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Waqf signal model for digital connectivity in Indonesia's 3T regions

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Abstract

Purpose – This study aims to develop and validate the "waqf signal model," a Sharia-compliant framework that integrates waqf assets with digital connectivity deployment in Indonesia's frontier, outermost, and underdeveloped (3T) regions to alleviate digital inequality. It evaluates stakeholder roles, governance feasibility, Sharia alignment, operational sustainability, and the socio-economic impact of the model.

Methodology – A qualitative exploratory approach was employed using a two-round Delphi technique with nine expert panelists representing telecommunications, Islamic finance, waqf management, mosque leadership, and local government. Additionally, a financial simulation was conducted to assess the operational viability of waqf-based Base Transceiver Station (BTS) deployment.

Findings – The Delphi panel reached a strong consensus on the model's Shariah compatibility through contracts such as *Ijarah Muntahiyah bi Tamlik* (IMBT), *Musyarakah*, and *Musharakah Mutanaqisah* (MMQ). The panel underscored the necessity of multi-stakeholder governance involving *nazhir*, telecommunication operators, local authorities, and community *wakif*. A high consensus was also achieved regarding village digital outlets as dual-purpose hubs for commercial services and waqf benefit distribution. Conversely, revenue-sharing feasibility yielded mixed perspectives, highlighting the need for refined legal and contractual frameworks. Finally, the financial simulation demonstrated that operational sustainability could be achieved within approximately six years under stable market conditions.

Implications – The proposed model offers a Sharia-aligned pathway for inclusive digital infrastructure, facilitating rural access to connectivity, digital financial services, and socio-economic empowerment while contributing to Sustainable Development Goals (SDGs) 9, 10, and 17.

Originality – This study pioneers the application of waqf in telecommunications, establishing an innovative model that synthesizes waqf asset utilization, BTS infrastructure deployment, multi-stakeholder governance, and rural digital inclusion.

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Introduction

Digital connectivity is critical for inclusive development. At the global level, access to reliable internet and mobile networks is closely linked to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 9.c, which emphasizes the expansion of access to information and

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communication technology and the provision of universal and affordable internet access in least developed countries (UNCTAD, 2016). Beyond infrastructure development, digital connectivity also supports education, decent work, economic growth, inequality reduction, and cross-sectoral partnerships, which are reflected in SDG 4, 8, 10, and 17 (UN Office, 2023). From a practical standpoint, this issue is increasingly important because digital connectivity determines whether rural communities can access online education, digital financial services, e-commerce, health information, public services and broader socioeconomic opportunities.

From a theoretical standpoint, digital connectivity is not merely a technological facility but a structural determinant of socioeconomic inclusion. The digital divide refers to unequal access to and use of information and communication technologies, which is shaped by income, education, geography, infrastructure availability, and institutional capacity (Castells, 2003). Rural connectivity studies further show that remote communities are often disadvantaged not only because of geographical isolation, but also because market-based infrastructure models tend to prioritize commercially attractive urban areas (Grubesic & Murray, 2004; Oyana, 2011; Townsend et al., 2013). Consequently, underserved rural communities may remain excluded from digital education, digital finance, market information, and public services, even when national Internet penetration increases.

Previous studies have found that Internet access contributes positively to productivity, market efficiency, income generation, and rural transformation. Internet adoption can reduce information transmission costs, improve labor and product market efficiency, and support more effective resource allocation in education and governance. Empirical studies also suggest that Internet access can increase farm household income, improve market responsiveness, and reduce the rural-urban income gap (Chang & Just, 2009; Siaw et al., 2020). In Indonesia, Sukma et al. (2025) found that self-employed farmers who use the Internet earn a higher income than those who do not, indicating that digital access has meaningful economic implications for rural livelihoods. However, digital benefits are not evenly distributed because internet use remains influenced by socioeconomic characteristics, urban residence, education, and access to ICT facilities (Alderete, 2019; Yesuf, 2021).

In the Indonesian context, the challenge of digital inclusion is particularly relevant for 3T regions, namely terdepan, terluar, and tertinggal areas. Indonesia has experienced rapid internet adoption, with 212 million internet users representing 74.6 percent of the population as of January 2025 (GWI, 2024). However, this figure masks persistent disparities in rural and remote areas. Many 3T regions face structural barriers to telecommunications infrastructure deployment, including difficult terrain, low population density, limited electricity supply, high capital expenditure, logistical constraints, and weak commercial incentives for private providers (Prioutomo 2023). These conditions indicate that the digital divide in Indonesia is not only a technological problem but also an infrastructure financing and governance problem.

From an infrastructure financing perspective, rural telecommunications deployment reflects broader market failure. Private investment incentives are often insufficient to support high-cost, low-return infrastructure in remote regions. Previous studies on rural broadband and mobile connectivity have therefore emphasized the need for alternative financing mechanisms, public-private collaboration, and community-based models to address infrastructure gaps (Grubesic & Murray, 2004; Oyana, 2011; Townsend et al., 2013). However, the role of Islamic social finance, particularly waqf, remains underexplored. Waqf offers a distinctive development logic because it combines asset preservation, long-term public benefits, social redistribution, and community participation. These characteristics make waqf theoretically relevant as an alternative mechanism for supporting essential infrastructure in Muslim-majority countries.

Waqf literature has demonstrated that waqf can contribute to poverty alleviation, education, healthcare, social enterprises, productive asset development, and community-based economic empowerment (Kahf, 1999; Mohsin & Muneeza, 2020; Tanjung & Windiarto, 2021). Previous studies have also discussed several innovative waqf models, including corporate waqf, venture waqf, cooperative waqf, waqf-based social enterprises, and waqf land development (Harun, 2014; Beik, 2015). More recent literature highlights the growing importance of waqf governance, productive

waqf, cash waqf, digital integration, trust, transparency, and community engagement in sustaining waqf-based initiatives (Firmannudin et al., 2024; Misbah & Johari, 2025; Wan Ismail et al., 2025; Zafar & Ali, 2026). In addition, mosque-based Islamic social finance and digital platforms have been shown to strengthen community welfare, financial inclusion, and public trust (Nuriyah & Fakhri, 2022). These studies indicate that waqf is increasingly being positioned as a flexible Islamic social finance instrument to meet contemporary development needs.

Despite these contributions, several important gaps remain unaddressed. First, studies on digital inclusion and rural connectivity have largely focused on technological, geographical, regulatory, and commercial barriers, while recent work continues to show that rural digital exclusion is shaped by infrastructure quality, affordability, capability, geography, and the difficulty of sustaining commercially viable broadband or mobile-network investment in remote areas (Chen et al., 2023; Kumar & Oughton, 2023; Marshall, 2024). Second, previous waqf studies have mostly examined cash waqf, productive waqf, corporate waqf, education, healthcare, poverty alleviation, social enterprise, and land development, while the use of waqf assets for telecommunications infrastructure remains unexplored. Recent systematic reviews further indicate that waqf scholarship is moving toward governance, stakeholder engagement, transparency, digital innovation, financial inclusion, and sustainability, but has not yet sufficiently examined waqf as a rural digital infrastructure-enabling mechanism (Dirie et al., 2024; Himmawan et al., 2025; Jafar et al., 2025). Third, existing Islamic finance and infrastructure studies have not sufficiently integrated Sharia-compliant contracts, waqf asset preservation, telecommunications infrastructure, multi-stakeholder governance, village digital outlets, and benefit distribution into a single operational model for underserved rural regions.

This study addresses these gaps by introducing and validating the Waqf Signal Model, a Sharia-compliant framework that links waqf assets to telecommunications infrastructure development in Indonesia's 3T regions. Unlike previous waqf models that focus mainly on conventional social sectors or general productive asset development, this model positions waqf as an enabler of digital connectivity, Islamic financial inclusion, and rural socioeconomic empowerment. The novelty of this study lies in its integration of waqf-based asset utilization, Base Transceiver Station (BTS) infrastructure, Sharia-compliant contractual arrangements, multi-stakeholder governance, village digital outlets, and waqf benefit distribution within one conceptual framework for inclusive digital development. Accordingly, this study aims to develop and validate the Waqf Signal Model as an alternative Islamic social finance framework to support digital connectivity in Indonesia's 3T regions. Specifically, this study seeks to answer the following research questions: (1) How can waqf assets be integrated into telecommunications infrastructure development in underserved rural regions? (2) What stakeholder roles and governance arrangements are required to implement the Waqf Signal Model? (3) What Sharia-compliant contractual and benefit-distribution mechanisms are considered feasible by experts? (4) To what extent is the model perceived as sustainable and replicable for addressing digital inequality in 3T regions?

Literature Review

Waqf as Islamic social finance and productive asset

Waqf is a key institution in Islamic social finance and has historically played an important role in redistributive justice, public welfare, and sustainable development (Kahf, 1999; Nuradi et al., 2025). In the Indonesian legal context, Law No. 41 of 2004 defines waqf as a legal act of an endower to allocate part of his or her owned assets to be utilized permanently or for a specified period in accordance with Islamic law for worship and/or public welfare purposes (Badan Wakaf Indonesia, 2009). Similarly, the AAOIFI defines waqf as the dedication of an asset in a way that prevents its transfer of ownership while directing its benefits to designated beneficiaries (Abdullah & Kroessin, 2014). These definitions highlight two essential features of waqf: the preservation of the principal asset and the continuous distribution of benefits.

Classical Islamic jurisprudence emphasizes the principles of asset preservation and benefit generation. The term waqf derives from the Arabic root waqafa, meaning "to hold" or "to stop,"

which implies the immobilization of asset ownership while allowing its usufruct to benefit others (Che Rahman, 2018). From a fiqh perspective, waqf is generally understood as withholding a durable asset while distributing its benefits for permissible and socially beneficial purposes (al-Shirbini & Lock, 2015). Although different schools of Islamic jurisprudence vary in their interpretation of ownership, duration, and control over waqf assets, they converge on the principle that waqf should generate lasting benefit for society (Lubis & Wajdi, 2016; Lubis, 2010; Mirwati, 2016; Mujahidin, 2021).

The theological foundation of waqf is rooted in Qur'anic and Prophetic encouragement of enduring charity and public benefit. The Qur'an encourages believers to spend from what they love, while the Prophetic tradition emphasizes the value of ṣadaqah jāriyah as a form of continuous charity whose reward extends beyond one's lifetime (Muslim, 1998). The precedent of Caliph Umar's waqf of land in Khaybar further illustrates the classical logic of preserving an asset while distributing its benefits to society. As a social finance instrument, waqf differs from zakat and sadaqah because its principal asset is preserved, while its usufruct is continuously directed toward public welfare (Sahroni, 2020). This makes waqf particularly suitable for long-term social infrastructure development, including education, healthcare, poverty alleviation, and digital infrastructure.

Maqasid al-Sharia as normative foundation

The normative foundation of waqf-based infrastructure development can be strengthened through the Maqasid al-Sharia. Maqasid al-Sharia refers to the higher objectives of Islamic law, which aim to protect and promote human welfare through the preservation of religion, life, intellect, lineage, and wealth (Chapra, 2012). In contemporary Islamic economics, the maqasid provides a framework for evaluating whether an economic activity contributes to justice, welfare, human dignity, and public benefit (Auda, 2008; Chapra, 2012). Therefore, the validity of waqf should not only be assessed from the perspective of legal formality but also from its capacity to generate maslahah or social benefit. Within this framework, the Waqf Signal Model can be understood as a Maqasid-oriented development model. By enabling digital connectivity in underserved rural regions, the model contributes to hifz al-din through access to digital Islamic learning, mosque-based digital services and Islamic financial literacy. It contributes to hifz al- 'aql through e-learning, digital literacy, and access to educational resources. It supports hifz al-mal by enabling rural communities and MSMEs to access e-commerce, mobile banking, digital payment systems, and shariah-compliant financial services. It also supports hifz al-nafs and hifz al-nasl by improving access to emergency communication, public services, health information, family welfare programs, and social assistance.

Thus, Maqasid al-Shariah provides ethical and normative justification for using waqf assets in telecommunications infrastructure. The model does not treat BTS infrastructure merely as a commercial asset but as a means of expanding knowledge, economic opportunity, social protection, and public welfare. This interpretation is consistent with the classical logic of waqf, in which the principal asset is preserved while its benefits are continuously distributed to mauquf 'alaih. Accordingly, the Waqf Signal Model operationalizes waqf as a productive Islamic social finance instrument that serves contemporary public needs.

Waqf business model innovation and infrastructure gap

Recent waqf literature increasingly emphasizes business model innovation, productive waqf, and professional asset management. Scholars have argued that waqf institutions need to move beyond passive asset administration and develop models that can generate sustainable socio-economic impact (Tanjung Windiarto, 2021). Several models have been proposed, including corporate waqf, cooperative waqf, venture waqf, waqf-based social enterprises, and waqf land development (Mohsin & Muneeza, 2020; Suhaimi et al., 2014). These models demonstrate the flexibility of waqf as a development instrument and show how waqf can be adapted to meet contemporary economic needs.

Corporate waqf models, such as those discussed by Ramli and Jalil (2013), demonstrate how waqf assets can be institutionalized through professional governance structures and used to support health, commercial, and social initiatives. Venture waqf, as proposed by Khan (2019), extends this logic by using waqf funds to support small, impactful, and Sharia-compliant businesses. Mohsin and Muneeza (2020) emphasized the potential of waqf-based social enterprises to support education, healthcare, and poverty alleviation. Meanwhile, Ali et al. (2015) highlight the need for effective business models to unlock the economic potential of underdeveloped waqf land. Allah Pitchay et al. (2018) further proposed a cooperative waqf model that aggregates small-scale contributions to local development projects.

More recent studies show that the success of innovative waqf models depends not only on Shariah compliance but also on governance quality, public trust, institutional credibility, stakeholder engagement, and community participation. Firmannudin et al. (2024), for example, show that perceived quality, brand association, and donor loyalty influence the public's willingness to participate in the Waqf Forest initiative. Misbah and Johari (2025) also identify rapid growth in waqf scholarship, particularly in cash waqf, governance, corporate waqf, and digital integration. Recent systematic reviews further emphasize that waqf governance requires stronger stakeholder analysis, trustee accountability, regulatory coordination, transparency, and digital innovation to achieve sustainability and social impact (Himmawan et al., 2025; Jafar et al., 2025). However, these findings also suggest that waqf research remains concentrated on financial instruments, governance structures, and social sector applications, with limited attention to the use of waqf for digital infrastructure development. This indicates a clear infrastructure gap in the Waqf business model literature. Existing waqf models have largely focused on conventional social sectors, such as education, healthcare, poverty alleviation, land development, retail, housing, agriculture, and social enterprises. Limited attention has been paid to the possibility of using waqf assets for telecommunications infrastructure, such as base transceiver stations, broadband networks, or rural digital connectivity systems. This gap is important because digital infrastructure has become an essential public good in contemporary societies. The Waqf Signal Model addresses this gap by positioning waqf assets as vehicles to support telecommunications infrastructure in underserved regions.

Digital connectivity, rural transformation, and digital divide

Digital connectivity plays a central role in rural transformation because it enables access to information, markets, education, financial services, public services and social networks. The digital divide refers to inequality in access to and use of information and communication technologies, particularly the internet (Castells, 2003). This divide is shaped by factors such as income, education, age, location, infrastructure availability, and institutional capacity (Alderete, 2019; Marshall, 2024; Yesuf, 2021). In rural areas, the digital divide is not merely a problem of individual access but also a structural issue related to infrastructure investment, geography, market incentives, and public policy.

Previous studies have shown that Internet access can generate meaningful economic benefits. Internet adoption can reduce information transmission costs, improve labor and product market efficiency, and support better resource allocation in education and governance (Min et al., 2020). Recent empirical research further shows that digital inclusive finance can strengthen rural economic resilience and support rural industry integration when supported by infrastructure, financial availability, and agricultural digitization (Huang et al., 2023; Ma et al., 2025). Empirical studies have also shown that Internet access can improve farm household income, increase market responsiveness, and reduce the rural-urban income gap (Chang & Just, 2009; Siaw et al., 2020). In Indonesia, Sukma et al. (2025) found that self-employed farmers who use the Internet earn a higher income than those who do not, demonstrating the relevance of digital access for rural livelihoods. The rural connectivity literature further suggests that conventional market-based infrastructure models often fail to serve remote and sparsely populated areas. Telecommunications providers tend to prioritize high-density urban markets because these areas offer higher returns on investment, lower infrastructure costs, and stronger commercial viability (Grubesic & Murray, 2004; Oyana, 2011; Townsend et al., 2013). Consequently, rural communities may remain digitally

excluded even when national Internet penetration improves. This condition indicates a form of market failure in which socially necessary infrastructure is underprovided because private returns are insufficient to support it.

The Indonesian 3T context illustrates this challenge well. The 3T regions, namely, terdepan, terluar, and tertinggal areas, are characterized by limited infrastructure, low accessibility, weak fiscal capacity, geographical isolation, and uneven human resource conditions (Syafii, 2018). Recent Indonesian telecommunications research confirms that disparities remain visible through "no signal" and "blank spot" conditions in rural and remote districts, and that infrastructure planning needs to combine network indicators with socioeconomic characteristics to prioritize underserved areas (Situmorang et al., 2023). These characteristics create high barriers to telecommunications deployment, especially for BTS infrastructure. Therefore, addressing the rural digital divide requires not only technological solutions but also alternative financing models, institutional coordination, and community-based mechanisms that can support infrastructure deployment in commercially unattractive areas.

Institutional theory and multi-stakeholder governance

Institutional Theory provides a useful lens for understanding the governance dimensions of the Waqf Signal Model. Institutions consist of formal rules, norms, routines, and shared meanings that shape organizational behavior and legitimacy (Scott, 1995). Organizations do not operate solely based on efficiency considerations but also respond to regulatory pressures, normative expectations, and cultural-cognitive legitimacy (DiMaggio & Powell, 1983; Scott, 1995). Recent waqf governance literature similarly emphasizes that stakeholder engagement, trustee accountability, regulatory alignment, transparency, and digital innovation are central to sustainable waqf administration (Himmawan et al., 2025; Wan Ismail et al., 2025). This perspective is particularly relevant for waqf-based telecommunications infrastructure, as the model involves multiple actors with different mandates, resources, and institutional logics.

The Waqf Signal Model requires coordination among nazhir institutions, telecommunication providers, local governments, regulators, mosques, and local communities. Nazhir institutions provide Sharia legitimacy, waqf asset stewardship and benefit distribution accountability. Telecommunication providers contribute technical expertise, network operations, and commercial experiences. Local governments support permits, local infrastructure access, spatial planning, and alignment with regional development priorities. Mosque institutions and community leaders can strengthen social acceptance, public trust, and local participation. Without institutional coordination, the model may face regulatory uncertainty, unclear role distribution, weak accountability, and limited operational sustainability issues.

Institutional Theory also helps explain why governance legitimacy is essential. For a waqf-based BTS model to be accepted, stakeholders need assurance that the waqf asset is legally protected, the contract is Sharia-compliant, the revenue-sharing mechanism is transparent, and the benefits are distributed to legitimate beneficiaries. Therefore, the model should not be framed only as a financing mechanism but as a multi-institutional governance arrangement. Its success depends on role clarity, accountability, regulatory alignment, Shariah supervision, and credible nazhir governance.

Social capital theory, trust, and community-based digital outlets

Social Capital Theory provides a complementary lens for understanding community participation and local adoption. Social capital refers to the networks, norms, trust, and reciprocal relationships that enable collective action (Coleman, 2009; Putnam et al., 2021). In community-based development, social capital helps explain why people cooperate, contribute resources, accept innovations, and sustain collective initiatives. This is particularly important in waqf projects because public participation depends heavily on trust in the nazhir, confidence in governance, and the belief that the benefits will reach the intended beneficiaries.

In rural and mosque-centered communities, social capital can strengthen the implementation of Waqf-based digital infrastructure. Local religious networks, mosque leadership,

community norms, and collective identity can encourage people to participate as wakif, users, outlet managers or beneficiaries. Nuriyah and Fakhri (2022) show that mosque-based Islamic social finance and digital platforms can improve community welfare, public trust, and financial inclusion in Indonesia. This finding is relevant to the Waqf Signal Model because village digital outlets are designed not only as commercial service points, but also as community nodes for digital literacy, Islamic financial services, subsidized internet access, and waqf benefit distribution.

Social capital is also important for reducing the risk of implementation. A waqf-based BTS model may face challenges related to community acceptance, land disputes, digital literacy, trust in revenue distribution, and willingness to use digital services. Strong local networks and trusted community institutions can help reduce these barriers by facilitating communication, monitoring, and participation in the health system. Therefore, digital outlets should be understood not only as business units but also as social infrastructure that connects connectivity, trust, literacy, and benefit distribution.

The 3T regions and the waqf signal nexus

The waqf signal model is positioned at the intersection of waqf innovation, digital connectivity, institutional governance and community-based development. In the context of Indonesia's 3T regions, telecommunications infrastructure faces high deployment costs, low commercial returns, geographical barriers, and institutional complexity. Conventional market-based models tend to leave such regions underserved because they prioritize efficiency and profitability over equity. Simultaneously, government-led interventions may face fiscal, administrative, and implementation constraints. This creates space for alternative models that combine Islamic social finance, public-private collaboration, and community participation. Islamic social finance offers an alternative. For example, Thaker et al.2020) show that Sharia-compliant crowdfunding can mobilize community-based funds to support sectors that are often underserved by formal financial institutions. This logic is relevant to the Waqf Signal because BTS deployment in remote 3T regions faces similar commercial infeasibility. By mobilizing waqf assets and integrating them with telecommunications partnerships, the model can support essential infrastructure while preserving waqf assets and directing their benefits to mauquf 'alaih.

Conceptually, the waqf signal model transforms waqf from a passive philanthropic instrument into a productive infrastructure. The model proposes that waqf land or waqf-linked assets can be used to support BTS infrastructure through Sharia-compliant contractual arrangements such as musyarakah, ijarah, Ijarah Muntahiyah bi Tamlik, Musharakah Mutanaqisah, or wakalah-based service arrangements. The resulting connectivity can then support village digital outlets, digital financial services, e-learning, MSME empowerment, subsidized data packages, and other community benefits.

This nexus is supported by the three theoretical foundations discussed previously. Maqasid al-Sharia explains why waqf-based digital infrastructure is normatively justified as a means of promoting maslahah, knowledge, welfare, and economic participation. Institutional Theory explains how the model can be governed through coordination among nazhir, telecommunications providers, government actors, and community institutions. Social capital theory explains why trust, local networks, mosque-based legitimacy, and community participation are essential for adoption and sustainability of the biogas digesters. Therefore, the waqf signal model contributes to the literature by integrating Islamic social finance, digital infrastructure, multi-stakeholder governance, and rural community empowerment into one conceptual framework for inclusive connectivity in 3T regions.

Research Methods

Research design

This study employed a qualitative exploratory research design using a two-round Delphi method to develop and validate the Waqf Signal Model. The Delphi method was selected because the proposed integration of waqf, telecommunications infrastructure, rural digital inclusion, and

multistakeholder governance remains underexplored and requires structured expert judgment. The Delphi method is particularly suitable for studies involving complex or emerging issues, where empirical evidence is limited and expert consensus is needed to refine a conceptual model (Hanafin, 2004; Steurer, 2011; Yousuf, 2007). In this study, the Delphi process was used not only to collect expert opinions but also to validate the key components, governance structure, Sharia alignment, sustainability logic, and replication potential of the proposed model.

Participant selection and sampling method

Participants were selected using purposive expert sampling methods. This technique was used because the study required respondents with specific knowledge and practical experience related to telecommunications infrastructure, Islamic finance, Waqf management, mosque-based community development, and local governance. The selection criteria were as follows: (1) having professional or institutional experience relevant to the Waqf Signal Model; (2) representing one of the key stakeholder domains, namely telecommunications, Islamic finance, waqf institution, mosque/community leadership, or local government; (3) having practical or decision-making exposure to infrastructure, financing, social finance, or community development; and (4) being willing to participate in two Delphi rounds.

Nine experts participated in this study. They represented telecommunications companies, Islamic banking, Waqf institutions, Badan Wakaf Indonesia, mosque leadership, and local community leadership. This multidisciplinary composition was intended to capture the technical, financial, Sharia, institutional, and community dimensions of waqf-based digital-infrastructure development.

Data collection procedure

The data collection process was conducted in two rounds of Delphi. First, the researcher reviewed the relevant literature on waqf, Islamic social finance, the digital divide, rural connectivity, infrastructure financing, Maqasid al-Sharia, institutional governance, and social capital. This review was used to identify the initial components of the Waqf Signal Model and design the Delphi questionnaire. Second, the Round 1 questionnaire was distributed to nine experts. The questionnaire consisted of open- and closed-ended questions. Open-ended questions were used to explore expert views, recommendations, perceived risks, and implementation challenges. Closed-ended questions were used to capture expert judgments on specific model components, including Sharia compliance, key stakeholders, digital outlets, benefit distribution, sustainability, revenue-sharing feasibility, and replication potential. Third, the responses from Round 1 were coded and summarized thematically. Similar answers were grouped into categories, whereas divergent opinions were retained to identify areas requiring further clarification. The results of Round 1 were used to refine the initial model and prepare the Round 2 validation instruments. Fourth, in Round 2, the summarized findings and draft Waqf Sighnal Model were returned to the same experts for validation. The experts were asked to confirm, revise, or provide additional comments on the proposed model components. The second round functioned as a controlled feedback mechanism, allowing participants to reconsider their views in light of the aggregated expert responses. Fifth, the final model was developed based on the combined results of Rounds 1 and 2. The final synthesis included the governance structure, Sharia-compliant contractual options, role of village digital outlets, benefit distribution mechanism, implementation challenges, sustainability strategy, and replication criteria.

Operational definitions and measurement

Because this study was qualitative and exploratory, it did not employ statistical independent and dependent variables. Instead, the main elements of the waqf signal model were operationalized as the Delphi dimensions. Each dimension was measured using expert judgment, closed-ended responses, categorical choices, and open-ended explanations.

Table 1. Operational definition

Dimension	Operational definition	Measurement
Sharia compliance	Expert assessment of whether the model aligns with Islamic legal and ethical principles when supported by contracts such as IMBT, Musyarakah, MMQ, or Wakalah	Closed-ended agreement and open-ended explanation
Key stakeholders	Institutions or actors considered essential for implementing the model	Open-ended identification and thematic grouping
Multi-stakeholder governance	Required coordination among nazhir, telecommunication providers, government, mosque/community actors, and other institutions	Open-ended responses coded into governance roles
Digital outlet necessity	Expert view on whether village digital outlets should be developed alongside BTS infrastructure	Closed-ended yes/no response and supporting explanation
Ideal digital outlet partner	Preferred local institution to manage village digital outlets	Categorical response, such as cooperative, BUMDes, youth group, mosque institution, or another actor
Outlet as benefit-distribution channel	Expert assessment of whether digital outlets can distribute waqf benefits, such as subsidized internet, digital literacy, vouchers, or Islamic financial services	Closed-ended agreement and qualitative explanation
Implementation challenges	Main barriers to implementing the Waqf Signal Model	Open-ended responses coded into themes
Sustainability strategy	Mechanisms needed to maintain the model beyond initial deployment	Open-ended responses coded into strategic themes
Revenue-sharing feasibility	Expert assessment of whether BTS revenue-sharing with waqf institutions or community programs is feasible	Categorical response, such as feasible, complicated, or unrealistic
Benefit distribution	Preferred form of waqf benefit distribution to mauquf 'alaih	Categorical response, such as cash/voucher, training, internet subsidy, or hybrid model
Replicability	Expert assessment of whether the model can be applied in other 3T regions	Closed-ended agreement and open-ended explanation
Suggested pilot location	Recommended regions or criteria for pilot implementation	Open-ended response coded by location and selection criteria
Financial feasibility	Indicative operational viability of waqf-based BTS deployment	Scenario-based financial simulation using Capex, Opex, ARPU, expected users, gross revenue, net surplus, waqf allocation, and break-even estimation

Source: Authors' analysis based on Delphi questionnaire design and literature synthesis.

Data analysis techniques

Data were analyzed using three techniques: thematic analysis, descriptive consensus analysis, and scenario-based financial simulation. First, thematic analysis was used to interpret the open-ended responses. The researcher coded expert responses, grouped similar ideas into themes, and identified recurring patterns related to governance, Shariah compliance, implementation risks, sustainability, benefit distribution, and replication. This technique was used to transform qualitative expert input into structured modelling components.

Second, a descriptive consensus analysis was used to summarize closed-ended and categorical responses. The level of consensus was calculated using simple frequency counts, such as 9/9, 8/9, or mixed distributions, such as 4+3+2. Consensus was classified into four categories: A "Very strong consensus" was assigned when all experts agreed on a specific closed-ended item.

"Strong consensus" was assigned when most experts agreed or when all experts converged on the same broad theme in open-ended responses. "Moderate consensus" was assigned when responses showed a dominant tendency but were distributed across several options. A "Weak consensus" was assigned when responses were fragmented or showed substantial disagreement.

Third, a scenario-based financial simulation was conducted to assess the feasibility of waqf-based BTS deployment. The simulation assumed values for capital expenditure, operational expenditure, average revenue per user, expected number of users, gross monthly revenue, net operating surplus, waqf allocation, and break-even period. The basic calculation followed these formulas:

- Gross monthly revenue = ARPU × expected number of users
- Net monthly surplus = gross monthly revenue – monthly operational expenditure
- Waqf allocation = gross monthly revenue × agreed waqf allocation percentage
- Indicative break-even period = capital expenditure ÷ net monthly surplus

The financial simulation was not intended to provide a definitive investment valuation but to support the Delphi findings by illustrating whether the proposed model could be operationally sustainable under reasonable assumptions. Therefore, the simulation should be interpreted as an exploratory feasibility illustration rather than a final projection.

Table 2. Expert panel profile

No	Name	Institution/Organization	Experience	Position/Role
1	Ifan Suryatmika	Indosat Ooredoo Hutchison	20+ years in telecom	AVP Site Monetization
2	Aliandi	Indosat Ooredoo Hutchison	20+ years in telecom	VP Business Planning
3	Tamsul Lubis	Lembaga Wakaf Baitul Makmur	30+ years in Sharia Business Consulting	Director
4	Edy Tri S	Islamic Bank	20+ years in Islamic Banking	Business Development Head
5	Suhendri Naswil	Indosat Ooredoo Hutchison	30+ years in telecom	VP Business Analytics and Insight-Kalisumapa
6	Hendriansyah	Lembaga Wakaf Baitul Makmur	20+ years in telecom and sharia business	Deputy Director
7	Murikhwan	DKM Surau As Sa'adah, Padang, West Sumatra	30+ years in community development	Head of Mosque Council (Ketua DKM)
8	Raji Reza	Badan Wakaf Indonesia	20+ years in regulatory and community development	Implementation Division
9	Murniyanti	RT Leader of Parak Laweh, West Sumatra	10+ years in community development	Neighborhood Leader (Ketua RT)

Source: Author' own

Final model development

Based on the two-round Delphi process, the final waqf signal model was developed by synthesizing expert responses from both open- and closed-ended questionnaire items. Round 1 responses were used to identify key model components, including stakeholder roles, Sharia compliance, governance structure, implementation challenges, sustainability strategies, revenue-sharing feasibility, digital outlet functions, benefit distribution, and replication potential. In Round 2, the draft model and summarized Round 1 finding were returned to the same experts for validation and refinement. Consensus levels were classified into four categories: very strong, strong, moderate, and weak.

The final model, illustrated in Figure 1, consists of four key institutional actors: the wakif or local community, nazhir as waqf manager, telecommunication provider, and local government. The model begins with the endowment of land or waqf-linked assets, which are managed by the nazhir and coordinated with telecommunication providers through Sharia-compliant contractual arrangements such as Musyarakah, Ijarah Muntahiyah bi Tamlik (IMBT), Musharakah Mutanaqisah

(MMQ), or Wakalah. The telecommunication provider is responsible for building and operating BTS infrastructure, while the local government facilitates permits, infrastructure access, and regional alignment. The revenue and benefits generated by the model are directed toward operational sustainability, village digital outlets, and community benefit distribution. Thus, the Delphi-informed Waqf Signal Model integrates Islamic social finance, telecommunications infrastructure, multi-stakeholder governance, and waqf benefit distribution to support inclusive digital connectivity in Indonesia's 3T regions.

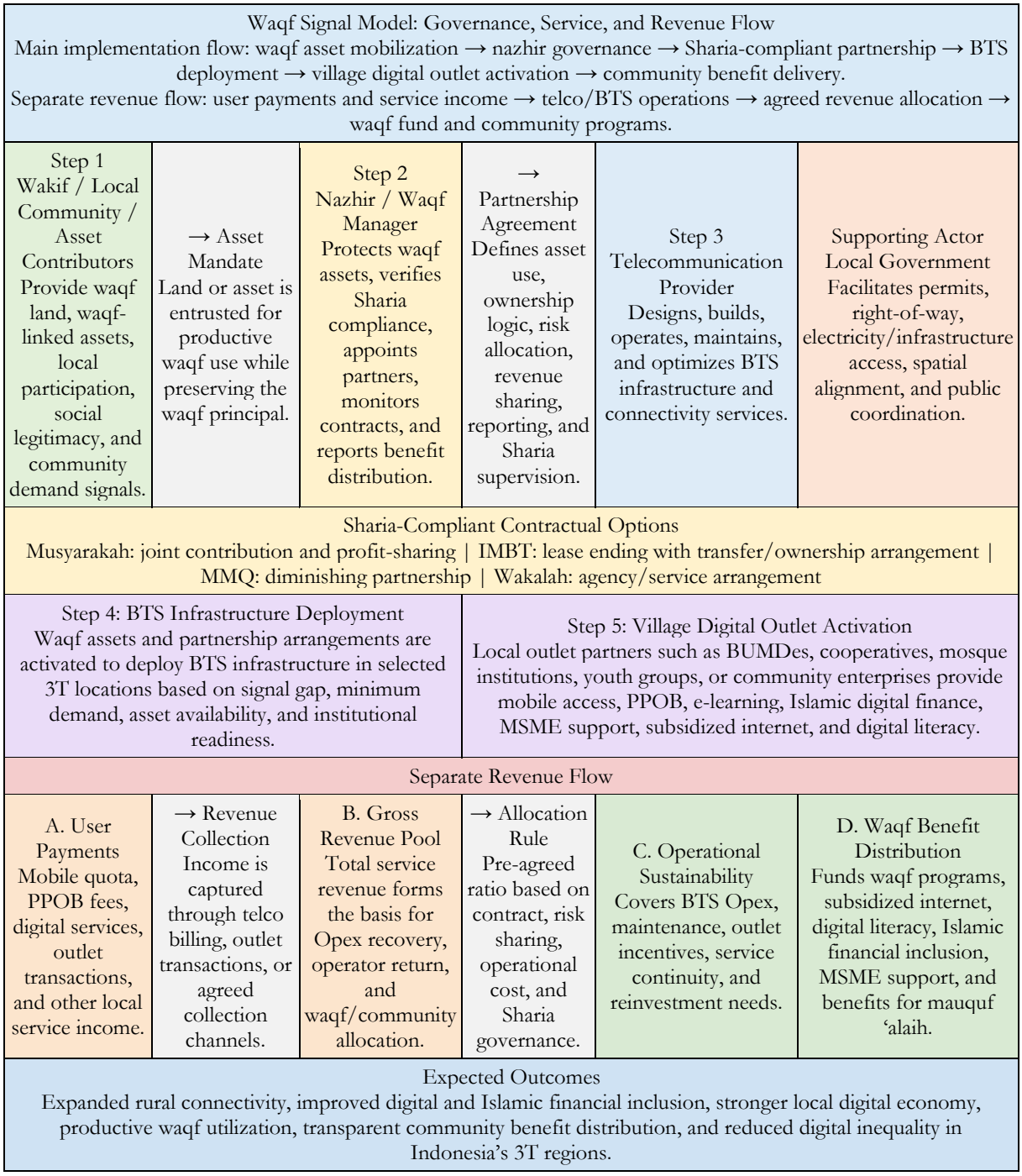

Figure 1. Proposed model
Source: Authors conceptual diagram based on the two-round Delphi synthesis.

Results and Discussion

This section presents the results and analytical discussion derived from a structured Delphi study involving nine experts representing key stakeholders in Islamic finance, telecommunications, and

RD. The Delphi method was employed to obtain collective insight and build consensus regarding the waqf signal model—an initiative to develop digital infrastructure through collaborative waqf mechanisms in Indonesia's underserved 3T (frontier, outermost, and underdeveloped) regions.

The overall findings reveal a strong alignment among participants on the conceptual viability of the model, with some key areas demonstrating very strong consensus and others reflecting a diversity of views requiring further structural and operational refinement.

Table 3. Delphi consensus on the waqf signal model (N = 9)

Aspect	Consensus Level (n)	Remarks
Sharia Compliance	Strong (8/9)	Majority agreed; contractual clarity and transparency required
Key Stakeholders	Diverse responses (4 stakeholder categories)	Spread across telco, nazhir, local government, and community
Necessity of Digital Outlets	Very Strong (9/9)	All respondents acknowledged strategic importance
Ideal Outlet Partner	Weak consensus / fragmented preferences (5 partner options)	Varied suggestions: sharia cooperatives, youth groups, BUMDes
Outlet as Distribution Channel	Very Strong (9/9)	Widely accepted as a means of distributing waqf benefits
Implementation Challenges	Very strong convergence (9/9 respondents identified challenges)	Literacy, financing schemes, and operator readiness highlighted
Sustainability Strategy	Very strong convergence (9/9 respondents proposed strategies)	Requires benefit-sharing schemes and local capacity development
Revenue Sharing Feasibility	Weak (4+3+2)	Split opinions: 4 "Complicated," 3 "Feasible," 2 "Unrealistic"
Distribution of Benefits	Moderate (4+3+2)	Mixed: 4 "Cash," 3 "Training," 2 "Internet subsidy"
Replicability	Strong (9/9)	Broad agreement that model can be applied in 3T regions
Suggested Pilot Locations	Diverse responses (8 suggested regions)	Examples include Aceh, Tapanuli, Java; needs criteria

Source: Authors' analysis based on two-round Delphi questionnaire responses from nine expert respondents.

Analytical interpretation of the Delphi findings

The Delphi results revealed three core takeaways regarding the waqf signal model. First, the model is perceived as normatively acceptable, but institutionally conditional. The strong expert consensus on Sharia compliance indicates that waqf-based telecommunications infrastructure is not rejected in principle. However, this acceptance is conditional upon the existence of clear Sharia-compliant contracts, credible nazhir governance, transparent benefit distribution, and legal certainty. This finding suggests that the main issue is not whether waqf can support digital infrastructure, but how the model should be institutionally structured to protect the waqf asset, distribute benefits fairly, and maintain public trust.

This finding is consistent with the waqf innovation literature, which emphasizes that the sustainability of productive waqf depends not only on the existence of assets, but also on professional governance, transparency, and institutional credibility (Firmannudin et al., 2024). From the perspective of Maqasid al-Sharia, the use of waqf assets for telecommunications infrastructure can be justified because digital connectivity supports the preservation of intellect through education, the preservation of wealth through economic participation, and the preservation of life and welfare through access to public services and emergency communication. Therefore, the waqf signal model extends the function of waqf from traditional social sectors to contemporary infrastructure needs.

Second, the findings show that digital infrastructure alone is insufficient without a community-based utilization system. The strong consensus on the importance of village digital outlets indicates that experts do not view BTS infrastructure merely as a technical facility. Instead, connectivity must be translated into usable services, such as prepaid mobile access, PPOB, digital financial services, e-learning, MSME support, and subsidized data packages. This finding is consistent with rural digital divide studies, which argue that connectivity gaps are not only about network availability, but also about affordability, literacy, adoption, quality of access, and meaningful use (Castells, 2003; Chen et al., 2023; Marshall, 2024; Salemink et al., 2017; Townsend et al., 2013). It is also consistent with recent evidence that digital inclusive finance and rural digital infrastructure can support rural industry integration, economic resilience, and income inclusion when accompanied by local capability and service ecosystems (Huang et al., 2023; Ma et al., 2025; Wen et al., 2024).

From the perspective of Social Capital Theory, village digital outlets function as local nodes that connect technology, trust, community participation, and benefit distribution. In rural communities, the adoption of new digital services depends not only on infrastructure availability but also on trusted intermediaries, local networks, and shared norms. This explains why mosque institutions, cooperatives, BUMDes, youth groups, and local community organizations were identified as potential partners. The fragmented expert opinion on the ideal outlet partner does not necessarily weaken the model; rather, it indicates that implementation should be context-specific and adapted to local social capital.

Third, the weak consensus on revenue-sharing feasibility represents the most important area that requires further refinement. The mixed responses suggest that experts recognize the potential of BTS revenue-sharing but remain cautious about its legal, financial, and operational complexity. This finding should not be interpreted as a rejection of this model. Instead, it identifies a boundary condition: the model becomes feasible only when revenue-sharing arrangements are supported by clear contracts, realistic financial assumptions, risk allocation, transparent reporting, and Shariah supervision.

This finding is consistent with literature on Islamic social finance and infrastructure financing, which emphasizes that innovative financing models require clear governance mechanisms, risk-sharing structures, stakeholder legitimacy, and long-term sustainability logic (Dirie et al., 2024; Himmawan et al., 2025; Jafar et al., 2025; Tanjung & Windiarto, 2021; Thaker et al., 2020). It is also aligned with rural telecommunications studies showing that network viability in remote areas depends heavily on adoption rates, average revenue per user, infrastructure sharing, and cost-efficient deployment models (Kumar & Oughton, 2023; Situmorang et al., 2023). Institutional Theory helps explain this result. The waqf signal model involves actors with different institutional logics: nazhir focuses on waqf preservation and public benefit, telecommunication providers focus on technical and commercial viability, local government focuses on regional development and regulatory facilitation, while communities focus on access, trust, and benefit. Therefore, the central challenge is to align these institutional logics with a coherent governance structure.

Overall, the Delphi findings suggest that the waqf signal model is conceptually promising but is operationally conditional. Its feasibility depends on the alignment of three mechanisms: Sharia legitimacy, institutional coordination and community adoption. Maqasid al-Sharia explains the normative purpose of the model, institutional theory explains the need for governance alignment among multiple actors, and social capital theory explains the role of trust and community-based participation in the model. This theoretical integration strengthens the argument that the waqf-based digital infrastructure is not merely a financing innovation but a Sharia-oriented, institutionally embedded, and socially grounded model for inclusive rural connectivity.

Sharia compliance and institutional governance

The question of whether the waqf signal model aligns with Sharia principles yielded a strong consensus, with eight of the nine respondents affirming that the model is, in principle, Sharia-compliant. Most experts indicated that, as long as the project uses transparent and legally binding Islamic contracts—such as Ijarah Muntahiyah bi Tamlik (IMBT), Musharakah Mutanaqisah (MMQ), or Wakalah arrangements—it would satisfy the conditions of a legitimate waqf-based

initiative. Several experts also emphasized the importance of operational governance, particularly the accountability and credibility of the appointed nazhir, to ensure continued Sharia compliance and public trust.

Nonetheless, one respondent abstained from issuing a conclusive judgment due to a lack of detailed exposure to the model's specific contractual and financial structure. This suggests that while the model holds a foundational degree of acceptance, further formalization and articulation of its Sharia mechanisms are required to solidify its acceptability among broader stakeholders, including regulators, Islamic jurists, and the investing public.

Multi-stakeholder roles and the need for collective ownership

Regarding the institutional responsibilities necessary to ensure successful implementation, the Delphi study found diverse opinions. Participants identified several critical actors, including nazhir waqf, telco providers, local governments, and the local community. The diversity of responses (with the four distinct stakeholder categories mentioned) indicates the absence of a dominant or centralized executor. Rather, it underscores the necessity of a multistakeholder governance model in which authority and operational tasks are distributed among parties with complementary roles and competencies.

This reflects the complexity of the digital infrastructure ecosystem, which entails regulatory, technological, financial, and socio-cultural dimensions. This implies that for the model to succeed, it must be embedded within a framework of collaborative governance that institutionalizes shared ownership and risk-sharing principles among the participating entities.

Digital outlet development as an integral pillar

There was very strong consensus (9 out of 9 respondents) that digital service outlets—such as mobile quota resellers, PPOB agents, and e-learning centers—must be co-developed alongside the BTS infrastructure to maximize the socio-economic value of connectivity. The presence of these outlets was pivotal in translating infrastructure availability into tangible benefits for the local population.

Interestingly, while the necessity of the outlets was undisputed, the question of the ideal partner to manage them revealed fragmented preferences. Suggestions ranged from Sharia cooperatives (the most mentioned), youth associations, village-owned enterprises (BUMDes), and faith-based organizations. This variation (5 different preferences) illustrates a weak consensus in this area, likely shaped by differing field experiences and community structures. It also reinforces the importance of contextualization and flexibility in implementation, allowing for locally appropriate partnership models rather than a one-size-fits-all approach to implementation.

When asked whether the outlets could function as distribution channels for waqf benefits—such as subsidized internet access, religious learning platforms, or social vouchers—all nine respondents affirmed positively. This strong consensus supports the inclusion of the outlet component not merely as a business entity but as a waqf value distribution mechanism, further amplifying the model's public good nature.

Challenges and pathways to sustainability

On the topic of implementation challenges, all respondents provided insights that converged on several recurring themes: low digital literacy, limited financial capacity, uncertainty of long-term operator commitment, and lack of institutional readiness at the grassroots level. These responses indicate a strong consensus regarding the bottlenecks to successful adoption of AI.

In addition, the respondents offered various strategies to ensure sustainability. All experts agreed (nine out of nine) that the model's continuity beyond five years would depend on the establishment of clear benefit-sharing schemes for local actors, structured community engagement programs, and consistent literacy initiatives. Several experts emphasized the importance of incentives for outlet managers—whether in the form of profit shares, fee waivers, or fixed stipends derived from waqf revenue—to motivate and professionalize the grassroots infrastructure.

This implies that sustainability is not a technical challenge alone but also a social and behavioral economic problem requiring carefully designed motivation structures aligned with Sharia principles.

Debates on revenue sharing and distribution models

The issue of revenue-sharing from BTS operations to the waqf fund or community programs was the most divisive. Four respondents stated that such schemes are "possible but complicated," three believed they are "very feasible," and two considered them "unrealistic." This weak consensus suggests that financial innovation, legal modelling, and Sharia harmonization are necessary before a definitive revenue-sharing structure can be proposed for pilot implementation.

The mixed responses regarding revenue-sharing feasibility should not be interpreted as a rejection of the model, but rather as an indication that the financial architecture requires more precise contractual, legal, and governance designs. In the context of Islamic social finance, revenue sharing is not merely a commercial arrangement but a mechanism to ensure fairness, risk sharing, accountability, and sustainable benefit distribution. Previous studies on innovative waqf models have emphasized that the sustainability of waqf-based initiatives depends on transparent governance, credible nazhir institutions, clear contractual arrangements, and the ability to generate recurring benefits for the intended beneficiaries (Kahf, 1999; Khan, 2019; Firmannudin et al., 2024). Similarly, Islamic crowdfunding and productive waqf models demonstrate that community-based financing can support sectors that are often considered commercially unattractive, provided that risk- and benefit-sharing mechanisms are clearly structured (Thaker et al., 2020). Within the Waqf Signal Model, revenue sharing can be structured through several Sharia-compliant arrangements, such as Musyarakah, Ijarah Muntahiyah bi Tamlik (IMBT), Musharakah Mutanaqisah (MMQ), or Wakalah-based service arrangements. Each contract implies different ownership, risk, and revenue allocation consequences for the parties involved. For example, Musyarakah may be suitable when the nazhir or waqf institution contributes land or capital into a joint infrastructure venture, while IMBT may be more appropriate when the telecommunication provider operates the BTS and gradually transfers certain economic benefits to the waqf institution under a pre-agreed arrangement. The MMQ may also be considered when ownership or economic participation is gradually transferred over time. Therefore, the weak consensus among experts highlights the need for a flexible contractual framework rather than a single standardized revenue-sharing model.

From the perspective of maslahah, the revenue-sharing mechanism should be evaluated not only for its financial return but also for its contribution to public welfare. The primary objective of the waqf signal model is to transform idle or underutilized waqf assets into productive infrastructure that expands access to connectivity, digital finance, education, and economic opportunities for underserved rural communities in India. In this regard, revenue generated from BTS operations should ideally be allocated into three complementary channels: first, operational sustainability of the infrastructure; second, reinvestment into village digital outlets and local capacity-building programs; and third, direct or indirect benefits for mauquf 'alaih, such as subsidized internet packages, digital literacy training, MSME support, or access to Islamic digital financial services. This hybrid distribution approach reflects the balance between productive and consumptive waqf benefits.

The revenue-sharing debate is closely aligned with the Sustainable Development Goals (SDGs). By enabling rural digital infrastructure, the model directly contributes to SDG 9 on industry, innovation and infrastructure. The distribution of waqf benefits to underserved communities supports SDG 10 by reducing inequalities. When revenue is used to support e-learning, digital literacy, and community training, it contributes to SDG 4 (quality education). Furthermore, the multi-stakeholder structure involving nazhir, telecommunication providers, local government, and community actors reflects SDG 17 on partnerships for the goals. Thus, the revenue-sharing mechanism should be positioned as an institutional bridge between Islamic social finance, sustainable infrastructure, and inclusive rural development.

Accordingly, mixed expert opinions on revenue-sharing feasibility suggest that the model is conceptually promising but requires further refinement before large-scale implementation. Rather than weakening the model, this finding strengthens the argument that the Waqf Signal Model should be piloted through context-specific contractual arrangements, transparent governance and measurable benefit-distribution indicators. Future implementation should define the pre-agreed revenue-sharing ratio, eligible beneficiaries, allocation priorities, reporting mechanisms, and Shariah supervision process. Such refinement would ensure that the model remains financially viable, sharia-compliant, and aligned with the broader maslahah agenda of promoting digital justice and inclusive socio-economic development.

Replication potential and pilot area identification

All nine participants expressed confidence in the replicability of the waqf signal model, with five affirming its high potential. The strong consensus (9/9) is grounded in the belief that the model can fill both the spiritual and digital void in many rural communities—if land waqf is available and local socio-political conditions are supportive.

Eight different pilot areas were proposed, including Aceh, North Sumatera, Central Java, and generic references to "3T areas with majority Muslim population." This indicates a diverse consensus, suggesting that a formal set of criteria (e.g., signal gap, community readiness, presence of Nazhir institutions, and local telco interest) is needed to systematically select and stage the rollout.

Macroeconomic and monetary implications of the waqf signal model

The Waqf Signal Model may also generate broader macroeconomic and monetary implications through financial inclusion, digital participation, and rural economic activation. Improved connectivity can enable unbanked and underbanked communities to access mobile banking, Islamic microfinance, e-wallets, QRIS-based payments, and digital financial services. Recent empirical studies show that digital inclusive finance can strengthen rural economic resilience, support rural industry integration, and reduce rural–urban income disparities when supported by infrastructure, financial availability, industrial upgrading, and local adoption capacity (Huang et al., 2023; Ma et al., 2025; Wen et al., 2024). Therefore, waqf-financed BTS deployment can be understood as an enabling infrastructure layer for Islamic financial inclusion and rural socioeconomic participation.

Second, the model reinforces the development of digital-finance ecosystems. By bridging rural connectivity gaps, the initiative allows fintech firms—particularly those offering Sharia-compliant payment solutions—to expand into underserved markets. This fosters the adoption of Islamic digital wallets, QRIS-based transactions, and peer-to-peer Sharia lending, which collectively increase monetary velocity and promote broader participation in the Islamic financial system.

Third, the Waqf Signal Model aligns with global sustainable financing practices, notably Green Sukuk and cash waqf-linked sukuk (CWLS) financing. The use of renewable energy-powered BTS (e.g., solar-based stations) opens avenues for integrating green financing instruments into waqf projects, thereby strengthening the Islamic finance sector's contribution to the United Nations Sustainable Development Goals (SDGs). This connection highlights the model's role in advancing environmentally responsible and socially impactful financial instruments.

Finally, the model enhances the resilience of the Islamic financial system by diversifying the funding sources for public infrastructure. By relying on waqf endowments rather than conventional public debt or commercial bank loans, the initiative reduces fiscal pressure on government budgets and mitigates exposure to interest-based funding. This fosters a more stable and ethically aligned macro-financial environment, consistent with the principles of Maqasid al-Sharia and monetary stability.

Financial simulation and sensitivity analysis of waqf-based BTS deployment

To strengthen the practical feasibility assessment of the Waqf Signal Model, this study conducted a simple scenario-based financial simulation. The simulation estimates the indicative operational viability of waqf-based BTS deployment under different assumptions regarding average revenue

per user (ARPU), number of users, operational expenditure, net monthly surplus, waqf allocation, and break-even periods. The simulation is exploratory in nature and is intended to illustrate financial sensitivity rather than provide a definitive investment valuation.
The basic calculation follows four formulas:

- Gross monthly revenue = ARPU × number of users
- Net monthly surplus = gross monthly revenue – monthly operational expenditure
- Waqf allocation = gross monthly revenue × waqf allocation percentage
- Indicative break-even period = capital expenditure ÷ net monthly surplus

For the simulation, the capital expenditure is assumed to be IDR 3.5 billion per BTS, covering the tower, equipment, and installation. Waqf allocation is assumed to be 10 percent of gross monthly revenue, subject to the contractual arrangement between the nazhir and telecommunication provider. Four scenarios were developed for the simulation: conservative, base, improved base, and optimistic.

Table 4. Revenue modelling

Scenario	ARPU	Users	Gross monthly revenue	Monthly opex	Net monthly surplus	Waqf allocation 10%	Indicative break-even
Conservative	IDR30,000	1,200	IDR36,000,000	IDR30,000,000	IDR6,000,000	IDR3,600,000	48.6 years
Base	IDR40,000	1,500	IDR60,000,000	IDR25,000,000	IDR35,000,000	IDR6,000,000	8.3 years
Improved Base	IDR40,000	2,000	IDR80,000,000	IDR25,000,000	IDR55,000,000	IDR8,000,000	5.3 years
Optimistic	IDR50,000	2,500	IDR125,000,000	IDR25,000,000	IDR100,000,000	IDR12,500,000	2.9 years

Source: Authors' scenario-based financial simulation using assumed Capex, Opex, ARPU, user base, and Waqf allocation parameters.

The sensitivity analysis shows that the model is highly sensitive to three key drivers: the user base, ARPU, and operational expenditure. In the conservative scenario, where the user base and ARPU are low while operational expenditure is higher, the break-even period becomes too long, indicating that the model would not be financially attractive without subsidy, blended finance, or additional revenue sources. In the base scenario, the model becomes more realistic but still requires a long-term horizon. In the improved base scenario, which assumes 2,000 users and stable operational expenditure, the break-even period improves to approximately 5.3 years. In the optimistic scenario, where user adoption and ARPU are higher, the model becomes financially stronger and can generate larger recurring waqf allocations for community programs.

These results provide important analytical insights: the Waqf Signal Model should not be implemented as a uniform model across all 3T regions. Instead, it requires careful pilot selection based on the minimum demand potential, population density, existing signal gap, community readiness, operational cost structure, and local institutional support. Areas with very low user potential or extremely high operational costs may require additional support from government subsidies, CSR funds, cash waqf, blended Islamic finance, or public-private partnership schemes. Conversely, areas with moderate user density, active local institutions, and a strong demand for digital services are more suitable for early pilot implementation.

The sensitivity analysis also clarifies the role of village digital outlets. Digital outlets are not only social benefit channels, but also demand-generation mechanisms. By providing prepaid services, PPOB, e-learning access, Islamic digital financial services, MSME onboarding, and subsidized data packages, these outlets can increase user adoption and improve the commercial viability of BTS's operations. This finding strengthens the argument that the sustainability of the Waqf Signal Model depends on both supply side infrastructure and demand-side community activation.

From the Maqasid al-Shariah perspective, financial simulation should not be interpreted solely through a commercial return lens. A longer break-even period may still be acceptable if the model generates significant public benefits, such as improved access to education, financial inclusion, emergency communication, Islamic learning, and rural entrepreneurship. However, from

an institutional perspective, long-term sustainability requires transparent contracts, clear revenue-sharing rules, realistic risk allocation and measurable benefit distribution indicators. Therefore, the financial feasibility of the Waqf Signal Model depends on balancing economic viability with social impact and Sharia-based public welfare.

Maqasid al-Sharia implications of the waqf signal model

Beyond financial feasibility, the waqf signal model also has important implications for maqasid al-Sharia. The model should not be understood merely as an infrastructure financing mechanism but as a Sharia-oriented development framework that transforms waqf assets into long-term public benefits. By enabling digital connectivity in underserved 3T regions, the model supports the broader objective of maslahah 'ammah, particularly by expanding access to knowledge, economic participation, financial inclusion, and community empowerment.

From the perspective of maslahah, the waqf signal model reflects the balance between productive asset utilization and social benefit distribution. The waqf asset remains preserved while its economic value is activated to generate recurring benefits for mauquf 'alaih. This aligns with the classical logic of waqf, in which the principal asset is maintained while its usufruct is directed toward public welfare. Therefore, the revenue-sharing mechanism should be designed not only to ensure operational sustainability but also to maximize social impact through transparent, accountable, and Sharia-compliant benefit allocation.

The maqasid implications of the model are also consistent with the sustainable development goals. The deployment of BTS infrastructure supports SDG 9 on industry, innovation, and infrastructure; the provision of connectivity to underserved communities supports SDG 10 on reduced inequalities; the use of digital access for learning and literacy supports SDG 4 on quality education; and the involvement of *nazhir*, telecommunication providers, local government, and community actors reflects SDG 17 on partnerships for the goals. Thus, the waqf signal model operationalizes *maqasid al-Sharia* within the contemporary agenda of inclusive and sustainable digital development in the following manner.

Accordingly, the main contribution of the waqf signal model lies in its ability to connect Sharia-based social finance with infrastructure justice. It positions waqf not only as a philanthropic instrument but also as a strategic enabler of digital inclusion, economic empowerment, and public welfare. This reinforces the relevance of *maqasid al-Sharia* in addressing contemporary development challenges, particularly in rural and underserved regions where market-based infrastructure investment remains limited.

Conclusion

This study successfully addressed its research objectives by developing and validating the waqf signal model as a Sharia-compliant Islamic social finance framework to support digital connectivity in Indonesia's 3T regions. The findings show that waqf assets can be conceptually integrated into telecommunications infrastructure when supported by clear stakeholder roles, credible nazhir governance, appropriate Sharia-compliant contracts, village digital outlet mechanisms, and transparent distribution of benefits.

Theoretically, this study extends the Islamic social finance literature by positioning waqf as a potential infrastructure-enabling instrument for digital inclusion, rather than merely a mechanism for conventional social sectors. It also contributes to digital divide and rural connectivity studies by introducing faith-based, community-oriented financing and governance logic for underserved areas. Practically, the model offers an initial collaboration framework for nazhir institutions, telecommunication providers, local governments, Islamic financial institutions, and community organizations to design pilot projects that combine BTS deployment, village digital outlets, and waqf benefit distribution.

However, this study had several limitations. The Delphi panel was relatively small, the model has not yet been tested through field implementation, and the financial simulation relies on indicative assumptions rather than audited investment data. In addition, the findings are situated

in Indonesia's 3T context; therefore, institutional and regulatory adaptation would be required before applying the model in other settings.

Future research should shift from conceptual validation to empirical testing. Pilot studies should examine financial performance, contractual feasibility, governance effectiveness, community acceptance, and measurable socio-economic impact in selected 3T locations. Further research should compare alternative Sharia-compliant contracts and blended finance structures and quantitatively assess the effects of waqf-based connectivity on digital inclusion, Islamic financial inclusion, MSME development, education access, and household welfare.

Abbreviations
3T: Frontier, outermost, and underdeveloped regions
AAOIFI: Accounting and Auditing Organization for Islamic Financial Institutions
ARPU: Average Revenue per User
BAZNAS: National Board of Zakat of Indonesia
BTS: Base Transceiver Station
BUMDes: Village-Owned Enterprise
BWI: Badan Wakaf Indonesia
Capex: Capital Expenditure
CSR: Corporate Social Responsibility
CWLS: Cash Waqf Linked Sukuk
DKM: Dewan Kemakmuran Masjid
EDHS: Ethiopia Demographic and Health Survey
GMM: Generalized Method of Moments
ICT: Information and Communication Technology
MSME: Micro, Small, and Medium Enterprise
Opex: Operational Expenditure
PPOB: Payment Point Online Bank
QRIS: Quick Response Code Indonesian Standard
RT: Rukun Tetangga
SDGs: Sustainable Development Goals
UN: United Nations
UNCTAD: United Nations Conference on Trade and Development.

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