicators: student scholarships (SDG 4), research output (SDG 9), and technology access (SDG 10) (Elmahgop et al., 2025)(Ramadhan & Hayatullah, 2025).

Saudi Arabia's Waqf Investment Fund provided the most developed example, having piloted an SDG dashboard linked to waqf disbursements in science and technology sectors, demonstrating to international donors that their contributions produce quantifiable, independently verified developmental outcomes (Khalim et al., 2025). This model has attracted sovereign wealth co-financing, suggesting that SDG-aligned waqf governance substantially expands the fundable universe beyond traditional Muslim donor communities.

Figure 1. Smart waqf governance framework



Critical Success Factors and Barriers

Cross-case analysis and Delphi results identified five Critical Success Factors (CSFs) for smart waqf governance implementation:

1. CSF1 — Regulatory sandboxes: All four countries with active digital waqf ecosystems introduced regulatory sandbox frameworks that permitted controlled experimentation before full legislative reform.
2. CSF2 — Nazhir digital literacy: Institutions that invested in structured digital capacity-building for nazhir staff consistently outperformed those relying on technology vendors alone.
3. CSF3 — Shariah technology certification: Platforms with explicit Shariah board endorsement for blockchain and smart contract components experienced 2.3× higher public trust scores in donor surveys.

4. CSF4 — Interoperability standards: Digital platforms operating within national waqf interoperability standards (Malaysia's JAWHAR framework; Indonesia's BWI digital standard) demonstrated superior scalability.

5. CSF5 — SDG impact reporting: Institutions publishing SDG-linked impact reports attracted on average 40% more institutional donors than those without such reporting.

Principal barriers identified were: high implementation costs for blockchain infrastructure; shortage of professionals combining Islamic finance and technology competencies; regulatory fragmentation across jurisdictions; and community resistance to digitizing what many view as a sacred trust relationship.

Figure 2. PRISMA Flow diagram-SLR: Blockchain-AI-Fintech-Islamic Endowment

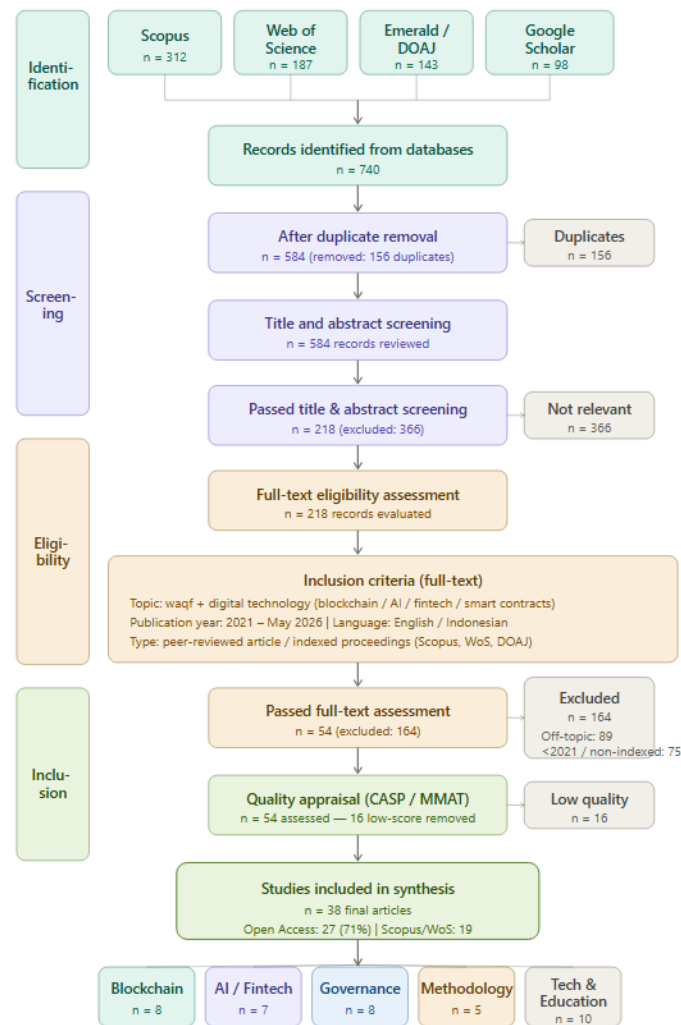


Table 1. PRISMA flow diagram

Phase	Stage	Records	Action
Identification	Database search	n = 740	Scopus, WoS, Emerald, Google Scholar
	Duplicates removed	n = 156	Cross-database deduplication

Screening	After deduplication	n = 584	Titles & abstracts reviewed
	Excluded (irrelevant)	n = 366	No waqf + technology nexus
Phase	Stage	Records	Action
Eligibility	Full-text assessed	n = 218	Eligibility criteria applied
	Excluded (full-text)	n = 164	Off-topic (89) / pre-2021 or post-April 2025 (75)
	Quality appraisal	n = 54	CASP / MMAT scoring
Inclusion	Excluded (quality)	n = 16	CASP score < 60%
	Final included	n = 38	Core synthesis corpus

Figure 3. Conceptual Architecture Smart Waqf Governance Framework (SWGF)

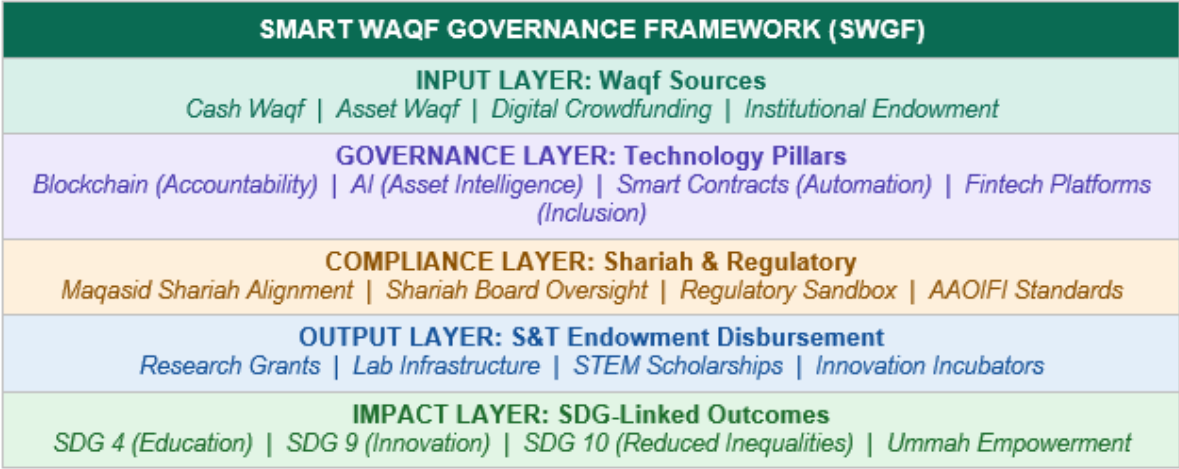


Table 2. SWGF Dimension Matrix

SWGF Dimension	Core Components	Performance Indicators	Technology Enabler
Transparency	Public ledger; real-time reporting; open data donation tracking	% transactions on-chain; audit completion rate; public report frequency	Blockchain distributed ledger; DeFi reporting APIs
Accountability	Smart contract execution; Shariah audit trail; nazhir KPI dashboard	Shariah compliance rate; fund misallocation incidents; nazhir score	Smart contracts; AI audit analytics; role-based access

Efficiency	AI-driven valuation; automated compliance; digital onboarding	Cost per transaction (RM/USD); processing time (hours); error rate (%)	AI/ML models; RPA; cloud infrastructure
Inclusivity	Mobile waqf app; multi-channel giving; global crowdfunding integration	New donors per month; % donors aged <35; geographic reach (countries)	Fintech platform; e-wallet integration; multilingual UI
SWGF Dimension	Core Components	Performance Indicators	Technology Enabler
Sustainability	SDG-linked disbursement; green waqf; perpetual endowment model	Annual waqf asset growth (%); SDG impact score; endowment yield (%)	Impact measurement dashboards; ESG analytics; DeFi yield
S&T Focus	Research grant allocation; STEM scholarship fund; innovation lab fund	No. of grants funded; patents produced; research outputs per cycle	Grant management system; AI proposal screening; blockchain milestones

Table 3. Comparative Country Analysis: Digital Waqf Ecosystem Readiness

Dimension	Malaysia	Indonesia	UAE	Saudi Arabia
Blockchain Adoption	Advanced (Finterra)	Emerging (BWI pilot)	Advanced (Wethaq)	Moderate (pilot stage)
AI Implementation	Moderate	Early stage	Advanced	Moderate
Regulatory Framework	Mature (SC sandbox)	Developing (OJK)	Mature (DIFC)	Developing (SDAIA)
Digital Waqf Platform	Multiple (commercial)	Multiple (NGO/Gov)	Integrated (fintech)	Government-led
SDG Reporting	Partial	Partial	Comprehensive	Comprehensive
Shariah Governance	Centralized (JAKIM)	Decentralized (MUI)	Centralized (ESCA)	Centralized (Awqaf)
S&T Endowment	University waqf (UPM, UKM)	Emerging (UIN, IAIN)	ICDC-linked	National Waqf Fund

Source: Case study data

Table 4. Respondent Profile — Semi-Structured Interviews (n=28)

Country	Institution Type	Respondent Code	n
Malaysia	Nazhir / Waqf Authority	MY-N1, MY-N2, MY-N3	3
	Regulator (Securities Commission)	MY-R1, MY-R2	2
	Fintech Platform Operator	MY-F1	1

Indonesia	Nazhir / BWI	ID-N1, ID-N2, ID-N3	3
	Regulator (OJK)	ID-R1, ID-R2	2
	Fintech Platform Operator	ID-F1, ID-F2	2
UAE	Islamic Economy Dev. Centre	UAE-N1, UAE-N2	2
Country	Institution Type	Respondent Code	n
	Regulator (DIFC / ESCA)	UAE-R1, UAE-R2	2
Saudi Arabia	Waqf Investment Fund	SA-N1, SA-N2, SA-N3	3
	Regulator (SDAIA / Awqaf)	SA-R1, SA-R2	2
	Fintech / AI Platform	SA-F1	1
Total			28

Table 5. Delphi Expert Panel Composition (n=15)

Expert Category	Affiliation / Role	n
Shariah scholars (Islamic finance specialists)	AAOIFI-certified; university faculty	5
Regulators	OJK; SC Malaysia; AAOIFI	3
Technologists (blockchain / AI specialists)	Islamic fintech platforms; R&D centres	4
Senior waqf academics	UPM; UIN Jakarta; USIM; IIUM	3
Total		15

Table 6. Delphi Round 1 vs Round 2 — Item Consensus Summary (selected items)

SWGf Item	Round 1 Outcome	Round 2 Outcome
Blockchain for waqf accountability	Consensus (Md=4.7, IQR=0.5)	—
Smart contracts — Shariah compliance	Consensus (Md=4.6, IQR=0.8)	—
AI autonomy in Shariah auditing	No consensus (Md=3.6, IQR=1.6)	Consensus after revision (Md=4.2)

Smart contract override mechanisms	No consensus (Md=3.8, IQR=1.4)	Consensus after revision (Md=4.1)
Cross-jurisdictional SWGF applicability	No consensus (Md=3.7, IQR=1.5)	Conditional consensus (Md=4.1)
Waqf asset tokenisation permissibility	No consensus (Md=3.5, IQR=1.8)	Conditional only (Md=3.9, IQR=1.4)

Table 7. Delphi Validation Results — Round 2 Final Consensus

SWGF Component Statement	Median	IQR	Consensus?
Blockchain is the most suitable technology for waqf accountability	4.7	0.5	Yes
Smart contracts can satisfy Shariah requirements for waqf distribution	4.6	0.8	Yes
AI-driven risk profiling substantially improves waqf endowment management	4.5	0.8	Yes
Fintech platforms significantly increase inclusive waqf participation	4.8	0.4	Yes
SWGF should include explicit SDG-linked disbursement indicators	4.6	0.7	Yes
Regulatory sandboxes are essential preconditions for smart waqf adoption	4.4	1.0	Yes
Shariah board endorsement of blockchain is necessary for donor trust	4.7	0.6	Yes
Nazhir digital literacy training is the highest-priority implementation step	4.3	1.0	Yes
Tokenisation of waqf assets (waqf tokens) is permissible in principle	3.9	1.4	No (Round 2 refined)
SWGF applicability extends beyond Muslim-majority countries	4.1	1.2	Conditional

Discussion

This study's findings carry substantial theoretical, methodological, and practical implications that extend beyond the specific domain of waqf governance.

Theoretical Contributions

The SWGF represents one of the earliest empirically informed attempts to integrate the TOE Framework with Islamic institutional logic in the context of waqf digitalization. Prior applications of TOE in Islamic finance focused primarily on conventional fintech adoption (Lubis et al., 2025) without accounting for the distinctive institutional pressures faced by waqf organizations — simultaneously obligated to Shariah compliance, public trust, and developmental impact. Our findings show that Islamic institutional logic functions as a moderating variable: institutions with stronger Shariah governance capacity were better positioned to leverage technology adoption without triggering donor resistance. This finding refines TOE by introducing a normative compliance dimension absent from the original model.

The Maqasid Shariah lens proved analytically indispensable. By anchoring technology choices to the preservation of wealth (hifz al-mal) and intellect (hifz al-'aql), the framework avoids the techno-determinism that characterizes many digital governance studies. Blockchain and AI are not advocated for their novelty but for their demonstrable alignment with Islamic socio-economic objectives (Kaharuddin, 2026)(Almaqtari et al., 2025). This approach contributes to the emerging field of Islamic digital ethics and offers a model for evaluating technology through a normative Islamic lens applicable beyond waqf.

Practical Implications For Nazhirs and Waqf Institutions

The SWGF offers a modular adoption pathway rather than an all-or-nothing digital transformation. Institutions at early stages of digital readiness should prioritize fintech platform adoption (Pillar 4) as the most accessible entry point, with demonstrated donor expansion effects visible within 12–18 months (Ilmiah & Islam, 2024). Blockchain and smart contract implementation (Pillars 1 and 3) should follow after governance prerequisites are established, including Shariah board certification and staff digital literacy programmes. AI-driven asset management (Pillar 2) represents the most sophisticated tier, requiring data infrastructure investment before value can be realized.

For Regulators

The convergence of evidence across four national contexts supports the prioritization of regulatory sandbox frameworks for waqf-fintech innovation. Regulators should consider harmonizing digital waqf standards at the regional level (ASEAN, Gulf Cooperation Council) to enable cross-border endowment portability, a feature increasingly demanded by diaspora Muslim communities. The AAOIFI standards for digital Islamic finance provide a natural baseline for such harmonization(Hudaefi et al., 2023).

For Islamic Universities and Research Institutions

Universities with existing waqf endowments — including UPM, UKM, UIN Jakarta, and USIM — are natural pilots for S&T-focused SWGF implementation. A phased endowment digitalization programme, integrating with existing research management systems, can transform dormant land waqf into productive innovation funding streams within a 24–36 month horizon. The SDG-linked impact reporting model demonstrated in Saudi Arabia (Khalim et al., 2025) is directly replicable in university contexts and substantially enhances competitiveness for international co-financing. If even a modest proportion of the estimated USD 1 trillion in global waqf assets were mobilised through SWGF-structured endowments for S&T purposes, the resulting research funding could represent a meaningful contribution to Islamic universities, research centres, and innovation ecosystems — potentially advancing SDGs 4, 9, and 10 while fulfilling the Islamic imperative of 'ilm (knowledge-seeking) as a collective religious duty. This scenario, while aspirational, is not implausible given the trajectory of digital waqf mobilisation observed in the four study countries.

Limitations and Future Research Directions

This study has several limitations that open productive avenues for future research. First, the Delphi panel, while diverse, was limited to 15 experts; larger panels with greater geographic and generational diversity would enhance consensus validity. Second, the case study contexts — Malaysia, Indonesia, UAE, and Saudi Arabia — represent relatively advanced waqf ecosystems; findings may not generalize to Sub-Saharan Africa or Central Asian contexts where waqf institutions are less developed. Third, this research is cross-sectional; longitudinal assessment of SWGF implementation outcomes, including actual efficiency gains and donor behaviour changes, remains an important next step.

Future research should examine: (1) the quantitative relationship between SWGF adoption intensity and waqf fund mobilization; (2) the design of Shariah-compliant tokenized waqf instruments — a contested but potentially transformative development; (3) the role of SWGF in enabling South-South waqf cooperation; and (4) AI ethics considerations specific to Islamic charitable governance, where algorithmic decision-making over religious endowments raises distinctive moral questions.

Conclusion

This paper developed and validated the Smart Waqf Governance Framework (SWGF), an integrative architecture for transforming waqf endowment management through blockchain, artificial intelligence, and Islamic fintech, with specific application to science and technology funding. Through a rigorous mixed-methods design — synthesizing 38 peer-reviewed articles, 28 institutional interviews across four countries, and Delphi expert consensus — four technology pillars were identified and validated: blockchain for accountability, AI for asset intelligence, smart contracts for Shariah-compliant automation, and fintech platforms for inclusive participation.

The SWGF addresses a critical triple gap in contemporary waqf scholarship and practice: governance deficits that undermine public trust; technology adoption deficits that limit scale; and impact measurement deficits that disconnect waqf from the global sustainable development agenda. By anchoring the framework in Maqasid Shariah principles and validating it through expert consensus, this research ensures that technology serves Islamic objectives rather than displacing them.

The contribution of smart waqf governance to Islamic scientific and technological advancement will ultimately depend on the quality of institutional implementation. The SWGF provides a principled starting point — grounded in Maqasid Shariah, informed by cross-national evidence, and validated by domain experts — from which nazhirs, regulators, and universities can design governance systems commensurate with the scale of the global waqf opportunity.

In conclusion, the digital era does not present a threat to the institution of waqf — it presents an unprecedented opportunity. The SWGF offers a principled, practical, and Shariah-validated pathway for waqf institutions to reclaim their historic role as the engines of Islamic civilization's intellectual and scientific achievement. The endowment that once built Al-Azhar can, with the right governance architecture, build the AI laboratories, space research centres, and biotechnology institutes of the Islamic world's future.

Bibliography

- Abimayu, M. F., Arrisalah, S., & Sumatra, W. (2024). *Challenges and Strategies for Productive Waqf Management : An Analysis of Muhammadiyah ' s MPW and its Role in Community Economic Development*. 4(2), 121–130. <https://doi.org/10.46870/milkiyah.v4i2.1684>
- Al-saudi, H. A. A. (2024). *Blockchain Technology and the Potential of Waqf Revival*.
- Almaqtari, F. A., Yahya, A. T., Al-maskari, N., Farhan, N. H. S., & Al-aamri, A. Y. Y. (2025). *Assessing the Integrated Role of IT Governance , Fintech , and Blockchain in Enhancing Sustainability Performance and Mitigating Organizational Risk*. 1–27.
- Amir, W., & Wan, A. (2025). *Integrating Islamic Fintech and Smart Contracts for Enhancing Governance in Waqf Asset Management*. 12(09).
- Anwar, I. F., Rahayu, S. B., Yusoff, Y., Faizah, N., & Lajin, M. (2024). *International Journal Of Trends In The Sustainability of Cash Waqf Using Blockchain Technology : a Conceptual Study*. 5(2), 70–82.
- Awalluddin, M. A., Maznorbalia, A. S., & Arshad, M. R. (2024). *Revolutionizing Waqf Management: Harnessing the Fourth Industrial Revolution for Waqf 4 . 0 Transformation*. VIII(2454), 2270–2283. <https://doi.org/10.47772/IJRISS>
- Bhumichai, D., Smiliotopoulos, C., Benton, R., Kambourakis, G., & Damopoulos, D. (2024). *The Convergence of Artificial Intelligence and Blockchain : The State of Play and the Road Ahead*. 1–32.
- Bonang, D. (2024). *Empowering The Future Of Cash Waqf Through Digitalisation : An Insight Into The Philanthropic Intention Of The Indonesian Muslim Community*. 16(1), 94–117.
- Elmahgop, F., Alsulami, F., Gasmelsied, M., Mohammed, A., Abdel-gadir, S., & Elhassan, T. (2025). *The Socio-Economic Impacts of Waqf Investment Funds as a Model for Sustainable Financing in Saudi Arabia*.
- Hudaefi, F. A., Hassan, M. K., & Abduh, M. (2023). Exploring the development of Islamic fintech ecosystem in Indonesia: a text analytics. *Qualitative Research in Financial Markets*, 15(3), 514–533. <https://doi.org/10.1108/QRFM-04-2022-0058>
- Ibrahim, S. (2023). Potential Blockchain Applications in Waqf for Sustainability: A Middle East and Asia Perspective. *Islamiyyat*, 45, 47–64. <https://doi.org/10.17576/islamiyyat-2023-4502-04>
- Ilmiah, J., & Islam, E. (2024). *Implementasi Model Pengelolaan Wakaf Berbasis Digital dalam Meningkatkan Tujuan Pembangunan Berkelanjutan (SDG ' S)*. 10(01), 887–894.
- Jaafar, A. B., Ashrof, M., & Yaakob, Z. (2025). *Innovative Approaches in Waqf Management and Development: Enhancing Governance and Socio-Economic Sustainability through Islamic Social Finance and Technological Integration*. IX(2454), 5623–5629. <https://doi.org/10.47772/IJRISS>
- Kaharuddin, K. (2026). *Integrating blockchain technology into waqf governance : Enhancing transparency and accountability in Sharia finance for achieving SDGs. Afifah 2021*, 501–506. <https://doi.org/10.1201/9781003645542-80>
- Kamaruzaman, N. R., Shahrul, M., & Ishak, I. (2023). *WAQF INSTITUTIONS: A Systematic Literature Review On Governance , Financial Models , And Socio-Economic Impact In Islamic Social Finance*. 5(18), 134–151. <https://doi.org/10.35631/AIJBES.518014>
- Karim, S., Zadjali, F. Al, Rawahi, M. Al, & Hazik, M. (2025). *Business trends & challenges in Islamic FinTech : A systematic*. 1–26.
- Khalim, M. A., Masruri, M., Zahari, W., Yusoff, W., & Hashim, M. S. (2025). *Integration*

- of Waqf and Modern Financial Instruments for Evaluating Their Impact on Social and Economic Development.* IX(2454), 4313–4325.
<https://doi.org/10.47772/IJRISS>
- Laili, N. H., Khairil, K. F., Masruki, R., & Sains, U. (2023). *Review of Blockchain Technology in Managing Waqf (Endowment)*. 23(20).
- Lubis, S., Ahmad, J., & Jovita-olvez, H. D. (2025). *Synergizing AI and blockchain : a bibliometric analysis of their potential for transforming e-governance in smart cities.* April, 1–20. <https://doi.org/10.3389/frsc.2025.1553816>
- Maretaniandini, S. T., Hilmiyah, F., Akbar, S., & Hamid, A. A. (2025). *Journal of Islamic Economic Laws* VIII(1) 210-236 (2025). 8(1), 210–236.
<https://doi.org/10.23917/jisel.v8i01.8518>
- Matthew, J., Joanne, E., Patrick, M., 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., Mayo-wilson, E., Mcdonald, S., Mcguinness, L. A., ... Moher, D. (2021). *Article : The PRISMA 2020 statement : An updated guideline for reporting systematic reviews.*
- Mazura, N., Mohaiyadin, H., Aman, A., & Palil, M. R. (2022). *Addressing Accountability And Transparency Challenges In Waqf Management Using Blockchain Technology.* 8, 53–80.
- Megat, P. A., Al-Shaghdari, F., Bin Ngah, B., & Abdelfattah, S. S. (2024). Assessing the predictive benefits of Waqftech smart contracts on corporate waqf crowdfunding among Malaysian enterprises. *Journal of Islamic Marketing*, 15(5), 1303–1325. <https://doi.org/10.1108/JIMA-08-2023-0262>
- Meskini, F. Z., & Aboulaich, R. (2024). *Insurance Based on Waqf and Blockchain Technology : A Strong Social Impact & Efficiency.* 21, 741–752.
<https://doi.org/10.37394/23207.2024.21.62>
- Muhammad, A. A., Ardo, A. M., Idriss, I. D., & Jajere, M. (2025). *Waqf as an Islamic Endowment : A Solution for Improving Educational Attainment in Northern Nigerian Communities.* 4(1), 44–50.
- Musyirah, W., Ismail, W., Misba, N. T., Amyra, N., & Isa, M. (2025). *Reimagining Waqf in the Digital Age : A Framework for Smart Waqf Governance Through Emerging Technologies.* IX(2454), 4704–4714. <https://doi.org/10.47772/IJRISS>
- Raihana, S., Ahmad, A., Ishak, N., Fadly, A., & Rasedee, N. (2025). *Revolutionizing Financial Inclusion : A Blockchain-AI Model for Zakat and Waqf Management in Malaysia and Beyond .* 173–193.
- Ramadhan, J., & Hayatullah, I. K. (2025). *importance of utilizing waqf assets for public purposes , such as education , health , and.* 3(1), 29–54.
- Sukmana, R. (2020). Heliyon Critical assessment of Islamic endowment funds (Waqf) literature : lesson for government and future directions. *Heliyon*, 6(10), e05074. <https://doi.org/10.1016/j.heliyon.2020.e05074>