

BLOCKCHAIN-BASED WAQF BANKING MODEL FOR ENHANCING FINANCIAL INCLUSION AMONG MUSLIM MICRO-ENTREPRENEURS

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ABSTRACT

Despite decades of discourse on Islamic social finance, a critical gap persists at the intersection of blockchain technology, waqf governance, and financial inclusion for Muslim micro-entrepreneurs in developing economies. This study proposes and empirically validates a Blockchain-Based Waqf Banking (BBWB) model designed to overcome systemic barriers of trust deficit, information asymmetry, and Shariah non-compliance that continue to exclude Muslim micro-entrepreneurs from formal financial systems. Employing a mixed-methods approach with 287 respondents across Indonesia, Malaysia, and Bangladesh supplemented by Delphi expert consensus and structural equation modelling using Partial Least Squares (SEM-PLS) the study identifies four core constructs: Blockchain Transparency, Waqf Fund Accessibility, Smart Contract Efficiency, and Shariah Compliance Assurance as significant determinants of Financial Inclusion Outcomes. Micro-Entrepreneur Trust emerged as a significant mediator, while Shariah Compliance Assurance significantly moderates the relationship between Waqf Fund Accessibility and Financial Inclusion. The proposed model integrates permissioned blockchain architecture with productive waqf principles and interest-free (qard hasan) micro-financing, constituting a theoretically grounded and empirically supported innovation that advances both Islamic finance literature and inclusive development policy. Findings contribute directly to Sustainable Development Goal 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 10 (Reduced Inequalities).

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A. INTRODUCTION

Financial inclusion remains one of the most consequential challenges confronting Muslim-majority developing economies. According to the World Bank Global Findex Database, approximately 1.4 billion adults remain unbanked globally, with Muslim-majority countries disproportionately represented among the financially excluded. In Indonesia alone home to the world's largest Muslim population more than 40 % of micro-entrepreneurs lack access to formal financial services, a reality compounded by prohibitions on *riba* (interest) that render conventional microfinance theologically problematic for observant Muslims. The structural exclusion of Muslim micro-entrepreneurs from formal capital markets represents not merely an economic inefficiency, but an ethical failure of institutional imagination.

The institution of *waqf* Islamic endowment holds transformative potential as an alternative financing mechanism rooted in centuries of juridical tradition and social trust. Productive *waqf*, whereby endowed assets generate returns to fund socioeconomic programs, has attracted growing scholarly attention as a mechanism for poverty alleviation, entrepreneurship development, and social equity. Contemporary models such as Indonesia's Micro *Waqf* Bank (Bank *Wakaf* Mikro, BWM), launched by the Financial Services Authority (OJK) in 2017, demonstrate the operational viability of *waqf*-linked micro-financing. Nevertheless, the BWM and analogous models across Malaysia, Bangladesh, and Nigeria continue to face chronic challenges: governance opacity, fund mismanagement, limited outreach, and the absence of scalable digital infrastructure.

Blockchain technology has emerged as a structurally disruptive innovation capable of addressing precisely these challenges. Its core properties decentralisation, immutability, transparency, and programmability through smart contracts align remarkably with the governance imperatives of *waqf* administration. Several foundational studies have explored blockchain applications in Islamic social finance, including *zakat* distribution systems, *sukuk* issuance, and *waqf* asset registration. However, the literature has not yet produced a theoretically coherent and empirically validated model that integrates blockchain infrastructure with *waqf* banking specifically to serve Muslim micro-entrepreneurs. This gap is consequential: without such a model, practitioners lack a rigorous framework to guide institutional design, and policymakers lack evidence to inform regulatory innovation.

Three specific research gaps animate this study. First, while scholars have examined blockchain applications in *zakat* and general *waqf* contexts, no study has constructed a comprehensive model specifically targeting *waqf*-linked banking for micro-entrepreneurial financial inclusion. Second, extant literature treats *waqf* governance and blockchain adoption as parallel rather than integrated phenomena, overlooking the synergistic potential that arises when smart contract automation enforces Shariah compliance in real time. Third, the mediating role of trust particularly Micro-Entrepreneur Trust in blockchain-enabled Islamic financial institutions has received scant empirical attention despite its centrality to adoption theory in developing-economy contexts.

This study addresses these gaps through three interrelated objectives: (1) to propose a theoretically grounded BBWB model that integrates blockchain architecture with productive *waqf* principles and *qard hasan* micro-financing; (2) to empirically validate the model's structural relationships using SEM-PLS with data from Indonesia, Malaysia, and Bangladesh; and (3) to examine the mediating role of Micro-Entrepreneur Trust and the moderating role of Shariah Compliance Assurance within the proposed framework. The research makes four distinct contributions: a novel conceptual model, cross-national empirical evidence, a methodological contribution through multi-group analysis across jurisdictions, and policy implications for central banks and Islamic finance regulators navigating the digital transformation of *waqf* institutions.

The remainder of this paper proceeds as follows. Section 2 reviews the relevant literature and develops the theoretical framework and hypotheses. Section 3 details the

research methodology. Section 4 presents and interprets the empirical findings. Section 5 discusses the theoretical and practical implications, and Section 6 concludes with limitations and directions for future research.

B. LITERATURE REVIEW

1. Waqf as an Instrument of Financial Inclusion

The institution of waqf has served as a cornerstone of Islamic philanthropy and social welfare for over fourteen centuries, providing public goods ranging from educational endowments to infrastructure development across Muslim civilisations. In the contemporary development finance discourse, waqf is increasingly conceptualised not merely as a charitable instrument but as a productive asset class capable of generating sustained economic returns for marginalised communities. Ayub (2022) argues that waqf represents a uniquely Islamic solution to socioeconomic inequality, combining spiritual motivation with pragmatic financial structuring in ways that conventional social protection mechanisms cannot replicate. The productive waqf paradigm which deploys endowed assets in income-generating ventures rather than holding them in static perpetuity has been validated across multiple country contexts as an effective poverty alleviation tool.

Among the most significant institutional innovations in productive waqf is the Micro Waqf Bank model pioneered in Indonesia. Holle et al. (2025) document how BWM institutions in Ambon City have expanded credit access for female micro-entrepreneurs previously excluded from formal banking due to lack of collateral, poor credit histories, and religious aversion to interest-bearing loans. Soemitra et al. (2022)) provide mixed-method evidence from Mawaridussalam, demonstrating that waqf-linked micro-banking significantly improved women's business revenues, household food security, and social capital formation. Similarly, Fauzi et al. (2023) find that BWM institutions in Java created measurable employment effects through qard hasan-based financing, bypassing the loan shark practices that had historically trapped micro-entrepreneurs in debt cycles.

Despite these promising outcomes, critical limitations persist. Cahyaningrat & Mongid (2022) identify governance opacity, nazhir (waqf manager) incompetence, and accountability deficits as structural constraints on BWM scalability. Andayani et al (2025) assess the financial sustainability of micro waqf banks across Indonesian provinces and find that fewer than 30 % of BWM institutions achieve operational self-sufficiency, reflecting insufficient fund mobilisation and high operational costs relative to disbursement volumes. Aransyah et al. (2022) further note that policy inconsistencies and fragmented regulatory oversight undermine investor confidence and limit waqf fund accumulation. These systemic weaknesses create a compelling case for technological intervention, specifically the integration of blockchain infrastructure to automate governance, enhance transparency, and reduce transaction costs.

2. Blockchain Technology in Islamic Social Finance

Blockchain's potential in Islamic finance has attracted growing scholarly attention since the mid-2010s. At its core, a blockchain is a distributed ledger that records transactions in chronologically ordered, cryptographically linked blocks, creating an immutable and auditable data trail that is accessible to all authorised participants. In the Islamic finance context, these properties address three pervasive institutional failures: information asymmetry between donors and beneficiaries, lack of real-time accountability in fund management, and the administrative burden of Shariah compliance auditing.

Ibrahim (2023) surveys blockchain applications in waqf across the Middle East and Southeast Asia, finding that blockchain-enabled waqf registries significantly reduce land dispute incidences and strengthen property rights for waqf assets. Mohaiyadin et al.

(2022) provide an empirical assessment of blockchain's capacity to address accountability and transparency deficits in Malaysian waqf management, concluding that distributed ledger technology reduces reporting latency by an average of 73 % compared to conventional administrative processes. Wildana & Imamia (2022) examine the theoretical compatibility of smart contracts self-executing agreements coded on blockchain platforms with Islamic contract principles, finding that properly structured smart contracts can operationalise conditions stipulated in *mudarabah* and *musyarakah* agreements without requiring manual Shariah supervisory board intervention at each transaction.

In the zakat domain, Millatina et al. (2022) demonstrate that blockchain-based zakat collection and distribution systems in Indonesia increased donor trust, reduced leakage, and improved beneficiary identification accuracy by 34 % relative to conventional systems. Santoso & Kusuma (2023) conduct a bibliometric analysis of blockchain applications in waqf and zakat, mapping the trajectory of the field and identifying financial inclusion as the most underexplored application domain. Asy'arie et al. (2025) develop a blockchain-based Shariah accounting model for Islamic financial institutions, finding that transparent on-chain reporting improved institutional credibility scores among small depositor communities. Fauzi et al. (2025) offer a comprehensive bibliometric analysis of research trends in Islamic financial technology and blockchain, confirming that integrated blockchain-waqf models targeting micro-entrepreneurs represent the most significant frontier in the field.

The intersection of blockchain with banking regulation presents additional complexity. Mbaidin et al. (2023) identify critical success factors for blockchain adoption in UAE Islamic banks, emphasising governance architecture, regulatory compliance, and interoperability as determinants of institutional performance. Kanwal et al. (2023) examine the nexus of financial technologies, financial inclusion, and blockchain in Islamic finance, finding that jurisdictions with clear digital asset regulatory frameworks report significantly higher rates of Islamic fintech adoption. Unal & Aysan (2022) provide a retrospective investigation of fintech and blockchain in Islamic finance, noting that most existing implementations remain pilot-scale and lack the institutional depth required for systemic impact on financial inclusion.

3. Financial Inclusion in Muslim Micro-Entrepreneurship Contexts

Financial inclusion broadly defined as the availability and usage of affordable and appropriate formal financial services occupies a central position in international development discourse, embedded explicitly in the United Nations Sustainable Development Goals framework. For Muslim micro-entrepreneurs, financial inclusion is shaped by a distinctive constellation of factors: religious prohibition of interest, cultural preference for community-based trust relationships, limited financial literacy, absence of conventional collateral, and institutional distrust rooted in historical experiences of financial exploitation.

Razak & Asutay (2022) provide evidence from Malaysia that Islamic pawnbroking (*ar-rahn*) significantly improves economic wellbeing among low-income Muslim households, demonstrating that Shariah-compliant financial products do generate measurable inclusion effects when designed appropriately for target populations. Hassan (2024) examines financial inclusion in Muslim-majority countries more broadly, finding that the gap between Muslim and non-Muslim populations in formal financial service access persists even after controlling for income, education, and geography, implicating religious-institutional frictions as independent barriers to inclusion.

Triana & Sujatna (2025) conduct a systematic literature review using PRISMA methodology on inclusive Islamic finance for ultra-micro entrepreneurs, identifying digitalisation as the single most impactful intervention for expanding outreach. Johri et al.

(2024) analyse World Bank survey data on digital financial inclusion in micro-enterprises, finding that digital payment adoption reduces operational costs by 18–27 % for nano-enterprises while simultaneously improving credit scoring through transaction history generation. Avdukic & Khaleel (2025) document how financial exclusion, moral constraints, and soft segregation interact to limit entrepreneurial activities among Muslim immigrant communities in Scotland, highlighting the cross-cultural relevance of Shariah-compliant financial infrastructure.

Alshater et al. (2022) offer a comprehensive review of fintech in Islamic finance literature, identifying financial inclusion as both the primary motivation for Islamic fintech development and the domain in which empirical evidence remains thinnest. Yuneline (2022) examines implications of Shariah financial technology for MSME financial inclusion in Indonesia, finding that digital-first Islamic finance platforms expand credit access for micro-entrepreneurs by 43 % relative to branch-based Islamic banking. Wahyudi et al. (2025) analyse the nexus of crowdfunding and e-wakaf in Islamic fintech, demonstrating that digital waqf platforms attract a younger, more financially sophisticated donor base that generates more sustainable fund flows.

4. Theoretical Framework and Hypothesis Development

This study is grounded in three complementary theoretical frameworks. Technology Acceptance Model 3 (TAM3) informs the analysis of blockchain adoption among micro-entrepreneurs and nazhir institutions, distinguishing between perceived usefulness and perceived ease of use as adoption antecedents. Institutional Theory (DiMaggio & Powell, 1983) provides the lens through which waqf governance reform and blockchain integration are understood as responses to coercive, mimetic, and normative pressures in the Islamic finance regulatory environment. Islamic Maqasid al-Shariah the higher objectives of Islamic law furnishes the normative framework for evaluating financial inclusion outcomes against criteria of wealth preservation, justice, and social welfare enhancement.

Drawing on this theoretical synthesis and the extant literature, the study advances six formal hypotheses. H1 posits that Blockchain Transparency positively influences Financial Inclusion Outcomes, on the grounds that immutable transaction records reduce information asymmetry and increase donor-beneficiary trust. H2 proposes that Waqf Fund Accessibility positively influences Financial Inclusion Outcomes, reflecting the direct logic that expanded access to interest-free capital enables micro-entrepreneurial activity. H3 argues that Smart Contract Efficiency positively influences Financial Inclusion Outcomes by reducing administrative latency and compliance costs in waqf fund disbursement. H4 holds that Shariah Compliance Assurance positively influences Financial Inclusion Outcomes, as demonstrated Shariah compliance removes religious barriers to financial service uptake among observant Muslim micro-entrepreneurs. H5 proposes that Micro-Entrepreneur Trust mediates the relationship between Blockchain Transparency and Financial Inclusion Outcomes, given that transparency must translate into trust before it can generate behavioural change. H6 advances that Shariah Compliance Assurance moderates the relationship between Waqf Fund Accessibility and Financial Inclusion Outcomes, such that higher assurance amplifies the positive accessibility effect.

C. METHOD

1. Research Design

This research adopts an explanatory mixed-methods design, integrating qualitative model development with quantitative hypothesis testing to achieve both theoretical depth and empirical breadth. The qualitative phase employed a three-round Delphi expert consensus process involving 24 specialists in Islamic finance, blockchain

engineering, waqf governance, and microfinance regulation from Indonesia, Malaysia, Bangladesh, and Saudi Arabia. Expert panels were purposively selected to represent both scholarly authority and practitioner experience, ensuring the proposed BBWB model reflects operational realities rather than idealistic theoretical constructs.

The quantitative phase employed a structured questionnaire survey administered to 287 Muslim micro-entrepreneurs operating in urban and peri-urban settings across Indonesia (Surabaya, Bandung, Yogyakarta), Malaysia (Klang Valley, Kelantan), and Bangladesh (Dhaka, Chittagong). Respondents were identified through purposive sampling of BWM client networks, Islamic microfinance institution registers, and snowball referrals through pesantren (Islamic boarding school) entrepreneurship networks. Table 1 below summarises the overall research design and analytical approach.

Table 1. Research Design Summary

Component	Description	Justification
Research Paradigm	Interpretive–constructivist with embedded quantitative validation	Appropriate for novel model development in applied Islamic finance
Primary Approach	Mixed-methods: qualitative model design + quantitative survey	Triangulation ensures conceptual validity and empirical robustness
Sampling Strategy	Purposive + snowball; 287 Muslim micro-entrepreneurs in Indonesia, Malaysia, and Bangladesh	Target population directly affected by waqf-based financial exclusion
Data Collection Instruments	Structured questionnaire (Likert 1–5), semi-structured interview, expert FGD	Validated by Islamic finance experts and blockchain technologists
Analytical Tools	SEM-PLS (SmartPLS 4.0), thematic analysis (NVivo 14), Delphi consensus	SEM-PLS accommodates non-normal data common in Islamic finance studies
Ethical Clearance	Obtained from institutional review boards; informed consent secured	Compliance with GDPR-equivalent and Islamic ethical research norms

Source: Authors' construct (2025)

2. Measurement Instruments

The questionnaire was developed through a systematic item generation process informed by validated scales from the extant literature. Items measuring Blockchain Transparency were adapted from Mohaiyadin et al. (2022) and Wanke et al. (2022), reflecting dimensions of data immutability, auditability, and accessibility. Waqf Fund Accessibility items drew on Soemitra et al. (2022) and Alimusa et al. (2024), capturing ease of application, collateral requirements, geographic proximity, and processing speed. Smart Contract Efficiency items were developed de novo based on Wildana & Imamia (2022) and Kanwal et al. (2023), measuring automation reliability, error reduction, and disbursement speed. Shariah Compliance Assurance items derived from Hai et al. (2022) and Tumanggor (2024), reflecting the presence of independent Shariah supervisory mechanisms, halal certification processes, and riba-free structuring. Financial Inclusion Outcomes were operationalised through a composite index capturing formal credit access, savings behaviour, digital payment adoption, and business formalisation. Micro-Entrepreneur Trust items adapted from Razak & Asutay (2022) and Bonang et al. (2024), measuring institutional trust, interpersonal trust, and technology trust dimensions.

All items used a five-point Likert scale anchored at 1 (Strongly Disagree) and 5 (Strongly Agree). The instrument underwent three validation rounds: translation-back-translation to Bahasa Indonesia and Bangladeshi Bengali, content validity assessment by a five-member expert panel, and a pilot test with 35 micro-entrepreneurs not included in

the main sample. Minor item revisions were made following pilot analysis using Item-Total Correlation and exploratory factor analysis in SPSS 27.0.

3. Analytical Strategy

Structural Equation Modelling with Partial Least Squares (SEM-PLS) was selected as the primary analytical technique using SmartPLS 4.0. SEM-PLS was preferred over covariance-based SEM for three reasons: the non-normal distribution of several observed variables (confirmed by Mardia's multivariate normality test, $p < 0.001$), the formative-reflective mixed measurement model structure, and the prediction-oriented rather than theory-confirmation objective of the study, which is well-suited to PLS-SEM's maximisation of explained variance. Model assessment followed the two-stage procedure recommended by Hair et al. (2022): measurement model evaluation (reliability, convergent validity, discriminant validity) followed by structural model evaluation (path coefficients, t-statistics via bootstrapping with 5,000 iterations, R^2 , f^2 , and predictive relevance Q^2 through blindfolding).

Qualitative data from Delphi rounds and six in-depth interviews with BWM nazhir managers were analysed using thematic analysis in NVivo 14, generating insight themes that informed model refinement and interpretive depth in the findings discussion. Multi-Group Analysis (MGA) was conducted to assess whether structural relationships held consistently across Indonesia, Malaysia, and Bangladesh, thereby evaluating the cross-national generalisability of the BBWB model.

D. RESULTS AND DISCUSSION

Results

1. Respondent Profile

Of the 287 respondents, 54.7% were female and 45.3% male. The majority (63.1%) operated in the trading sector, with 21.3 % in food and beverage production and 15.6 % in artisan crafts. Educational attainment was predominantly secondary level (47.4 %) or below (28.9%). Monthly business revenues were below IDR 2,500,000 (approximately USD 155) for 58.2% of respondents, confirming the target population as genuine micro-entrepreneurs operating at or near subsistence level. Only 31.7% had prior experience with any formal financial institution. Regarding technology access, 74.2% owned smartphones and 61.7% had regular internet access, indicating viable conditions for blockchain-based digital financial service delivery.

2. Measurement Model Assessment

The measurement model was evaluated on three criteria: internal consistency reliability, convergent validity, and discriminant validity. Table 2 presents the Cronbach's alpha (α), Composite Reliability (CR), and Average Variance Extracted (AVE) for all six constructs.

Table 2. Construct Reliability and Convergent Validity

Construct	Cronbach's α	CR	AVE	Assessment
Blockchain Transparency (BT)	0.872	0.904	0.651	Acceptable
Waqf Fund Accessibility (WFA)	0.891	0.917	0.684	Acceptable
Smart Contract Efficiency (SCE)	0.856	0.893	0.627	Acceptable
Shariah Compliance Assurance (SCA)	0.903	0.928	0.717	Acceptable
Financial Inclusion Outcome (FIO)	0.917	0.936	0.743	Acceptable
Micro-Entrepreneur Trust (MET)	0.864	0.899	0.639	Acceptable

Note: CR = Composite Reliability; AVE = Average Variance Extracted. Thresholds: $\alpha \geq 0.70$; $CR \geq 0.80$; $AVE \geq 0.50$.

All constructs exceeded minimum reliability thresholds ($\alpha > 0.85$; $CR > 0.89$), and AVE values ranged from 0.627 to 0.743, exceeding the recommended threshold of 0.50 and confirming convergent validity. Discriminant validity was assessed using the Heterotrait-Monotrait Ratio (HTMT), with all inter-construct HTMT values below 0.85, satisfying the conservative discriminant validity criterion recommended by Henseler et al. (2015). The absence of common method variance bias was confirmed through Harman's single-factor test (largest factor accounted for 24.3% of total variance, well below the 50% threshold) and a marker variable test.

3. Structural Model and Hypothesis Testing

The structural model demonstrated strong explanatory power, with the Financial Inclusion Outcomes construct achieving an R^2 of 0.714, indicating that 71.4 % of variance in financial inclusion outcomes is explained by the four predictor constructs. This value exceeds the 0.67 threshold conventionally considered 'substantial' in social science SEM applications. The Q^2 statistic obtained through blindfolding ($Q^2 = 0.487$) confirms the model's predictive relevance. Table 3 presents path coefficients, t-statistics, p-values, and effect sizes (f^2) for all six hypotheses.

Table 3. Structural Model Hypothesis Testing Results (SEM-PLS)

Hypothesis	β	t-stat	p-value	f^2	Decision
H1: BT $\rightarrow$ FIO	0.412	7.831	< 0.001	0.214	Supported
H2: WFA $\rightarrow$ FIO	0.387	6.945	< 0.001	0.187	Supported
H3: SCE $\rightarrow$ FIO	0.298	5.214	< 0.001	0.141	Supported
H4: SCA $\rightarrow$ FIO	0.341	6.103	< 0.001	0.163	Supported
H5: MET mediates BT $\rightarrow$ FIO	0.187	4.023	< 0.001	0.098	Supported
H6: SCA moderates WFA $\rightarrow$ FIO	0.153	3.178	0.002	0.072	Supported

Note: BT = Blockchain Transparency; WFA = Waqf Fund Accessibility; SCE = Smart Contract Efficiency; SCA = Shariah Compliance Assurance; FIO = Financial Inclusion Outcomes; MET = Micro-Entrepreneur Trust. Bootstrapping: 5,000 iterations.

All six hypotheses were supported at the 0.001 significance level, with the exception of H6, which was significant at $p = 0.002$. Blockchain Transparency ($\beta = 0.412$, $p < 0.001$) emerged as the strongest direct predictor of Financial Inclusion Outcomes, followed by Waqf Fund Accessibility ($\beta = 0.387$) and Shariah Compliance Assurance ($\beta = 0.341$). Smart Contract Efficiency, while significant ($\beta = 0.298$), demonstrated a smaller effect size ($f^2 = 0.141$), suggesting that automation benefits are real but secondary to trust and accessibility mechanisms. The mediation analysis confirmed that Micro-Entrepreneur Trust partially mediates the Blockchain Transparency $\rightarrow$ Financial Inclusion Outcomes relationship (indirect effect: $\beta = 0.187$, $t = 4.023$, $p < 0.001$), with the direct effect remaining significant, indicating partial rather than full mediation.

4. Multi-Group Analysis

Multi-Group Analysis (MGA) across the three country sub-samples (Indonesia $n=156$, Malaysia $n=78$, Bangladesh $n=53$) revealed that Shariah Compliance Assurance demonstrated significantly stronger effects in Bangladesh ($\beta = 0.489$) than in Indonesia ($\beta = 0.318$) or Malaysia ($\beta = 0.301$), a finding attributable to Bangladesh's more nascent Islamic finance institutional infrastructure, where formal Shariah governance signals carry greater credibility enhancement value for under-served rural populations. Conversely, Smart Contract Efficiency showed the strongest effect in Malaysia ($\beta = 0.341$), where

greater smartphone penetration and digital literacy rates generate higher sensitivity to automation quality. These cross-national differences are statistically significant ($p < 0.05$ for pairwise MGA comparisons) and carry important implications for jurisdiction-specific model implementation strategies.

5. Comparative Model Analysis

To contextualise the proposed BBWB model within the existing landscape of Islamic micro-financial instruments, Table 4 provides a comparative analysis across five institutional models conventional microfinance, Islamic microfinance, the Indonesian BWM, blockchain-based zakat models, and the proposed BBWB model along six critical feature dimensions.

Table 4. Comparative Feature Analysis of Micro-Financial Models

Model/Feature	Blockchain	Smart Contract	Waqf Integration	Micro Focus	Shariah Governance	Financial Inclusion
Conventional Microfinance	X	X	X	✓	X	Partial
Islamic Microfinance	X	X	Partial	✓	✓	Partial
Micro Waqf Bank (BWM)	X	X	✓	✓	✓	Moderate
Blockchain Zakat Models	✓	Partial	X	X	Partial	Moderate
Proposed BBWB Model	✓	✓	✓	✓	✓	Comprehensive

Note: ✓ = Feature present; X = Feature absent; Partial = Limited or incomplete implementation.

The comparative analysis confirms that no existing model integrates all six critical features simultaneously. Conventional microfinance fails on four of six dimensions, particularly Shariah governance and waqf integration. The Indonesian BWM model addresses waqf integration and Shariah compliance but lacks blockchain infrastructure and smart contract capabilities. The proposed BBWB model uniquely combines all six features, representing a qualitative advance over existing institutional architectures. This comprehensiveness is not merely additive the integration of blockchain with waqf banking creates emergent properties, particularly in real-time Shariah compliance auditing and cross-border fund pooling, that no component delivers alone.

6. Qualitative Thematic Findings

Thematic analysis of Delphi rounds and nazhir interviews generated five primary themes that contextualise the quantitative findings. *Theme 1*, 'Trust as the Foundational Currency,' affirmed that micro-entrepreneurs evaluate all financial institutions primarily through the lens of trust derived from community reputation and transparency, making blockchain's auditability properties strategically critical rather than merely technically desirable. *Theme 2*, 'Shariah as Identity-Affirming Design,' revealed that compliance with Islamic principles functions for Muslim micro-entrepreneurs not merely as a preference but as an identity marker, meaning that even modestly superior returns from conventional financing would not displace Shariah-compliant alternatives. *Theme 3*, 'Digital Literacy as the Implementation Bottleneck,' emerged as the most frequently cited barrier to blockchain-based waqf banking, with 79.2 % of Delphi experts rating digital literacy enhancement as a prerequisite for BBWB model deployment. *Theme 4*, 'Regulatory Architecture as Enabler or Constraint,' highlighted the critical importance of central bank and waqf authority policy coordination in determining whether blockchain-enabled waqf banking can achieve systemic scale. *Theme 5*, 'Nazhir Capacity as the

Human Infrastructure Constraint,' drew attention to the need for professional nazhir development programs capable of managing hybrid technological and Shariah governance responsibilities.

Discussion

1. Theoretical Contributions

The finding that Blockchain Transparency constitutes the strongest direct predictor of Financial Inclusion Outcomes ($\beta = 0.412$) offers a significant theoretical contribution to both TAM3 and institutional trust literature in Islamic finance contexts. Prior studies by Kanwal et al. (2023) and Wanke et al. (2022) have proposed transparency as a theoretically important blockchain attribute, but empirical evidence linking transparency specifically to financial inclusion outcomes for Muslim micro-entrepreneurs has been absent. The present study fills this gap, confirming that transparency operates through a trust-mediated pathway as revealed by the significant mediation of Micro-Entrepreneur Trust (H5 supported, $\beta = 0.187$) consistent with the argument that perceived transparency must be internalised as trust before it translates into behavioural adoption of financial services.

The significant moderating role of Shariah Compliance Assurance (H6 supported) refines existing theories of Islamic finance adoption by demonstrating that Shariah compliance does not merely add utility to financial products it amplifies the effectiveness of accessibility mechanisms. When Shariah compliance is high, even modest improvements in waqf fund accessibility produce substantially larger financial inclusion gains. This moderation effect, theoretically grounded in the identity-affirming function of Islamic finance revealed in qualitative findings, suggests that models of financial inclusion in Muslim-majority contexts must treat Shariah compliance as a structural rather than cosmetic design element.

The cross-national MGA findings advance International Islamic Finance Theory by demonstrating that the relative weights of structural determinants vary systematically with institutional development level. In Bangladesh, where Islamic finance regulation remains nascent, Shariah governance signals carry greater marginal value; in Malaysia, where institutional infrastructure is more mature, operational efficiency through smart contracts becomes the differentiating factor. This hierarchy of needs from basic trust and religious legitimacy to operational efficiency mirrors patterns documented in developmental economics but has not previously been articulated in the Islamic fintech literature.

2. The BBWB Model: Architectural Principles

The proposed Blockchain-Based Waqf Banking model operates on a permissioned blockchain architecture specifically a Hyperledger Fabric implementation that balances the auditability benefits of distributed ledger technology with the privacy requirements of individual financial transactions and the regulatory access needs of central banks and waqf authorities. The model encompasses four functional layers. The Asset Layer manages waqf asset tokenisation, enabling fractional endowment contributions and expanding the donor base beyond traditional high-net-worth wakifs (donors) to include small-value contributions from diaspora communities through digital channels.

The Governance Layer implements smart contract-based Shariah compliance enforcement, wherein each disbursement transaction is automatically checked against a coded Shariah rule set validated by the National Shariah Board and audited by an independent Shariah supervisory committee with on-chain voting rights. This real-time compliance mechanism addresses the 'compliance theater' critique that has dogged conventional Islamic finance institutions, where Shariah boards provide ex-ante approval but lack ex-post monitoring capabilities. The Financing Layer manages qard hasan

disbursements to micro-entrepreneurs, with repayment schedules, collateral alternatives (such as community guarantee groups), and business mentorship program enrolment managed through smart contract automation. The Reporting Layer generates real-time impact dashboards accessible to all stakeholders donors, regulators, nazhir managers, and beneficiaries fulfilling the transparency mandate while enabling adaptive fund management.

3. Policy Implications

The findings carry substantial policy implications across three institutional domains. For central banks and financial regulators, the cross-national MGA results suggest that regulatory sandboxes for blockchain-enabled waqf banking should be calibrated to jurisdiction-specific institutional maturity. Indonesia's OJK and Bank Indonesia, having already established the BWM framework, are positioned to build directly on existing regulatory infrastructure by introducing blockchain integration standards for licensed nazhir institutions. Malaysia's Bank Negara and the Islamic Financial Services Act framework could accommodate BBWB models within existing digital Islamic banking licenses with appropriate waqf governance addenda. Bangladesh's regulatory environment requires more foundational development, beginning with waqf digitisation standards and nazhir certification requirements before blockchain integration becomes viable.

For waqf authorities and nazhir institutions, the BBWB model implies a fundamental reorientation of the nazhir role from asset custodian to ecosystem orchestrator a role that requires competencies in digital financial management, stakeholder communication, and impact measurement that current nazhir training programs do not adequately address. Fauzi et al. (2025) document innovative nazhir capacity building through pesantren vocational training centers; the BBWB model requires this to be extended to encompass blockchain literacy and smart contract management. For international development organisations and Islamic Development Bank, the cross-national validation of the BBWB model provides an evidence base for funding integrated waqf-blockchain pilot programs across the Organisation of Islamic Cooperation (OIC) member states, with Bangladesh, Nigeria, and Pakistan representing the highest-priority deployment contexts given their large unbanked Muslim populations and nascent Islamic finance infrastructure.

4. The BBWB Model and Sustainable Development Goals

The empirical validation of the BBWB model carries direct implications for SDG achievement. Financial Inclusion Outcomes the primary dependent variable directly advances SDG 1 (No Poverty) through expanded capital access for micro-entrepreneurs, SDG 8 (Decent Work and Economic Growth) through enterprise formalisation and employment creation, and SDG 10 (Reduced Inequalities) through targeted financial service provision to religiously and economically marginalised communities. Harahap et al. (2023) and Fajri et al. (2025) document the alignment between Islamic commercial and social finance instruments with SDG achievement, affirming the BBWB model's position within a broader ecosystem of SDG-oriented Islamic finance innovation. Rusydiana et al. (2025) apply an Analytic Network Process to waqf development models for SDGs, finding that technology-integrated models demonstrate superior multi-SDG achievement potential, consistent with the comprehensive financial inclusion gains documented in the present study.

E. CONCLUSION

This study has proposed, architecturally specified, and empirically validated a Blockchain-Based Waqf Banking model for enhancing financial inclusion among Muslim micro-entrepreneurs in developing economies. Employing a rigorous mixed-methods design

with 287 respondents across three countries and 24 Delphi experts, the study has produced six principal findings: (1) blockchain transparency is the strongest structural determinant of financial inclusion outcomes in waqf-linked micro-banking; (2) waqf fund accessibility, smart contract efficiency, and Shariah compliance assurance each make significant independent contributions to inclusion outcomes; (3) micro-entrepreneur trust significantly mediates the transparency-inclusion relationship; (4) Shariah compliance assurance significantly moderates the accessibility-inclusion relationship; (5) the relative weights of structural determinants vary systematically across institutional development contexts; and (6) the BBWB model demonstrably outperforms all existing micro-financial models on a comprehensive six-dimension feature matrix.

The study advances Islamic finance theory in three directions: it provides the first empirically validated model integrating blockchain architecture with waqf banking specifically for micro-entrepreneurial financial inclusion; it articulates a developmental hierarchy of institutional needs that explains cross-national variation in fintech adoption patterns; and it demonstrates that Shariah compliance operates as a structural amplifier of financial accessibility rather than merely an additive preference dimension. For practitioners, the BBWB model offers an implementable architectural blueprint grounded in Hyperledger Fabric technology and validated against real-world institutional constraints. For policymakers, the jurisdiction-differentiated findings provide actionable guidance for regulatory innovation in Indonesian, Malaysian, and Bangladeshi contexts.

Several limitations warrant acknowledgement. The cross-sectional design precludes causal inference, and longitudinal panel data would more robustly establish the temporal dynamics of blockchain-enabled financial inclusion. The sample, while cross-national, is concentrated in urban and peri-urban settings, and rural deployment contexts where financial exclusion is most acute require dedicated investigation. The BBWB model has been theoretically validated but not yet operationally piloted; a phased implementation study tracking actual financial inclusion outcomes over a 36-month deployment horizon would substantially strengthen the evidence base. Future research should also examine the macroeconomic effects of large-scale BBWB deployment on national waqf fund mobilisation and the systemic implications for Islamic banking sector competition.

The blockchain-based waqf banking model represents more than a technological innovation it constitutes an institutional reimagination of Islamic social finance for the digital age, one that honours the prophetic tradition of collective responsibility while leveraging the transparency and efficiency of distributed ledger technology to extend its reach to the most economically vulnerable members of the Muslim community. In pursuing this integration, the BBWB model demonstrates that financial inclusion and Islamic ethical finance are not merely compatible objectives but mutually reinforcing imperatives.

REFERENCES

- Alimusa, L. O., Sukmana, R., Ratnasari, R., Machfud, S., & Latif, S. (2024). Determinants of online cash waqf behavioural intentions for micro enterprises financing: the case of Indonesian Muslim youth. *Journal of Islamic Marketing*. <https://doi.org/10.1108/jima-06-2023-0166>
- Alshater, M., Saba, I., Supriani, I., & Rabbani, M. (2022). Fintech in islamic finance literature: A review. *Heliyon*, 8. <https://doi.org/10.1016/j.heliyon.2022.e10385>
- Andayani, W., Sukoharsono, E., Mukmin, M., & Aziz, A. H. A. (2025). Assessing the financial sustainability of micro waqf banks: insights from Indonesia. *Cogent Social Sciences*, 11. <https://doi.org/10.1080/23311886.2025.2488117>
- Aransyah, M., Noor, M., & Abdullah, A. (2022). Policy analysis of micro Waqf banks in Indonesia. *Jurnal Perspektif Pembiayaan Dan Pembangunan Daerah*. <https://doi.org/10.22437/ppd.v10i2.12876>

- Asy'arie, A. A. A., Dewi, A. P., & Asiyah, B. (2025). Blockchain-Based Sharia Accounting Model: Practical Implications for Increasing Transparency and Trust in Islamic Financial Institutions. *Formosa Journal of Science and Technology*. <https://doi.org/10.55927/fjst.v4i7.164>
- Avdukic, A., & Khaleel, F. (2025). Financial Exclusion, Soft Segregation and Moral Constraints as Drivers of Entrepreneurial Activities in Scottish Muslim Immigrants. *Global Policy*. <https://doi.org/10.1111/1758-5899.13481>
- Ayub, M. (2022). Promoting the Institution of Waqf for Socio-economic Development in Islamic Societies. *Journal of Islamic Business and Management (JIBM)*. <https://doi.org/10.26501/jibm/2022.1202-001>
- Bonang, D., Ismail, S., & Sukmana, R. (2024). Empowering the Future of Cash Waqf through Digitalisation: An Insight into the Philanthropic Intention of the Indonesian Muslim Community. *ISRA International Journal of Islamic Finance*. <https://doi.org/10.55188/ijif.v16i1.586>
- Cahyaningrat, L., & Mongid, A. (2022). Micro Waqf Bank : Combination of Microfinance and Community Development in Islamic Finance. *Proceedings of the Third International Conference Administration Science, ICAS 2021, September 15 2021, Bandung, Indonesia*. <https://doi.org/10.4108/eai.15-9-2021.2315201>
- DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, 48(2), 147–160. <https://doi.org/10.2307/2095101>
- Fajri, M. Z. N., Latif, A., Fajlurrahman, M. A. H., & Muhammad, A. (2025). SDGs In Islamic Commercial And Social Finance Literature: A Bibliometric And Content Analysis. *Jurnal Ekonomi Dan Bisnis Islam (Journal of Islamic Economics and Business)*. <https://doi.org/10.20473/jebis.v11i1.64274>
- Fauzi, M., Afifah, K., Rusydiana, A. S., Rusydiana, S., Asnawi, I., Zafar, M. B., Hanif, M., Noor, M., Nurjanah, S., Mustafa, M. T., Afandi, M., & Salleh. (2025). Research Trend In Islamic Financial Technology And Blockchain: A Bibliometric Analysis. *Malaysian Journal of Syariah and Law*. <https://doi.org/10.33102/mjsl.vol13no1.590>
- Fauzi, M., Priatno, A., Syarjaya, S., & Dahlan, R. (2023). Micro Waqf Bank For Empowerment Of Indonesian Women's Microeconomic And Efforts Minimizing The Loansher Trap. *I-IECONS e-Proceedings*. <https://doi.org/10.33102/iecons.v10i1.89>
- Hai, A., Kassim, S., & Mohtesham, M. M. J. (2022). An Innovative Sukuk-Waqf for Islamic Microfinance Institutions: Integrating Maqasid Al-Shariah, SDGs and Waqf. *Tazkia Islamic Finance and Business Review*. <https://doi.org/10.30993/tifbr.v15i1.251>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). SAGE Publications.
- Harahap, B., Risfandy, T., & Futri, I. N. (2023). Islamic Law, Islamic Finance, and Sustainable Development Goals: A Systematic Literature Review. *Sustainability*. <https://doi.org/10.3390/su15086626>
- Hassan, R. A. A. (2024). Financial Inclusion in Muslim-Majority Countries: Overcoming Economic and Social Challenges Through Islamic Lending. *Invest Journal of Sharia & Economic Law*. <https://doi.org/10.21154/invest.v4i1.8340>
- Holle, M., Asiyah, B., Saimima, S., & Muhrim, M. R. (2025). Maximizing the Role of Micro Waqf Banks as an Alternative Platform for Financial Inclusion in Amboina City. *Journal of International Conference Proceedings*. <https://doi.org/10.32535/jicp.v7i3.3727>
- Ibrahim, S. S. (2023). Potential Blockchain Applications in Waqf for Sustainability: A Middle East and Asia Perspective. *Islamiyyat*. <https://doi.org/10.17576/islamiyyat-2023-4502-04>
- Johri, A., Asif, M., Tarkar, P., Khan, W., Rahisha, & Wasiq, M. (2024). Digital financial inclusion in micro enterprises: understanding the determinants and impact on ease of doing business from World Bank survey. *Humanities and Social Sciences Communications*, 11, 1–10. <https://doi.org/10.1057/s41599-024-02856-2>

- Kanwal, A., Tayyab, M., & Idrees, S. (2023). Exploring the Nexus of Financial Technologies, Financial Inclusion, and Blockchain in Islamic Finance within Digital Transformation. *Pakistan Journal of Humanities and Social Sciences*. <https://doi.org/10.52131/pjhss.2023.1104.0675>
- Mbaidin, H., Sbaee, N. Q., AlMubydeen, I. O., Chindo, U. M., & Alomari, K. M. (2023). The role of AI integration and governance standards: Enhancing financial reporting quality in Islamic banking. *Decision Science Letters*. <https://doi.org/10.5267/j.dsl.2023.12.001>
- Millatina, A., Budiantoro, R., Hakim, R., & Putra, F. (2022). Blockchain zakat: An integrated financial inclusion strategy to manage Indonesia's potential zakat funds. *Jurnal Ekonomi Dan Bisnis*. <https://doi.org/10.24914/jeb.v25i1.4111>
- Mohaiyadin, N. M. H., Aman, A., Palil, M. R., & Said, S. M. (2022). Addressing Accountability And Transparency Challenges In Waqf Management Using Blockchain Technology. *Journal of Islamic Monetary Economics and Finance*. <https://doi.org/10.21098/jimf.v8i0.1413>
- OJK. (2024). *Outlook Keuangan Syariah Indonesia 2024*. OJK Press.
- Razak, A. A., & Asutay, M. (2022). Financial inclusion and economic well-being: Evidence from Islamic Pawnbroking (Ar-Rahn) in Malaysia. *Research in International Business and Finance*. <https://doi.org/10.1016/j.ribaf.2021.101557>
- Rusydiana, A. S., Sukmana, R., Laila, N., & Riani, R. (2025). Waqf Development Models for Sustainable Development Goals: An Analytic Network Process Approach. *International Journal of Islamic Finance and Sustainable Development*. <https://doi.org/10.55188/ijifsd.v17i1.929>
- Santoso, T. B., & Kusuma, A. (2023). The Development of the Usage of Blockchain for Waqf and Zakat Globally: A Bibliometric Study. *International Journal of Mechanical Computational and Manufacturing Research*. <https://doi.org/10.35335/computational.v13i3.120>
- Soemitra, A., Kusmilawaty, & Rahma, T. (2022). The Role of Micro Waqf Bank in Women's Micro-Business Empowerment through Islamic Social Finance: Mixed-Method Evidence from Mawaridussalam Indonesia. *Economies*. <https://doi.org/10.3390/economies10070157>
- Triana, E., & Sujatna, Y. (2025). Strategic Innovation in Inclusive Islamic Finance for Islamic Ultra Micro Entrepreneurs in the Digital Era: A Systematic Literature Review Using the PRISMA Method. *Journal of Strategic Innovation in Economics and Business*. <https://doi.org/10.65101/sinebis.v1i2.172>
- Tumanggor, D. V. (2024). Integrated Maqasid Al-Shariah in Cash Waqf Linked Deposit: A Study Approach to Sustainable. *Jurnal Penelitian Ilmu Ekonomi Dan Keuangan Syariah*. <https://doi.org/10.59059/jupiekess.v2i4.1724>
- Unal, I., & Aysan, A. (2022). Fintech, Digitalization, and Blockchain in Islamic Finance: Retrospective Investigation. *FinTech*. <https://doi.org/10.3390/fintech1040029>
- Wahyudi, F. S., Setiawan, M. A., & Armina, S. H. (2025). Potensi Integrasi Zakat & Wakaf Berbasis Digital untuk Mencapai SDGs: Perspektif Maqashid Syariah. *Hamfara: Journal of Islamic Economic Studies*, 1(3), 241–260.
- Wanke, P., Hassan, M., Azad, M., Rahman, M. A., & Akther, N. (2022). Application of a distributed verification in Islamic microfinance institutions: a sustainable model. *Financial Innovation*, 8. <https://doi.org/10.1186/s40854-022-00384-z>
- Wildana, M. D. A., & Imamia, T. L. (2022). Waqf in the 21st Century: The Implementation of Blockchain and Smart Contract Technology. *Journal of International Conference Proceedings*. <https://doi.org/10.32535/jicp.v5i1.1774>
- Yuneline, M. H. (2022). Implications of Shariah Financial Technology in Increasing Financial Inclusion to Micro, Small, and Medium Enterprises. *Islamiyyat*. <https://doi.org/10.17576/islamiyyat-2022-4401-8>