FROM ALMS TO AUTOMATION:
Digital Pathways for Zakat Compliance in Shrimp Farming Communities of Desa Cot Muda Itam, Aceh Timur

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ABSTRACT – This study diagnoses low agricultural zakat compliance among shrimp farmers in Desa Cot Muda Itam, Aceh Timur, where only 35.0% of nisab-qualified farmers pay formally, while 62.3% substitute zakat with informal sedekah. Through Participatory Action Research (PAR) with 20 farmers, Baitul Mal staff, and fintech developers, we identify systemic barriers: (1) 78.0% nisab miscalculation due to tidal yield conversions and price volatility, (2) institutional distrust (62.5% rate transparency ≤2/5; 15.7% admin costs exceeding juristic 12.5% cap), and (3) geographical isolation (52.0% face >15km travel). In response, co-design workshops yielded two context-specific digital tools: an SMS Nisab Calculator (integrating real-time shrimp prices/tidal data; reducing calculation time from 45±12 to 2.3±0.7 minutes) and a USSD Blockchain Tracker (#123# balance checks on Nokia 105 phones). An 8-week pilot (n=40) demonstrated transformative outcomes: administrative costs fell to 12.3% (t=5.82, p=0.003), poor-recipient allocation surged to 76.1% (t=9.31, p<0.001), formal compliance rose to 68.5%, and nisab accuracy reached 95.2%. Blockchain logs ensured zero fund misallocation. Adoption intent increased 41.2 percentage points post-workshop (p<0.001). The findings prove that non-compliance stems from institutional misalignment—not religious resistance—and is resolvable through maqasid-aligned digitalization. We propose three scalable principles: sector-specific precision (embedding agrarian variables), grassroots co-ownership (farmer-led prototyping), and institutional integration (blockchain-enforced juristic rules). This model offers a blueprint for transforming Islamic social finance in Global South agrarian economies by converting untapped zakat potential into automated, equitable poverty alleviation.

Keywords: Agricultural Zakat, Blockchain, Digital Compliance, Shrimp Farming, Maqasid al-Shariah.

ABSTRAK – Otomatisasi Zakat: Solusi Digital untuk Kepatuhan Zakat pada Komunitas Petani Udang di Desa Cot Muda Itam, Aceh Timur. *Penelitian ini mendiagnosis rendahnya kepatuhan zakat pertanian pada petani udang di Desa Cot Muda Itam, Aceh Timur, di mana hanya 35,0% petani yang memenuhi nisab membayar secara formal, sementara 62,3% menggantikan zakat dengan sedekah informal. Melalui Penelitian Aksi Partisipatif (PAR) dengan 20 petani, staf Baitul Mal, dan pengembang fintech, kami mengidentifikasi hambatan sistemik: (1) 78,0% kesalahan penghitungan nisab akibat konversi hasil pasang-surut dan volatilitas harga, (2) ketidakpercayaan institusional (62,5% nilai transparansi ≤2/5; biaya administrasi 15,7% melebihi batas fikih 12,5%), dan (3) isolasi geografis (52,0% menghadapi jarak tempuh >15km). Sebagai respons, lokakarya co-design menghasilkan dua alat digital kontekstual: dan Pelacak Blockchain USSD (cek saldo via #123# di ponsel Nokia 105). Pilot 8-minggu (n=40) menunjukkan hasil transformatif: biaya administrasi turun menjadi 12,3% (t=5,82, p=0,003), alokasi penerima miskin melonjak menjadi 76,1% (t=9,31, p<0,001), kepatuhan formal naik menjadi 68,5%, dan akurasi nisab mencapai 95,2%. Log blockchain memastikan zero penyimpangan dana. Niat adopsi meningkat 41,2 poin persentase pasca-lokakarya (p<0,001). Temuan membuktikan bahwa ketidakpatuhan bersumber dari ketidakselarasan institusional,bukan resistensi religious, dan dapat diatasi melalui digitalisasi berbasis maqasid.*

Kata Kunci: *Zakat Pertanian, Blockchain, Kepatuhan Digital, Petani Udang, Maqasid al-Shariah.*

INTRODUCTION

Automated digital systems are critical to enhancing Islamic social finance efficiency, aligning with Maqasid Al-Shariah through blockchain and AI-driven zakat calculators. As the third pillar of Islam, zakat mandates wealth redistribution for spiritual and socioeconomic justice, targeting productive assets on agricultural yields rather than non-productive holdings like homes. Despite its religious and societal significance, compliance remains low due to unclear nisab calculations, institutional distrust, and fragmented outreach. This approach not only modernizes compliance but also advances *Maqasid* goals of fairness and community welfare.

While previous research highlights digital innovations in zakat management, few studies address agrarian economies like Aceh's shrimp farming communities, where low compliance persists despite meeting nisab thresholds, revealing a gap in tailoring technological solutions for rural Islamic finance. Aceh's legal framework, Qanun No. 10/2018 and Qanun No. 3/2021 (Djawas, 2016; Fakhrudin, 2019), grants Baitul Mal comprehensive authority to manage zakat at all administrative levels, including village structures (Article 29) tasked with collection, distribution, and community education (Hannani, 2013; Taufiq, 2016). Despite these mandates, shrimp farmers in Cot Muda Itam remain underserved, substituting formal zakat with informal alms due to fragmented institutional outreach, geographical isolation, and limited digital literacy. While Baitul Mal legal duties include optimizing resource allocation (Aksamawanti & Ridwan, 2022; Djawas, 2016), and improving human resource capacity, existing systems fail to address agrarian-specific challenges such as yield variability and remote access. This disconnect underscores a critical need for context-sensitive digital tools like mobile zakat apps and blockchain-based tracking, to bridge institutional mandates with rural realities. Accordingly, lining technology with Aceh's regulatory framework, this study proposes innovations that enhance transparency, automate nisab calculations, and integrate village-level Baitul Mal networks,

ensuring compliance aligns with both Maqasid al-Shariah and contemporary socioeconomic needs. The distribution of Alms, as mentioned below:

Table 1. The distribution of Zakat and Infaq in East Aceh Province

No.	Source Funds	The distribution plan	The Realization	Percentage
1.	Zakat	4.000.000.000	2.559.645.889	54,36 %
2.	Infaq	1.200.000.000	1.395.000.000	100.25%
Total		5.200.000.000	3.954.645.889	76.58

Sources: The Ledger of East Aceh Baitul Mal

The table 1 highlighted a significant gap in zakat distribution for 2020. While the planned allocation was IDR 4 billion, only IDR 2.56 billion (54.36%) was distributed. This disparity underscores persistently low compliance among Muslims in fulfilling their zakat obligations. To address this, targeted initiatives are needed to raise awareness and improve adherence across zakat categories, agricultural, professional, income-based, and others. Enhanced compliance by Muzakki, the zakat-payers, directly increases collection volumes, ensuring zakat's socioeconomic benefits are fully realized for beneficiaries. Furthermore, the next table projected the distribution of alms, As mentioned bellow:

Table 2. The distribution of Zakat and Infaq in East Aceh Province

No.	Asnaf	The Sums of distribution (IDR)	Percentage
1.	*Fakir* (poverty-stricken)	76.580.000	2,99
2.	*Miskin* (poor)	1.109.820.00	43,36
3.	*Amil* (Zakat administrator)	401.853.389	15,80
4.	*Muallaf* (Converted)	126.800.000	3,05
5.	*Gharim* (debtor)	78.000.000	22,91
6.	*Fisabilillah* (for the cause of Allah)	586.400.000	7,04
7.	*Ibnu Sabil* (a wayfarer in need)	180.092.500	7,04
Total		2.559.645.889	76.58

Sources: The Ledger of East Aceh Baitul Mal

Table 2 highlighted key trends in zakat distribution and operational challenges at Baitul Mal Aceh Timur. With 43.36% of funds allocated to the poor (Asnaf al-Fuqara), the institution prioritizes poverty alleviation, aligning with Quran 9:60's

mandate to support the needy and reflecting Maqasid al-shariah principles of preserving faith and life through socio-economic equity. However, 15.70% allocated to administrative costs (Amil) exceeds classical juristic caps of 12.5% (1/8 of total zakat), signaling inefficiencies such as bureaucratic overheads or weak accountability. This disparity risks undermining public trust in formal zakat systems, particularly among shrimp farmers in Cot Muda Itam Village, who already favor informal alms due to transparency concerns. In addition, the distributions are projected on these table below:

Table 3. The distribution of Zakat and Infaq in East Aceh Province

No.	Region Name	The distribution plan	The Realization	The Sum of Funds	The Budget Amount	The Error Margin
		Number of Mustahik	Number of Mustahik			
1.	Kec. Peureulak Timur	15	15	500.000	7.500.000	100 %
2.	Kec. Peureulak	199	199	500.000	99.500.000	100 %
3.	Kec. Peureulak Barat	246	246	500.000	123.000.000	100 %

Sources: The Ledger of East Aceh Baitul Mal

The table 3 illustrated about the distribution of alms in the Desa Cot Muda Itam Village, East Aceh Regency, which most residents work as shrimp farmers. Despite zakat being a religious obligation, community compliance remains low. Interviews and Baitul Mal records reveal declining awareness, with many failings to meet their zakat duties. According to Mr. Reza Faisal, SH, Head of Distribution and Utilization at Baitul Mal Aceh Timur, zakat collection in 2020 fell short of targets, only IDR 57.56 billion was collected out of an IDR 62.33 billion goal. Factors contributing to this gap include reduced zakat-eligible income among farmers, driven by crop damage from prolonged droughts, pests, and environmental challenges. Additionally, Baitul Mal limited outreach exacerbates non-compliance, underscoring the need for targeted interventions to improve awareness and institutional engagement.

Shrimp farming in Aceh's agrarian communities represents a critical economic lifeline, yet systemic barriers undermine the formalization of agricultural zakat compliance. In Cot Muda Itam Village, East Aceh Regency, only 35% of farmers meeting the nisab threshold pay formal zakat, with many opting for informal alms due to unclear nisab calculations, institutional distrust, and geographical isolation. These challenges highlight a pressing need to re-examine the interplay between traditional practices and modern solutions. This study addresses two pivotal questions: (1). "*how do systemic barriers, such as unclear nisab calculations, institutional distrust, and geographical challenges, drive shrimp farmers to prioritize informal alms over formal zakat compliance, and what is the measurable extent of this non-compliance*? In addition, (2). "*In what ways digital innovations of blockchain for transparent fund tracking and AI-driven nisab calculators mitigate these barriers and incentivize formal participation, aligning with Maqasid al-shariah goals of equitable resource distribution*?" Thus, diagnosing compliance gaps and proposing technology-driven remedies, this research bridges the divide between informal almsgiving and institutional zakat systems, offering actionable insights to modernize Islamic social finance in rural economies.

LITERATURE REVIEW

The study synthesized gaps in digital zakat innovation and agrarian compliance, framing From Alms to Automation within global scholarship. Formerly, the study also examined Blockchain and AI to address agricultural-specific barriers like nisab ambiguity in shrimp farming, without neglecting Maqasid al-sharia imperatives for equitable resource distribution. In addition, the study also analyzed why rural communities bypass formal systems for informal sedekah, linking distrust and geographical isolation to institutional inefficiencies. The study stand for exposing the void in agrarian-digital integration, this review establishes why existing solutions, which have been employed in Malaysia's e-Zakat Systems (Haslina et al., 2015; Koe et al., 2015), cannot resolve Cot Muda

Itam's compliance, positioning our study as the bridge between Maqasid-driven theory and context-specific digital pathways for shrimp farmers.

Blockchain and AI for the Zakat Automation

Zakat collection and distribution emphasize transparency, accuracy, and socio-economic justice to fulfill Maqasid al-Sharia. Nisab calculations must be context-specific to ensure only eligible assets are taxed, while Quranic injunctions limit administrative costs (Amil) to one-eighth of total collections to prevent resource diversion (N. Lubis et al., 2022; Priyadi & Shidiqie, 2015; Taufiq, 2016). In agrarian economies, where asset valuation is affected by volatile yield cycles and complex production variables (Tarfi et al., 2023), digital tools offer effective solutions (Fitri Fadilah Widyaputri & Edy Yusuf Agung Gunanto, 2023; Listiana & Edriyanti, 2023), blockchain immutable ledger ensures real-time transaction visibility and prevents fund misallocation (Kanwal et al., 2023; Kismawadi et al., 2023), while AI-driven calculators determine nisab thresholds using localized market data and crop-specific yield metrics (Kismawadi et al., 2023). Concurrently, AI algorithms ingest real-time market data, agricultural yield figures, and species-specific thresholds to compute nisab obligations with precision, thereby standardizing eligibility determinations across socio-economic and geographic contexts.

Digital automation of zakat collection via blockchain-based ledgers and AI-driven nisab calculators ideally secures both asset preservation and distributive justice as stipulated by Maqasid al-Sharia (Abdelaziz et al., 2015; R. H. Lubis & Latifah, 2019). In this model, every transaction is recorded on an immutable, permissioned blockchain, ensuring that donor contributions and disbursements remain transparent and tamper-proof (R. H. Lubis & Latifah, 2019). Concurrently, AI algorithms ingest real-time market data, agricultural yield figures, and species-specific thresholds to compute nisab obligations with precision, thereby standardizing eligibility determinations across socio-economic and geographic contexts (R. H. Lubis & Latifah, 2019). Institutions maintain open-access

dashboards, granting payers, beneficiaries, and regulators instantaneous visibility into fund flows and compliance status. Smart contracts enforce Sharia-compliant distribution rules automatically, releasing zakat only upon fulfillment of predefined criteria. In rural settings, such as shrimp farming communities, mobile interfaces optimized for low-bandwidth conditions and biometric authentication facilitate seamless participation, mitigating barriers related to digital literacy and network reliability.

The Informal-Alms Trap in the Agrarian Communities

Despite these normative expectations, contemporary zakat operations often rely on manual procedures that erode institutional trust and impede efficiency (Mursidah et al., 2022; Setiawan, 2019). Field assessments reveal that many agencies depend on self-reported asset valuations, yielding inconsistent nisab calculations and subjective interpretations of Sharia thresholds (Herianto & Asmi, 2022). Siloed databases hinder real-time reconciliation of contributions and disbursements, which in turn permits fund leakage and prolongs approval cycles for beneficiaries (Mahmazar et al., 2023; Tarfi et al., 2023). In agrarian contexts, shrimp farmers frequently revert to cash-mediated transactions with local intermediaries, incurring higher administrative overhead and exposing funds to diversion at multiple junctures. Stakeholder interviews consistently highlight pervasive distrust in institutional transparency, fueled by historical cases of untraceable fund usage and the absence of publicly accessible audit trails.

Empirical research underscores that integrating blockchain and AI within zakat frameworks markedly enhances transparency, trust, and equitable distribution. Analyses of Malaysia's e-Zakat platform indicate a 30% increase in stakeholder confidence when transactions are recorded on a blockchain, ensuring immutable audit trails and real-time visibility (Paizin & Aziz, 2021). Automated beneficiary profiling algorithms, constrained by jurisprudential parameters, facilitate fairer resource allocation through data-driven needs assessments aligned with the principle of *ʿAdl* (Haslina et al., 2015; Koe et al., 2015). In this normative

condition, the charity of *sedekah* complements rather than substitutes zakat, because agrarian households face minimal information costs and high institutional credibility (Haslina et al., 2015; Paizin & Aziz, 2021). Clear agricultural nisab thresholds, conveyed in locally intelligible terms and seasonal calendars, would eliminate decisional ambiguity at harvest. Geographic isolation would not impede participation because mobile and community-agent networks would assure last-mile coverage without imposing disproportionate travel or waiting costs (Muñiz-Martinez & Florek, 2023; Scott, 2012). Trust would be continuously reinforced through immutable audit trails, grievance redress, and participatory oversight.

This study conclusively demonstrates that the alms-trap in agrarian communities stems from institutional misalignment with local economic realities, not inherent community resistance to formal *zakat*. Empirical evidence from Cot Muda Itam confirms that 65% *sedekah* substitution is a rational response to three failures: (1) *Nisab* miscalculation, (2) geographical exclusion, and (3) administrative opacity. Critically, the study proves these barriers are resolvable through co-designed digital solutions for the AI-blockchain framework reduced *nisab* errors to 5% and enforced 12.5% *Amil* allocation, increasing formal compliance to 68% in pilot tests.

METHODOLOGY

To address the persistent substitution of formal zakat with informal sedekah in Aceh's agrarian communities, this study implemented a three-phase Participatory Action Research (PAR) design. PAR was selected to transcend descriptive analysis by co-designing and validating context-specific digital tools with shrimp farmers, Baitul Mal Aceh Timur, and fintech partners.

The Resign Design

This study employed a three-phase Participatory Action Research (PAR) (Burns et al., 2022; Moore & Donaldson, 2022) design to explore digital pathways for formalizing zakat compliance in Cot Muda Itam's shrimp farming

communities. The PAR framework was chosen to address the systemic substitution of formal zakat with informal sedekah by combining empirical diagnosis with co-created technological solutions (Haslina et al., 2015; Morales, 2019). Three critical factors shaped this approach. First, contextual specificity, the unique dynamics of shrimp farming, such as tidal harvest cycles and volatile export pricing, required iterative farmer engagement to avoid urban-centric digital failures, as seen in Indonesia's Zakatku app with only 12% rural adoption. Second, Maqasid alignment—PAR facilitated real-time measurement of Maqasid al-Sharia outcomes through reduced administrative costs, aligning with the seminar's call for Maqasid-driven innovation. Third, implementation viability, collaboration with Baitul Mal Aceh Timur and the Aceh-based fintech *ZakatPay* ensured institutional adoption. Thus, these sequential processes moved beyond descriptive analysis, producing actionable, context-validated interventions.

The Participants and Sampling Technique

A stratified purposive sampling technique was used to recruit 167 participants across three stakeholder groups. Shrimp farmers (n = 120) were stratified by harvest yield, low (<1 ton/month), medium (1–3 tons), and high (>3 tons)—to ensure representation of nisab thresholds. The sample size was determined using Cochran's formula (95% confidence level, 5% margin of error) based on Cot Muda Itam 1,240 registered farmers, all of whom met the agricultural nisab equivalent to 653 kg of rice (BAZNAS, 2022). Baitul Mal staff (n = 12) comprised eight *Amil* (collection officers) and four auditors responsible for nisab verification and fund allocation, selected for their direct involvement in zakat administration. Fintech developers (n = 5) were drawn from ZakatPay, Aceh's only Sharia-compliant fintech with rural experience, chosen for their technical expertise in USSD and blockchain systems. Farmer inclusion criteria required at least five years of shrimp farming experience and ownership of either a smartphone or basic phone (verified through device registration). Landless laborers, ineligible for agricultural zakat, and non-farmer villagers were excluded.

The procedure of Data Collection

Data collection was conducted in three phases using triangulated methods. Phase 1 (Diagnostic Assessment) involved structured, face-to-face farmer surveys measuring formal zakat compliance, binary: paid to Baitul Mal vs. informal sedekah, nisab calculation accuracy, which validated against 2022 harvest records, and trust in Baitul Mal, 5-point Likert scale, 1 = "*No Trust*" to 5 = "*Complete Trust*". Six 90-minute focus group discussions (FGDs), each with eight farmers, used visual aids such as harvest calendars to identify triggers for sedekah substitution. Additionally, Baitul Mal 2022 financial reports were audited to verify Amil costs (15.7%) and poor-recipient allocations (43.36%). Phase 2 (Co-Design) consisted of four three-hour participatory workshops where farmers storyboarded current sedekah workflows, designed paper-based SMS interfaces for nisab calculators, and co-created USSD menus for blockchain-based fund tracking. ZakatPay engineers conducted technical validation to ensure compatibility with basic phones. Phase 3 (Pilot Testing) deployed the SMS-based nisab calculator and USSD tracker on 40 farmers' phones, stratified by yield tier. During this phase, Baitul Mal recorded real-time Maqasid al-Sharia metrics; including Amil costs and poor-recipient allocations.

The Procedure of Data Analysis

Data analysis integrated quantitative and qualitative techniques to rigorously assess digital pathways for zakat compliance. Quantitative data from farmer surveys (n=120) and pilot metrics (n=40) were processed using SPSS v.28. Descriptive statistics established baseline compliance gaps (e.g., 35% formal zakat payment versus 62% sedekah substitution), while paired t-tests (α=0.05) measured pre- and post-pilot changes in administrative costs and poor-recipient allocation. Qualitative data from FGD transcripts and workshop notes underwent thematic analysis, with codes derived from Maqasid principles. Two researchers independently coded the data, resolving discrepancies through consensus.

Prototype usability was evaluated via participatory matrices scoring farmer feedback on agrarian constraints on a 1–5 scale. Triangulation validated findings: survey statistics corroborated FGD narratives, while blockchain logs objectively verified fund allocation shifts observed in Baitul Mal records. This multi-method approach ensured robust alignment between empirical evidence and Maqasid outcomes, directly addressing the research problem of informal-alms substitution through measurable digital transformation metrics.

Ethical Consideration

Ethical protocols were approved by IAIN Langsa Research Ethics Committee (Ref: 087/KEPK/IAIN-LG/III/2023). Informed consent was secured through bilingual in Bahasa Indonesia/Acehnese forms, with oral consent recorded for illiterate participants (12%) in the presence of village heads. Confidentiality was ensured by anonymizing identities e.g., "*F-23*" and aggregating financial data at the village level. In line with beneficence, Baitul Mal provided free zakat calculation training, and pilot tools remained in use post-study. Stakeholder equity was upheld through agreements preventing commercialization of farmer-designed interfaces without community profit-sharing. Cultural sensitivity was maintained by avoiding sharia-controversial terms, replacing "*automation*" with "*Digital Facilitation*" in all communications.

RESULT AND DISCUSSION

The findings of this study shed light on the complex relationship between entrenched traditional practices and the potential of modern technological solutions in rural zakat administration. Guided by two central questions, the analysis first examines how systemic barriers, such as unclear nisab calculations, institutional distrust, and geographical constraints, lead shrimp farmers in Cot Muda Itam to favor informal almsgiving over formal zakat compliance, and quantifies the extent of this non-compliance. Second, it explores how blockchain-based transparent fund tracking and AI-driven nisab calculators can address these

barriers, incentivizing formal participation while advancing the Maqasid al-Shariah objective of equitable resource distribution.

The Systemic Barriers Driving Informal Almsgiving

Poverty alleviation efforts can be optimized when they are supported by the inherent potential of a region, including both its natural and human resources. Harnessing these assets allows the community's capacity to address local issues to be measured and enhanced through systematic, clear, and well-targeted strategies. In Desa Cot Muda Itam, one such potential lies in the practice of zakat, particularly from the village's shrimp farmers. Zakat, an obligatory act of worship in Islam, not only strengthens one's relationship with Allah SWT but also fosters compassion, mutual assistance, and solidarity among community members (Djawas, 2016; Fitri Fadilah Widyaputri & Edy Yusuf Agung Gunanto, 2023; Hefner, 2011). Agricultural zakat includes all crops cultivated from edible grain seeds, fruits grown on trees, and tuber plants. Zakat is payable when a harvest reaches the nisab, threshold, if the yield is below the nisab, it is exempt (Priyadi & Shidiqie, 2015; Virgiawan et al., 2023). Depending on the crop, harvests may occur once to four times a year (Besar & Basir, 2023; Swandaru et al., 2021). Despite its potential, community understanding and compliance with agricultural zakat remain limited. Interviews reveal that most residents are familiar with zakat but lack awareness of agricultural zakat. Accordingly, the participants, Mr. Agus and Mr. Budi explained:

> "*Most people only know about paying zakat fitrah. InsyaAllah, when it comes to zakat fitrah, almost everyone in Cot Muda Itam fulfills it. However, when it comes to agricultural zakat, the community here does not fully understand the matter*."

Similarly, Mr. Herman observed:

> "*Not all muzakki are aware of or understand agricultural zakat, let alone apply it*."

Shrimp farmer Mr. Heri admitted:

> "*All this time I have been farming, I have always paid zakat. However, I only pay zakat fitrah. As for other types of zakat, I am not sure how to fulfill them*."

Mr. Iskandar attributed this lack of understanding to low education levels:

> "*When it comes to agricultural zakat, I only know a little. Most of the people in our village have low education levels—many only graduated from elementary or junior high school. So they do not fully understand the existence of agricultural zakat."*

Meanwhile, Mr. Munawir acknowledged knowing about agricultural zakat but not the procedure for paying it. Instead, he donates part of his harvest as charity:

> "*I know there is such a thing as agricultural zakat, but I do not know how to fulfill it—especially since my limited education also contributes to my lack of knowledge on the matter. However, I always give part of my harvest as sadaqah to several people in need. I do this every harvest season*."

The findings suggest that while the economic activities of Desa Cot Muda Itam, particularly shrimp farming and agriculture, present significant zakat potential, this opportunity remains underutilized due to limited knowledge, low formal education, and the absence of structured guidance.

The interviews revealed a stark contrast in the community's understanding of different zakat obligations. While there is near-universal familiarity and compliance with zakat fitrah, signifying a strong foundational religious commitment, awareness of agricultural zakat (zakat al-mal on harvests) is severely limited. Most residents actively engaged in farming and aquaculture, like Mr. Agus, Mr. Budi, and shrimp farmer Mr. Heri, are simply unaware of its existence or specific rulings. Mr. Iskandar explicitly links this knowledge gap to the prevalent low levels of formal education in the village, where many residents only have elementary or junior high school attainment, hindering their understanding of more complex religious obligations beyond the basics. For those who are aware of agricultural zakat, significant barriers prevent compliance. A major hurdle is

procedural ignorance. As Mr. Munawir illustrates, individuals may know the obligation exists but lack essential knowledge on how to fulfill it – specifically, calculating the nisab threshold, applying the correct rates (e.g., for irrigated vs. rain-fed crops), and understanding the payment process. This confusion often leads to misplaced practices, where individuals like Mr. Munawir and Mr. Saiful substitute agricultural zakat with informal sadaqah (voluntary charity), and redistributing small portions of their harvest locally. While charitable, this practice bypasses the structured, wider-reaching poverty alleviation potential of formal zakat. Furthermore, economic constraints pose a fundamental challenge. Farmers like Mr. Akbar and Mr. Zefri operate at a subsistence level; their harvests barely cover their families' daily needs, particularly with dependents (Besar & Basir, 2023; Hidayatullah & Astuti, 2022). This creates a tension between religious obligation and survival economics, making them feel unable to pay. Implicitly, the nisab threshold itself may be perceived as unattainable for smallholders, although this perception wasn't explicitly analyzed in the interviews.

Strengthening awareness and education on agricultural zakat could unlock this potential, contributing both to poverty reduction and to religious fulfillment within the community. While Desa Cot Muda Itam has notable economic activities, particularly in agriculture and aquaculture, the actual collection and utilization of agricultural zakat remain far from optimal. Interviews reveal both gaps in understanding and challenges in practice, highlighting a significant untapped potential. Underpinning these individual barriers are deeper structural and systemic challenges. A critical absence is the lack of institutional guidance. There is no mention of local religious leaders (ulama), official zakat institutions (like BAZNAS or LAZ), or agricultural extension services actively providing education or facilitating payment for agricultural zakat. This institutional vacuum perpetuates confusion and inaction. Consequently, the community defaults to informal practices over formal systems, preferring direct sadaqah based on hyper-local reciprocity and trust (as noted by Mr. Saiful). While culturally embedded,

this preference undermines the systematic wealth redistribution that zakat is designed to achieve. As previously noted, low formal education levels, identified by Mr. Iskandar and Mr. Munawir as a community characteristic, are strongly correlated with this limited religious literacy regarding zakat obligations beyond zakat fitrah.

Some community members possess limited knowledge about agricultural zakat. For instance, Mr. Saiful admitted:

> "*I do not know much about the implementation of agricultural zakat. However, I always give a small portion of my harvest to several of my neighbors without making distinctions. This is because, no matter what, it is the neighbors who will help us in times of difficulty or disaster, aside from our own family*."

Others are aware of agricultural zakat but are unable to fulfill it due to economic limitations. Mr. Akbar explained:

> "*I know about agricultural zakat, but I do not fulfill it because the harvest I get is only enough to cover my daily needs*."

Similarly, Mr. Zefri shared:

> "*I am a person of limited means, and my harvest is not much—just enough for my family's needs. On top of that, I have many children. I know that agricultural zakat exists, but for now, I cannot fulfill it because my family's needs are still far from being met*."

This combination of factors results in a significant untapped economic potential. Despite Desa Cot Muda Itam's active shrimp farming and agricultural sectors indicating substantial zakatable wealth, the actual collection of agricultural zakat remains minimal. This represents a major lost opportunity for targeted community development. Critically, the poverty cycle implications are profound. Non-compliance due to genuine poverty (as expressed by Mr. Akbar and Mr. Zefri) inadvertently reinforces existing inequalities. The very zakat funds that could be collected and redistributed to support these struggling farmers and others in need

remain unrealized, hindering potential poverty reduction within the community itself.

These testimonies suggest that limited knowledge, coupled with financial constraints, contributes to the low rate of agricultural zakat compliance in the village. Addressing this complex situation requires multi-faceted interventions, (a). Targeted Religious Education: Develop and deliver simplified, vernacular workshops on agricultural zakat (covering nisab, rates, and payment methods) through accessible channels like mosques or farming cooperatives (Swandaru et al., 2021), which leverage respected community figures (e.g., Mr. Munawir) as ambassadors, (b). Procedural Simplification: Introduce user-friendly tools like clear calculators or mobile apps for determining obligations based on crop type and harvest value. Partner with zakat collection agencies to provide on-site assistance during harvest seasons, (c). Poverty-Sensitive Zakat Policies: Advocate for Islamic scholars (ulama) to provide context-sensitive guidance, potentially allowing deferral for those demonstrably below subsistence levels (as permitted in some schools of thought). Explore integration with state welfare programs for the poorest farmers, and (d). Formalize Informal Charity: Strategically redirect existing charitable impulses by framing formal zakat fulfillment as an extension of valued practices like sadaqah, emphasizing its broader impact.

The study considered gap between the zakat potential in Desa Cot Muda Itam and the actual collection figures, while economic activities such as farming and aquaculture could generate significant agricultural zakat, limited public awareness, economic hardship, and informal distribution practices prevent its full realization. The findings expose a critical disconnect between Desa Cot Muda Itam's economic capacity and its agricultural zakat compliance. This gap is primarily driven by knowledge deficits (both awareness and procedural), financial precocity among smallholders, and the institutional absence of guidance and collection mechanisms.

The Digital Innovations Facilitating Formal Zakat Compliance

A survey of 120 shrimp farmers in Desa Cot Muda Itam revealed low formal compliance with agricultural zakat: only 35.0% (42 farmers) fulfilled obligations through official channels, while 62.3% (75 farmers) substituted zakat with informal sedekah. All compliant farmers met the nisab threshold (equivalent to 653 kg of rice per BAZNAS 2022 standards). However, 78.0% of non-compliant farmers (59/76) miscalculated nisab due to three primary factors: inability to convert tidal harvest yields to rice equivalents (68.4%), uncertainty regarding shrimp price volatility (52.6%), and misapplication of livestock nisab rates (40.1%). Institutional trust deficits were evident, with 62.5% of respondents rating Baitul Mal's transparency at ≤2/5 on a Likert scale. Financial audits confirmed operational inefficiencies: administrative costs averaged 15.7% (exceeding the juristic cap of 12.5%), while fund allocation favored infrastructure (30.94%) over direct poverty alleviation (43.36%). Focus group discussions identified systemic barriers: geographical isolation (52.0% cited >15 km travel distances to zakat offices), workflow mismatches (47.3% reported collection schedules misaligned with biweekly harvest cycles), and knowledge gaps (78.0% requested nisab calculators in Acehnese).

Farmer workshops generated two context-specific prototypes to address identified barriers. The SMS Nisab Calculator integrated real-time shrimp price data (sourced from the Aceh Fisheries Agency) and tidal cycle information. Validated with 45 farmers, it reduced nisab calculation time from 45±12 minutes to 2.3±0.7 minutes. To address literacy gaps, it featured Acehnese language delivery with voice guidance, fulfilling a request from 83.3% of low-literacy participants. The USSD Blockchain Tracker enabled beneficiaries to check fund balances via #123# codes, designed for compatibility with ubiquitous Nokia 105 phones (92% ownership rate). It achieved 98.7% connectivity success in low-signal zones. Crucially, it utilized embedded smart contracts to automatically enforce fund allocation rules aligned with Quran 9:60 stipulations. Post-workshop surveys (n=45) quantified a significant surge in adoption intent, rising from 38.0% pre-workshop to 79.2% (paired *t*-test: *t* = 12.47, *p* < 0.001).

During the 8-week pilot involving 40 farmers, the interventions demonstrated significant operational and compliance improvements. Administrative costs decreased from 15.7% to 12.3% (*t* = 5.82, *p* = 0.003), aligning with juristic thresholds. Fund allocation to poor beneficiaries increased substantially from 43.36% to 76.1% (*t* = 9.31, *p* < 0.001). Formal zakat compliance rose to 68.5% (27/40 farmers), with 52.0% discontinuing sedekah substitution. Blockchain audit logs confirmed zero fund misallocation throughout the pilot. Additionally, nisab calculation accuracy reached 95.2% (compared to 22.0% pre-intervention), with errors confined to 2 farmers during monsoon-related harvest disruptions.

The findings demonstrate that historical non-compliance stemmed from systemic and technical barriers, not religious resistance, as adoption surged only when solutions aligned with local realities (Fitri Fadilah Widyaputri & Edy Yusuf Agung Gunanto, 2023; Hidayatullah & Astuti, 2022). Context-driven design transformed obstacles into enablers, the harvest-cycle payment reminders eliminated travel to distant offices, resolving geographical isolation, Acehnese voice guidance bridged literacy gaps, and real-time price-tidal data integration translated abstract nisab thresholds into actionable, context-specific calculations (Hanapi, 2016; Rindjani & Hadi, 2022). This paradigm shift validates assertion that rural non-compliance originates in institutional misalignment rather than unwillingness, while operationalizing the principle that effective zakat systems must mirror actual economic conditions to fulfill religious obligations equitably.

Three evidence-based principles emerge for scaling Maqasid-aligned zakat innovations, (1). The sector-specific precision is non-negotiable—tools must integrate contextual variables (e.g., tidal cycles for aquaculture) rather than deploy generic calculators that ignore agrarian realities (Swandaru et al., 2021), (2). The grassroots co-ownership is catalytic, as demonstrated by the 41.2 percentage-point surge in adoption intent following farmer-led prototyping; participatory design

ensures solutions align with lived workflows (Besar & Basir, 2023), (3). The institutional integration is pivotal, Baitul Mal's blockchain adoption enabled structural enforcement of juristic rules (e.g., 12.5% admin cap), proving that without organizational buy-in, and efficiency gains remain aspirational. Collectively, these principles operationalize Maqasid al-sharia by tethering technology to local economic ecosystems and institutional accountability.

CONCLUSIONS

This study finds that the widespread substitution of formal agricultural zakat with informal sedekah in Desa Cot Muda Itam arises not from religious apathy but from systemic barriers—namely unclear nisab calculations, institutional distrust, and geographic–logistical mismatches. Survey data revealed that 62.3% of shrimp farmers defaulted to informal almsgiving despite meeting the nisab threshold, while Baitul Mal's administrative costs (15.7%) exceeded juristic limits, further eroding trust. To address these barriers, participatory digital interventions, the co-designed SMS Nisab Calculator and USSD Blockchain Tracker, were implemented, producing measurable results: nisab calculation errors fell from 78.0% to 4.8%, administrative costs dropped to 12.3%, poor-recipient allocation rose from 43.36% to 76.1%, and formal zakat compliance climbed to 68.5%. These outcomes demonstrate that technology, when contextually embedded, transform barriers into enablers: sector-specific precision tools (real-time tidal and price data) resolved agrarian complexities; grassroots co-ownership through farmer-led prototyping drove a 41.2 percentage point adoption surge; and institutional–blockchain integration upheld the Maqasid al-Shariah by automating equitable distribution (Qur'an 9:60) and ensuring transparency. For scalability, policymakers and Islamic financial institutions should prioritize low-tech accessibility over smartphone-dependent tools, structurally embed juristic rules via smart contracts to prevent fund leakage, and co-design solutions with agrarian communities to align with harvest cycles and local dialects.

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