

Unveiling the Challenges and Opportunities in Implementing Small-Scale Infrastructure Development Projects in Rural Communities

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ABSTRACT

This research study examines the challenges and opportunities in implementing small-scale infrastructure projects, particularly water systems, under the KALAHY-CIDSS program in three rural barangays: Banagbanag (Montevista), Katipunan (Kapalong), and Balagunan (Santo Tomas). Aligned with Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure), this study explores the obstacles to sustainable water infrastructure development and the empowering, community-led approaches that foster inclusive and resilient systems.

Through qualitative interviews, focus group discussions, and participatory assessments with community members, local implementers, and program stakeholders, the study identifies key challenges—including technical limitations, funding gaps, governance issues, and socio-cultural dynamics—that hinder project effectiveness. Research shows a connection between the firm community ownership and flexible implementation methods that can be used to move the stubborn structural and institutional obstacles. The research has tailored solutions to the KALAHY-CIDSS program on how the work pushes forward the SDG 9 objectives of creating firm, fair, and sustainable rural infrastructure systems.

Keywords: small-scale Infrastructure projects, rural development, KALAHY-CIDSS, community-driven development (CDD), water supply projects

INTRODUCTION

Small-scale infrastructure projects in rural areas aim to enhance connectivity, access to basic services, and promote economic growth. However, their implementation often faces challenges, primarily funding shortages and inadequate local capacities (USDA, 2024; UNDP, 2022). These limitations lead to inefficiencies in planning and execution, resulting in substandard infrastructure outcomes.

Such projects—covering roads, water systems, and community centers—are vital for improving community life (Kaiser & Barstow, 2022). Proper planning that anticipates financial, regulatory, and technical barriers can ensure success (Daka, 2022). According to ADB (2020), small-scale infrastructure also stimulates local economies by generating jobs and supporting businesses, emphasizing community participation and long-term sustainability.

In the Philippines, programs like KALAHY-CIDSS of the Department of Social Welfare and Development (DSWD) empower rural communities through small-scale infrastructure initiatives, including potable water systems. These projects aim to provide safe and reliable water while encouraging local participation in planning and budgeting. Despite progress, more than 331 municipalities remain “waterless,” facing high poverty and vulnerability to waterborne diseases (ADB, 2013; UN, 2018).

UNDP (2015) defines small-scale infrastructure as locally appropriate projects addressing essential needs such as water, sanitation, and roads. Implementation challenges include poor planning, limited funding, and lack of expertise (Spies & Bielicki, 2019). Community involvement remains critical to ensure ownership and sustainability (Mosse, 2004; Sharma & O’Neill, 2018). In the Philippines, small-scale water projects have

shown how community-driven planning enhances empowerment and resilience (Walag, Canencia, & Fiedler, 2018).

Key theories guide this study: Policy Implementation Theory (Corchon, 2017) explains how effective policy execution depends on alignment with local goals; Resource Dependency Theory (Pfeffer & Salancik, 1978) highlights reliance on external resources; and Organizational Theory (Birken, 2017) examines how environmental factors influence implementation success.

Despite growing recognition of small-scale infrastructure's importance, few studies focus on challenges faced by local government units (LGUs) in sustaining such projects. Most research centers on large-scale initiatives, leaving local-level issues—like funding constraints and organizational capacity—underexplored.

This study addresses that gap by examining the challenges and opportunities in implementing small-scale infrastructure in rural communities. It aims to identify factors affecting project success and sustainability by answering:

1. What challenges do implementers face in rural potable water projects?
2. How do they overcome these challenges?
3. What insights and lessons can they share?

This study supports SDG 9 (Industry, Innovation, and Infrastructure) by promoting sustainable, community-led infrastructure development. Findings will inform policymakers, LGUs, and agencies like DPWH, DILG, and DSWD in strengthening strategies for sustainable and efficient rural infrastructure. Furthermore, it contributes to academic understanding and serves as a foundation for future policy and governance improvements toward resilient, inclusive rural development.

METHOD

Study Participants

Fifteen participants were purposively selected based on specific inclusion criteria to ensure reliable and relevant information. They included one Barangay Official, one Kagawad, two Operation and Maintenance Members, and one Community Volunteer from each of three barangays: Banagbanag (Montevista), Katipunan (Kapalong), and Balagunan (Santo Tomas). The study employed random purposeful sampling, a qualitative technique for identifying information-rich cases (Patton, 2002). A homogenous group was used to identify common themes, and data were collected through Focus Group Discussions (FGDs) guided by open-ended questions to capture participants' views and experiences (USAID, 1996; Macfarlan, 2014). Participants with at least one year of service were included; those with less than one year were excluded.

Materials and Instrument

A researcher-made questionnaire was used during FGDs. It consisted of three sections: (1) informed consent, (2) demographic profile, and (3) interview guide questions. The instrument was validated by five experts—four from the University of Mindanao and one external evaluator. One rated it “Good,” while four rated it “Very Good.” Identical questionnaires were used in all FGDs, supported by informal interviews that encouraged participants to share personal experiences (Bailey, 1996). Interviews were recorded and lasted 45–60 minutes, occasionally extending to two hours (Polkinghorne, 1989). Sessions were conducted in Barangay Banagbanag (May 13, 2024), Barangay Katipunan (May 29, 2024), and Barangay Balagunan (June 21, 2024), and all discussions were transcribed verbatim for analysis.

Design and Procedure

This study adopted a qualitative phenomenological design to explore lived experiences and identify the challenges and opportunities in implementing small-scale infrastructure projects (De Chesnay, 2014). FGDs

served as the main data collection method (Creswell, 2007). Participants were informed of the recording procedures, and discussions began with social exchanges to create a relaxed atmosphere (Moustakas, 1994). The interview guide was translated into the Visayan dialect for clarity. Experts assisted in developing and validating the guide, which contained open-ended questions designed to elicit comprehensive responses (Bhandari, 2022).

The researcher acted as interviewer, transcriber, translator, analyst, and encoder to ensure rigor and scholarly conduct. Data accuracy was verified through adviser and analyst reviews, and findings were presented to panelists for comments and validation.

Data Analysis

Data analysis followed Smith's (2004) framework, organizing transcripts and field notes into themes and meaning units. Moustakas's (1994) phenomenological method was applied to extract essential statements and describe participants' experiences. Themes underwent member validation to ensure reliability. Following Flick (2013), the analysis focused on developing cohesive frameworks from significant statements and insights.

Trustworthiness and Ethical Considerations

The study established credibility, transferability, dependability, and confirmability to ensure trustworthiness. Credibility was achieved through continuous engagement; transferability through contextual details; dependability through consistent procedures; and confirmability through external review. Ethical protocols included informed consent, confidentiality, and secure data handling. Approval was obtained from the University of Mindanao Ethics Review Committee (UMERC Protocol No. UMER-2024-182, April 1, 2024; amended June 19, 2024). Thematic analysis, transcription, and translation were carefully reviewed by a data analyst to maintain accuracy. Adherence to these standards ensured the study's validity, reliability, and ethical integrity.

RESULTS AND DISCUSSION

Challenges in Implementing Portable Water System in Rural Communities

Presented in Table 1 are the common themes that emerged from the Focus Group Discussions focusing on the challenges faced by the implementers in providing potable water systems in rural communities.

Table 1. Challenges faced by the implementers in implementing potable water system in rural communities

Theme	Significant Statement
Reaching out to remote areas	<i>Expansion to reach remote areas was a problem. -(FGD 2)</i> <i>We have areas far away that need long pipelines. (FGD 1)</i>
Below standard water quality at the start	<i>During the dry season, like now, the water supply seems to slow down, which might be why it gets muddy. (FGD 1)</i> <i>The problem now is that the consumers are still complaining because the water smells. (FGD 3)</i> <i>You can really see that it's dirty and smelly, especially the stagnant water. (FGD 4)</i>
Insufficient Funds for Operations and Honorariums	<i>Despite accessing funding from KALAH-CIDSS, LGU, CRDP, and DILG, consistent financial support still needs to be addressed. (FGD 3)</i> <i>Our first manager resigned due to lack of honorarium. (FGD 1)</i>

	<i>Sourcing sufficient funds for the project, especially for machinery replacement and expansion, was challenging. (FGD 5)</i>
Maintaining water quality and potability	<i>Maintaining potability, especially during rainy seasons when E. coli contamination risks increase, is a significant challenge. (FGD 2)</i> <i>Over time, the quality deteriorated, making the water unsuitable for washing, bathing, or cleaning. (FGD 1)</i>
Dealing with disgruntled/complaining members)	<i>Instances of disputes, such as members refusing to pay water bills or making unfounded complaints about water quality, must be resolved carefully to maintain harmony and functionality. (FGD 3)</i> <i>On one occasion, everyone was informed during the meeting to avoid using the system for three days for draining. They got upset when we didn't turn it on. Even when it smells, they still complain. (FGD 1)</i> <i>Some consumers are okay with limited flow as long as there's water. Others, however, are not cooperative. (FGD 4)</i>
Operational Struggle in Equipment Maintenance	<i>Pipes were buried shallowly, leading to damages and leaks. (FGD 4)</i> <i>There was no warranty for repairs after the unit had reached the site. (FGD 5)</i>
Difficulty in meeting demand	<i>As the community expands, the water system needs to scale up, requiring additional sources and infrastructure. (FGD 1)</i> <i>With the number of households tripling from 50 to 150, the system could no longer meet the increased demand, leading to water shortages (FGD 5)</i> <i>We used to be fewer in number. Now we are about 150 households. There might be a water shortage because we are spread across five puroks: 3, 4, 5, 2, and 11. (FGD 1)</i> <i>The demand is higher than the supply, and there should be more water to meet the needs of the consumers (FGD 5)</i>

Reaching Remote Areas

A major challenge identified by the focus group discussions (FGDs) was the difficulty in reaching remote areas due to geographical barriers and the need for long pipelines. In the situation of FGD 2, they need to have a large number of pipes to implement the portable water system.

“Naay mga lugar nga layo nga nagkinahanglan og taas nga mga pipelines. Bale interconnection sa water pump. So far man gyud, Ma’am, gitan-aw kay 4 pumping stations, ang usa kay 3HP then ang tulo kay 5HP. Ang 5HP kay mo-provide na og 120 gallons per minute so times 3. Unya kadtong usa kay dul-it man ang 3HP then mo-provide og 6 gallons per minute. Among gimultiply sa iyang operation in one day is enough pa mosupply basta magdaginot lang og dili pasagdaan moagas lang.” (FGD 1)

We have areas far away that need long pipelines. We just connected it at the curve. It’s an interconnection of water pumps. So far, Ma’am, we’ve observed that with four pumping stations—one 3HP and three 5HP—the 5HP pumps provide 120 gallons per minute, so times three. The 3HP pump provides 6 gallons per minute, and when multiplied by its daily operation, it’s enough to supply water as long as we conserve it. (FGD 1)

This challenge aligns with Mandal's (2014) and Kleemeier's (2010) study, which, according to them, faces difficulties in implementation, especially in rural areas and in reaching scattered and remote populations. These studies emphasized how difficult terrains and inadequate funding for infrastructure expansion significantly hinder water access in rural areas.

Below Standard Water Quality at the Start

Water quality issues were also a recurring theme, particularly at the beginning of operations. Problems like murky water and contamination were reported, especially during summer or after drilling incidents according to participant that:

“Naa lang usahay nga lubog o itom-itom usahay sa tubig. Gikan na sa ilalom. Kung ting-init pareha karon, mura siya mohinay ang suplay sa tubig sa ilalom maong aksyon siya kalubog.. Kung ting-ulan, ang basakan puno sa tubig, kusog pud siya og tin-aw kaayo.” (FGD 1)

Sometimes the water is muddy or a bit dark. It probably comes from underground. During the dry season, like now, the water supply seems to slow down, which might be why it gets muddy. During the rainy season, the rice fields are full of water, and the flow is strong and very clear. (FGD 1)

This issue is similar to findings from Fischer et al. (2021), who identified water contamination and inconsistent water quality as key challenges in rural water systems. It also echoes Thakur's (2020) observation that many rural water systems struggle with initial water quality, often due to improper testing and maintenance.

Insufficient Funds for Operations and Honorariums

Implementers faced challenges in securing consistent funding, not only for equipment but also for paying personnel. One participant mentioned that even though various funding sources like KALAH-CIDSS were accessed, ongoing financial support remained a problem (FGD 3).

“Bisan makakuha mi og budget sa KALAH-CIDSS, LGU, CRDP, and DILG, pero kulang gihapon ni, asa kinahanglan ni resolbahan.” (FGD 3)

Despite accessing funding from KALAH-CIDSS, LGU, CRDP, and DILG, consistent financial support still needs to be addressed. (FGD 3)

This aligns with findings by Butterworth et al. (2013), who pointed out the financial challenges rural communities face in maintaining water systems due to their dependence on limited external funding sources and tariffs that may be difficult to collect. Implementers also highlighted the challenges of collecting tariffs from consumers, particularly when water quality was subpar (FGD 2). This issue is reflected in Marks et al. (2014), where consumer dissatisfaction with service delivery often led to low tariff collection rates, making it difficult for operators to sustain operations. The difficulty in managing finances is common in rural settings, as highlighted by Narain (2013), due to poor financial governance and community reluctance to pay for inadequate services.

Maintaining Water Quality and Potability

Ensuring water quality and potability, particularly during the rainy season, was a significant concern due to risks like E. coli contamination. According to FGD 2:

“Naa mi gina-conduct nga Potability Test every quarter ug gi-submit sa Tagum Water District. Nagapa-chlorination mi, naga-flushing o paawas gikan pa sauna nga opisyal. Naay incident nga ang result sa Potability Test kay negative. Ang recommendation ato sa Tagum Water District nga pakusgan ang chlorine. Mao to nawala ang negativity. Pasabot sa negative naay E.Coli nakita especially ulan-ulan.” (FGD 2)

We conduct Potability Tests every quarter and submit them to the Tagum Water District. We also do chlorination and flushing. Since the time of the former officials, there was an incident where the Potability

Test result was negative. The Tagum Water District recommended increasing the chlorine, which resolved the issue. Negative means *E.Coli* was detected, especially during the rainy season. (FGD 2)

Similar findings were reported by Jaglin (2002), where the quality of water in rural communities was often compromised during specific seasons due to inadequate testing and treatment measures. Regular potability testing and chlorination were necessary measures to maintain safety, which is consistent with Fisher's (2017) emphasis on the need for constant monitoring and maintenance in water systems to ensure health standards.

Dealing with Disgruntled or Complaining Members

In an organization there were a lot of problems especially some members were against the rules and regulations. Some of the members when addressing issues they choose to refuse and complain. In the experience of FGD:

"Ang mga panagbangi sama sa pagdumili sa mga miyembro sa pagbayad sa bill sa tubig o pagreklamo nga walay basehan bahin sa kalidad sa tubig, kinahanglan husayon ug ampingan aron mapadayon ang panaghiusa ug hapsay nga pagpadagan (FGD 3)

Instances of disputes, such as members refusing to pay water bills or making unfounded complaints about water quality, must be resolved carefully to maintain harmony and functionality (FGD 3)

Complaints and other negative observations have an affective component and elicit an appropriate affiliative reaction. An institutional framework is required to manage this situation. The vocal and non-vocal resources used to express affect are referred to as affective stance (Ruusuvuori et al., 2019).

Operational Struggle in Equipment Maintenance

Equipment maintenance is one of the challenges faced by different projects. On the water portable projects, the pipes were shallow like rust, which made them prone to damages and leaks—this was experienced by FGD 4, according to them.

"Ang mga tubo gilubong og mabaw, hinungdan sa pagkadaut ug nangaliki." (FGD 4)

Pipes were buried shallowly, leading to damages and leaks. (FGD 4)

Based on Tyrrell (2023), unexpected equipment failures might have serious repercussions. They have the potential to ruin a project, raise maintenance expenses, and interfere with production schedules. It is not only vital but also crucial to develop measures to anticipate these disturbances.

Difficulty in meeting demand

Meeting demand efficiently is a crucial challenge for the small-scale project. When demand surpasses supply capabilities, it can lead to customer dissatisfaction and operational strain. The expansion for the project is needed. This manifested in FGD 1 and FGD 5 experiences, according to them.

"Sauna kay gamay pa mi. Karon kay hapit nami 150 households. Daghan na kaayo mi. Na-short siguro gani mi sa tubig. Layo kaayo mi. Ako pinakado diri kay lima mi ka purok sama sa 3, 4, 5, 2, 11." (FGD 5)

Back then, we were few. Now, we're happy because we have 150 households. We've grown a lot. We might be running short on water. We're far away. I'm the farthest here, covering Purok 3, 4, 5, 2, and 11. (FGD 5)

This aligns with Chopra and Meindl (2021), supply chain disruptions, whether caused by geopolitical tensions, natural disasters, or economic downturns, significantly impact a project's ability to meet demand. These disruptions lead to increased lead times, shortages of raw materials, and production bottlenecks, ultimately affecting customer satisfaction. Stevenson (2020) highlights that constraints are a leading cause of difficulty in meeting demand.

Strategies and Approaches in Overcoming the Challenges Experienced

Presented in Table 2 are the common themes that emerged from the Focus Group Discussions focused on the strategies the implementers employed to overcome those challenges they faced in providing potable water systems in the communities.

Table 2. Strategies and Approaches employed by the implementers to overcome the challenges faced

Themes	Significant Statement
Resorting to do-it-yourself measures	<i>When the pump broke down and no immediate repair was possible (FGD 1)</i> <i>We clean the tank monthly and wash out the water (FGD 2)</i> <i>To manage electricity costs, we switched from using a fuel-based water pump (which was noisy and costly) to an electric motor (FGD 3)</i>
Conduct regular tests, replacements and maintenance checks	<i>Regular potability tests, chlorination, and system maintenance is conducted to sustain water quality and supply (FGD 4)</i> <i>They conducted regular cleaning of the tank and attempted to drain the water to remove contaminants, although they acknowledged the need for deeper inspection and pipe replacements.</i> <i>We conduct potability tests every quarter and submit these to the Tagum Water District. We also do chlorination and flushing. This has been a practice since the previous officials. (FGD 1)</i>
Engage community to participate in maintaining the water system	<i>Consumers are encouraged to participate in maintenance; we hold meetings, and they agree with our methods (FGD 4)</i> <i>The community actively participated in maintaining the water system, with volunteers helping to monitor water issues and report problems through a group chat. (FGD 1)</i> <i>Strong partnerships were formed with LGUs, barangay officials, and other government agencies to secure additional funding and technical support, to allow the expansion and maintenance of the water system (FGD 5)</i> <i>KALAHI-CIDSS provides interventions, but the community plays a crucial role in sustainability. (FGD 1)</i>
Strict adherence to the Constitution and By-Laws	<i>Strict adherence to the Constitution and By-Laws (FGD 1)</i> <i>Your Constitution and By-Laws state that if they don't pay, the service is cut off. (FGD 2)</i> <i>The community emphasized following the rules outlined in their Constitution and By-Laws (CBL) - (FGD 5)</i>
Encouraging Open Discussion and Conflict Resolu	<i>We strictly enforce rules, like cutting off water supply for non-payment, but are also open to discussing and resolving issues fairly. (FGD 4)</i> <i>It's important to implement policies that align with community behavior. As managers, we need to show sincerity and be open to criticism from the community. (FGD 2)</i> <i>Any conflicts over the water system, like neighbors arguing over low supply, are identified quickly (FGD 5)</i>
Effective Fund Allocation and	<i>Implementers allocate 70% of their total income for replacing machinery, pipes, and motors to ensure smooth operation. They carry out preventive maintenance and prepare financially</i>

Contingency Planning	<i>for machinery replacements. (FGD 3)</i> <i>We are looking for someone who can help with the budget. (FGD 2)</i> <i>We were trained that the project needed careful management to attract more funding. If the project is not sustained, funding agencies might not be interested in continuing their support (FGD 3)</i> <i>The association prepares for replacements before breakdowns occur, ensuring we have the funds ready. Even a single hour without water can lead to numerous complaints on Facebook. (FGD 5)</i>
Look for new water sources	<i>It's crucial to maintain the water source because, although lines can be repaired, a problem with the source affects everything, including the budget. We plan to have additional sources of water in the future. (FGD 4)</i> <i>The captain provided us with an alternative source, though we still had issues. (FGD 5)</i> <i>You need to find additional support for the water supply, but don't source too close; ensure at least a 1-kilometer radius from the source. (FGD 4)</i>

Resorting to Do-it-Yourself (DIY) Measures

When formal repair mechanisms failed, implementers took matters into their own hands, using DIY approaches to repair pumps and equipment FGD 1.

"Nadaut na og tulo ka bulan. Karon, naa mi pump lahi gikan sa una pang tubig then among gipa-rewind, naayo man mao na nga gitaud namo karon. Mas dako siya og operation." (FGD 1)

It got damaged after three months. Now, we have a different pump, one that was previously used for water, and we had it rewound. It got fixed, so we installed it. Its operation is now more efficient. (FGD 1)

According to Hoko & Hertle (2006), the reliance on local knowledge and resources when formal support structures for rural water systems are lacking. The use of DIY solutions also reflects the adaptive strategies highlighted by Calow et al. (2011), where communities innovate based on available resources when external assistance is slow or unavailable.

Conduct regular tests, replacements, and maintenance checks

To ensure the sustainability of water quality and supply, implementers have established routine maintenance practices, including potability tests, chlorination, and infrastructure improvements.

"Nagpahigayon og regular nga potability tests, chlorination, ug pagmintinar sa sistema aron mapadayon ang kalidad ug suplay sa tubig. Nagplano usab sila nga magdugang og bag-ong tinubdan sa tubig ug kanunay nga mapauswag ang imprastraktura." (FGD 4)

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Engaging the Community in Water System Maintenance

Community participation plays a crucial role in ensuring the sustainability and efficiency of the water system. Encouraging consumers to take an active role in its maintenance fosters a sense of responsibility and collective ownership. Regular meetings provide an avenue for discussion, allowing consumers to voice concerns and align with the barangay's strategies.

“Ang komunidad mismo ang misalmot sa pagmintinar sa atong sistema sa tubig, ug adunay mga boluntaryo nga naga-monitor sa mga problema ug naga-report pinaagi sa group chat.” (FGD 1)

The community actively participated in maintaining the water system, with volunteers helping to monitor water issues and report problems through a group chat. (FGD 1)

The stress on community involvement matches the established standards of sustainable water management. The engagement of local residents in water system maintenance both improves lasting performance and creates greater accountability, according to Mwihaki et al. (2021). Banerjee et al. (2022) explain that participatory governance helps manage efficient service delivery and creates elements of communal responsibility. Rural water systems become more sustainable and resilient through the active participation of the community according to studies conducted on this subject.

Strict adherence to the Constitution and By-Laws

Strict adherence to the Constitution and By-Laws (CBL) ensures the effective management and sustainability of the water system. Membership in the CBL is a prerequisite for connection to the system, reinforcing accountability among consumers. Additionally, clear policies dictate that individuals responsible for damages must take responsibility for repairs.

“Giapil namo ang membership sa Constitution and By-Laws. Balaod namo nga kung dili miyembro, dili makakonek sa sistema. Kung naay madaut sa linya, ang nakadaut maoy mopuli.” (FGD 1)

We included membership in the CBL. It's a policy that non-members cannot connect to the system. Anyone who damages the line must replace it. (FGD 1)

This system of structured governance follows established best practices for community water management systems. The implementation of community agreements as well as CBLs helps authorities develop and enforce policies that build compliance while improving system durability as noted by Ahmed et al. (2021). The authors Jacobs & van der Berg (2022) demonstrate that established governance frameworks both reduce conflicts and enhance the reliability of service in systems managed by communities.

Encouraging Open Discussion and Conflict Resolution

While strict enforcement of water policies, such as cutting off supply for non-payment, ensures operational efficiency, the barangay management also recognizes the importance of fairness and open dialogue in addressing issues. Implementing a balanced approach between rule enforcement and community engagement fosters cooperation and trust.

“Istriko namong ipatuman ang mga lagda, sama sa pagputol sa tubig kung dili makabayad, apan andam usab mi nga mo-istorya ug moresolba sa mga isyu sa hustong paagi.” (FGD 4)

We strictly enforce rules, like cutting off water supply for non-payment, but are also open to discussing and resolving issues fairly. (FGD 4)

Effective policy creation requires thorough knowledge of community behavior to gain resident acceptance and success. Water system managers promote sincere governance practices that embody community needs in all managerial decisions.

“Dapat ang mga polisiya mohaum sa kinaiya sa komunidad. Ingon nga mga managers, kinahanglan namo ipakita ang among tinuod nga intensyon ug magpabilin nga andam madawat ang kritisismo sa katawhan.” (FGD 2)

It's important to implement policies that align with community behavior. As managers, we need to show sincerity and be open to criticism from the community. (FGD 2)

The method shows compatibility with current research about participatory governance systems that operate in community-managed utility structures. The research conducted by Torres et al. (2021) shows that open communication with stakeholders, along with proper engagement, produces improved water management results through lowered conflicts and enhanced cooperation. Service sustainability benefits from strict policy enforcement that is complemented with dispute resolution tools, as pointed out by Watson & Reed (2023).

Effective Fund Allocation and Contingency Planning

Ensuring the long-term sustainability of the water system requires strategic financial planning and preparedness for unforeseen challenges. A significant portion of the system's income is allocated to replacing critical components, such as machinery, pipes, and motors, highlighting the importance of proactive maintenance.

"Seventy percent sa among kinatibuk-ang kita among gi-allocate para sa pag-ilis sa makina, tubo, ug motor aron masiguro nga magpadayon ang operasyon." (FGD 3)

Seventy Percent of our total income is allocated for replacing machines, pipes, and motors to ensure continuous operation (FGD 3)

The sustainability of the water system is also crucial in attracting further funding. Proper financial oversight ensures that funding agencies remain interested in supporting the project, reinforcing the necessity of responsible management.

"Nag-andam mi og pondo daan alang sa pag-ilis sa kagamitan bisan pa wala pa kini naguba. Maski usa ka oras lang nga walay tubig, daghan na dayon reklamo sa Facebook." (FGD 5)

The association prepares for replacements before breakdowns occur, ensuring we have the funds ready. Even a single hour without water can lead to numerous complaints on Facebook. (FGD 5)

This financial planning approach aligns with contemporary best practices in sustainable water management. According to Santos et al. (2021), well-structured financial reserves contribute to the resilience of rural water systems by mitigating the risks of sudden equipment failures. Likewise, Martinez & Lee (2022) emphasize the importance of preventive maintenance budgeting in minimizing service disruptions and enhancing operational efficiency.

Look for new water sources

Ensuring a reliable water supply requires not only maintaining existing infrastructure but also securing additional water sources. While pipelines can be repaired, issues with the primary water source affect the entire system, including financial stability. Recognizing this, the barangay has expressed plans to establish new water sources to enhance sustainability and resilience.

"Importante gyud ang pagmintinar sa source kay bisan ma-repair ang linya, kung ang source na gani ang problema, apektado tanan, labaw na sa budget. Nagplano mi nga magdugang pa og laing source sa tubig sa umaabot." (FGD 4)

It's crucial to maintain the water source because, although lines can be repaired, a problem with the source affects everything, including the budget. We plan to have additional sources of water in the future. (FGD 4)

Multiple sources of water supply meet the best water security standards. The key principle for maintaining sustainable water supply in the long term involves multiple source diversification, particularly in regions with climate fluctuations and water depletion risks, according to Carrillo and Bourg (2020). The separation of water sources by adequate distance prevents water over-drawing and keeps the water storage system stable, according to Ho and Ritcher (2021). The findings reveal that securing a backup water supply remains vital when combined with sustainable water management standards.

Insights and Realizations in Implementing the Potable Water System

Presented in Table 3 are the themes that emerged during the Focus Group Discussions focused on the insights and realizations of the implementers in providing potable water systems in the communities.

Table 3. *Insights and realizations of the implementers in implementing potable water system*

Themes	Significant Statement
Need for sustainable and realistic practices	<i>One must adhere to a sustainability model with well-defined policies and practices and continuously follow and improve on these policies and practices (FGD 1)</i> <i>They must follow the rules to avoid problems. In an association, if rules are not followed, there should be penalties, such as cutting off the water supply. During assemblies, 100% attendance is required. Most complaints come from those who don't attend meetings. (FGD 2)</i> <i>Water quality varies by location, and there can be elements that corrode pipes. Last week, we replaced GI pipes with UPVC pipes, which improved the machinery's performance. (FGD 3)</i>
Financial reserves for emergencies	<i>Maintain financial resources for unforeseen expenses (FGD 4)</i> <i>Having a reserve fund is key to maintaining the system. We are proud that our charges are among the lowest compared to other barangays, and we manage our finances well, covering electricity, maintenance, honoraria, and replacements. (FGD 4)</i>
Community/ barangay involvement and collaboration	<i>Active community participation and transparent communication during meetings were vital to ensure that everyone understood the processes and responsibilities. (FGD 3)</i> <i>We rely on the barangay for support in case of any issues with the water system (FGD 4)</i> <i>One key to our success is maintaining a good relationship with barangay officials (FGD 1)</i>
Value of technological support from Experts	<i>It's crucial to maintain the pumps because once they break down, it's very costly. (FGD 5)</i> <i>Technical knowledge is essential to address problems promptly. (FGD 4)</i>
Importance of strong and clear policies	<i>Implementers realized that strong, clearly communicated policies were essential for the long-term success of the water system. (FGD 3)</i> <i>The Constitution and By-Laws played a crucial role in ensuring that consumers adhered to payment schedules and that the system remained financially sustainable. (FGD 4)</i> <i>Following the rules in the CBL was crucial for smooth operations (FGD 4)</i> <i>They should follow the CBL to ensure long-term operations (FGD 4)</i> <i>The policies and Constitution and By-Laws provided a good foundation (FGD 3)</i>
Be proactive; adjust to policies	<i>Learn to adjust policies and adopt new technology (FGD 5)</i>

and technology	new	<i>The ability to adjust policies, adopt new technologies like improved piping systems, and plan for future expansion (FGD 4)</i> <i>Implementers learned that taking initiative and being proactive in addressing challenges was key to maintaining operations. For example, anticipating the need for backup resources like an additional water pump to ensure long-term functionality and prevent disruptions. (FGD 3)</i>
Maintain cleaning and inspection	regular and	<i>Implementers realized the importance of regular cleaning and inspections to maintain water quality and prevent issues like foul smells. (FGD 4)</i> <i>They emphasized the importance of regular maintenance of pumps and pipelines to prevent costly breakdowns. Addressing issues immediately helps prevent larger, more expensive problems in the future. (FGD 5)</i>
Plan for expansion	future	<i>The increase in households using the system highlighted the need to plan for future expansions and ensure that water sources could meet the growing demand. (FGD 1)</i> <i>We plan to have additional sources of water in the future. (FGD 2)</i> <i>Implementers stress the importance of thinking long-term, with a focus on sustainable management, maintaining infrastructure, and planning for future water sources to ensure continued service for growing communities (FGD 5)</i>

Need for Sustainable and Realistic Practices

To ensure the long-term viability of the water system, stakeholders emphasize the need for a sustainability model with well-defined policies and continuous improvements. This structured approach helps maintain operational efficiency and service reliability.

“Kinahanglan nga sundon ang usa ka modelo sa kalambuan nga adunay klaro nga mga polisiya ug praktis, ug padayon nga ipatuman aron mapauswag kini.” (FGD 1)

One must adhere to a sustainability model with well-defined policies and practices and continuously follow and improve on these policies and practices. (FGD 1)

“Kinahanglan sundon ang mga lagda aron malikayan ang mga problema. Sa asosasyon, kung adunay dili mosunod sa lagda, adunay silot, sama sa pagputol sa tubig. Sa among asembliya, kinahanglan ang 100% attendance. Kadaghanan sa mga reklamo naggikan sa mga wala motambong sa tigum.” (FGD 2)

They must follow the rules to avoid problems. In an association, if rules are not followed, there should be penalties, such as cutting off the water supply. During assemblies, 100% attendance is required. Most complaints come from those who don't attend meetings. (FGD 2)

This mirrors the findings of Thakur (2020), who emphasized that rural water projects must incorporate sustainable and adaptable management practices to ensure longevity. Fischer et al. (2021) also noted that clear policies and sustainability models are critical in addressing both technical and financial challenges.

Financial reserves for emergencies

In maintaining the water portable system, finances must be adequate. The necessity of having financial reserves for unforeseen expenses, such as equipment breakdowns, was a key realization (FGD 4).

"Ang pagbaton og reserbang pondo maoy yawe sa pagmintinar sa sistema. Garbo namo nga ang among bayranan kay usa sa labing ubos kung ikompara sa ubang barangay, ug maayo among pagdumala sa pondo—makabayad sa kuryente, maintenance, honoraria, ug mga ilisanay. (FGD 4)

Having a reserve fund is key to maintaining the system. We are proud that our charges are among the lowest compared to other barangays, and we manage our finances well, covering electricity, maintenance, honoraria, and replacements. (FGD 4).

This finding is consistent with Mandal (2014), who pointed out the need for emergency funds to cover unexpected costs in rural water systems, especially in communities that rely heavily on fragile infrastructure.

Community Involvement and Collaboration

The water system requires sustained operation through active community engagement together with transparent collaboration with barangay officials. The system's maintenance requirements become clear to members when transparency in communication and regular member meetings take place. When community members work together it creates both responsibility and mutual trust among the people.

“Importante ang aktibong partisipasyon sa komunidad ug open nga komunikasyon panahon sa mga miting aron masabtan sa tanan ang proseso ug mga responsibilidad.” (FGD 3)

Active community participation and transparent communication during meetings were vital to ensure that everyone understood the processes and responsibilities. (FGD 3)

Moreover, barangay officials provide essential support in addressing water system challenges.

“Usa sa mga yawe sa among kalamantasan mao ang maayong relasyon sa mga opisyal sa barangay.” (FGD 1)

One key to our success is maintaining a good relationship with barangay officials. (FGD 1)

Implementers recognized that strong relationships with barangay officials and the active participation of community members were crucial for the success and sustainability of the system. This is consistent with the findings of Marks et al. (2014), who highlighted that community engagement fosters a sense of ownership and improves the chances of long-term success for rural water systems.

Value of Technological Support from Experts

Adequate knowledge of technical professionals stands essential for effective water system management and sustainable operations. The specialized expertise of professionals enables organizations to make improved decisions as they develop better maintenance practices for better resolution of technical challenges. The organization acquires improved operational performance through trained personnel who strengthen its ability to implement sustainable management solutions.

“Pasalamat mi karon kay ang mga tawo kay mas na-train na sila ug among manager kay naa siyay knowledge sa water system kay mechanical engineer man siya so mas nakaganar og maayo ang association kay mas knowledgeable siya compared sa mga board of directors.” (FGD 4)

We're grateful now because the people are more trained, and our manager has knowledge about the water system since he is a mechanical engineer. So, the association is benefiting more because he is more knowledgeable compared to the board of directors.” (FGD 4)

“Nakita nako nga dapat ma-sustain ug ma-maintain gyud ang pump. Kay once madaut, dako kaayo pangayunon. Kung madaut, ma-address dayon ang problema.” (FGD 5)

I've observed that the pump must be sustained and maintained because if it breaks, the cost is high. If it breaks, the problem must be addressed immediately. (FGD 5)

The importance of technical expertise for rural water management has gained support from recent scholarly investigations. The combination of engineering expertise within community water projects results in longer lasting systems and lower maintenance expenses as per Smith et al. (2021). The authors of Martinez & Gupta

(2022) advocate for trained personnel in rural infrastructure management because technical training promotes the long-term viability of community-run projects.

Importance of Strong and Clear Policies

The sustainability and effectiveness of a community-managed water system heavily rely on well-defined policies and structured governance. Establishing clear guidelines, such as membership regulations and accountability measures, ensures that the system operates efficiently and fairly. The inclusion of policies in the Constitution and By-Laws (CBL) provides a strong foundation for maintaining order and preventing conflicts within the association.

“Among gihimo nga gibutang sa CBL ang membership. Naa pud sa policy nga bawal mag-connect kung dili member sa association. Kung kinsa maka damage sa linya, siya automatic mag-replace.” (FGD 3)

We included membership in the CBL. There’s also a policy that prohibits connections for non-members of the association. Whoever damages the line must automatically replace it. (FGD 3)

Moreover, a well-structured governance framework also contributes to the long-term success of community projects.

“Kami gyud ang unang nagdumala sa association nga tungod sa pagsunod namo sa polisiya na ilang gi-introduce. Ug gi-introduce pud nila ang paghimo nga pinakamaayo nga Constitution and By-Laws. Didto mi nanukad na i-sustain gyud ang project. Pasalamat pud mi sa amung mga kauban nga opisyaales atong panahon nga ni-cooperate sa pag-sustain sa atong project. Ug naa pud gihimo nga Operation Plan, Sustainability Plan, 5-Year Development Plan mao na amung i-evaluate kung asa nga portion ang wala natuman ug unsa pud ang maayong effect ato.” (FGD 4)

We were the first to manage the association because we followed the policies they introduced. They also taught us to create a strong Constitution and By-Laws. That’s how we learned to sustain the project. We’re also grateful to our fellow officials at the time who cooperated in sustaining the project. We also created an Operation Plan, Sustainability Plan, and a 5-Year Development Plan, which we use to evaluate what hasn’t been achieved and what has worked well (FGD 4)

Research shows that community-managed projects need well-defined governance systems to succeed. Transparency in policies combined with structured planning leads to enduring efficient water supply systems according to Harris et al. (2021). Thompson & Rivera (2022) explain that sustainable local water governance requires organizations to include plans that aid in adjusting to environmental and financial shifts. Uniting research from multiple sources confirms how crucial it is to establish robust policies and governance systems to support sustainable work of community-initiated programs.

Be Proactive: Adjust to Policies and New Technology

Ensuring the sustainability of a community-managed water system requires a proactive approach that includes financial preparedness, technological adaptation, and policy compliance. One of the key strategies is setting aside funds for maintenance and equipment replacement before issues arise. This prevents disruptions in water supply and reduces long-term costs associated with emergency repairs.

“Among plano nga magpondo gyud og water pump para ingkaso madaut ang isa naa dayon ikapuli ug iparewind tong nadaut.” (FGD 4)

We’re planning to set aside funds for a water pump so that if one gets damaged, we can immediately replace it and have the damaged one rewound. (FGD 4)

Water system efficiency depends heavily on adopting new technologies while having solid financial reserves. Research shows that thorough maintenance planning, along with advanced water management solutions, create substantial system resistance capabilities. Remote monitoring systems implemented in community water

projects reduce operational breakdowns and enhance operational performance, according to research by Patel et al. (2023). Predictive maintenance models with integrated systems reduce costs of repairs while guaranteeing water supply stability, according to the research of Dawson & Hughes (2022).

Maintain Regular Cleaning and Inspection

Regular cleaning and inspection are essential in ensuring the long-term functionality and efficiency of water systems. Water system implementers prioritize routine maintenance activities such as tank cleaning, leak monitoring, and sediment removal to enhance water quality and system sustainability.

... naa mi plano nga maghabwa ang sediments sa ilalom aron gwapo ang agas sa tubig. Kung dili maayo ang makina, siyempre ang kuryente dako og kaon. Maapektuhan ang panudlanan. Kailangan alagaan gyud ang source sa tubig. Kay ang mga linya ma-repair man na pero kung ang source ang madiskaril maapektuhan ang tanan apil na ang panudlanan. Nakita nato nga angay gyud i-maintain ang source sa tubig.” (FGD 5)

“... we plan to remove the sediments underground to improve water flow. If the machine isn’t working well, electricity consumption increases, affecting the reservoir. The water source must be taken care of because while the lines can be repaired, if the source is compromised, everything is affected, including the reservoir. We’ve seen that the water source must be maintained.” (FGD 5)

Research supports the importance of proactive maintenance in community-managed water systems. For instance, Johnson et al. (2022) highlight that periodic tank cleaning and pipeline inspections reduce contamination risks and improve system efficiency. Similarly, a study by Carter and Smith (2021) found that preventative maintenance strategies help extend the lifespan of water infrastructure, reducing operational costs and improving service reliability.

Plan for Future Expansion

Sustainable water management needs anticipatory measures to handle rising community demands. Human population growth and increasing water demands have compelled water system implementers to find new water sources that ensure sustainable water security for the long term.

"Naay project ang gobyerno sa bukid, mababa lang to, additional gyud to source sa tubig. Nakita namo nga ang quality sa tubig diri, pinaka-the best gyud kay pila na ka siglo nagaawas ang spring. Daghan tubod didto, crystal ang tubig. Nindot kaayo para sa community." (FGD 1)

“... there’s a government project in the mountains, which will be an additional water source. We’ve seen that the water quality here is the best because the spring has been flowing for centuries. There are many springs there with crystal-clear water. It’s excellent for the community.” (FGD 1)

Studies emphasize the necessity of proactive planning in water resource management. For instance, Herrera et al. (2023) highlight the role of long-term water supply forecasting in ensuring sustainability amidst population growth. Similarly, Patel and Kumar (2021) stress the importance of integrating local water sources with government-initiated projects to enhance community resilience to future water shortages.

Implications for Future Research and Recommendations

Future studies on small-scale rural infrastructure should focus on the long-term sustainability of community-managed projects and the effectiveness of local participation in maintaining accountability, compliance, and maintenance engagement. Research must identify which community involvement strategies yield the highest impact on payment behavior and adherence to maintenance protocols. In addition, investigations should explore how alternative water supply models perform in high-demand areas with limited resources to ensure resilient rural systems.

Technological innovation presents a critical area for further exploration. Future research should assess how tools such as remote monitoring systems, data analytics forecasting, and advanced water treatment

technologies can enhance the efficiency and reliability of rural water systems. Moreover, examining the role of local government units (LGUs) in promoting and sustaining provincial infrastructure initiatives is vital. Studies should analyze how collaboration among LGUs, non-governmental organizations (NGOs), and community-based organizations (CBOs) can overcome financial and logistical barriers to project implementation. Evaluating policies that either support or hinder community cooperation would provide essential insights for improving governance in small-scale projects.

Based on the study's findings, several recommendations are proposed to improve the sustainability of potable water systems in rural areas. The **Department of Public Works and Highways (DPWH)** should design long-term infrastructure plans that anticipate population growth and environmental challenges such as seasonal water fluctuations. Standardized maintenance procedures and regular technical training for local implementers are essential to prevent system breakdowns. The DPWH must also secure sufficient funds through increased budget allocations or partnerships with private and international organizations. Encouraging local ownership and participation will ensure accountability and long-term sustainability.

The **Department of the Interior and Local Government (DILG)** should strengthen LGU capacities through specialized training in project management, financial oversight, and policy implementation. Establishing clear governance mechanisms such as the Constitution and By-Laws (CBL) will help maintain transparency and accountability. The DILG should also facilitate coordination between LGUs, DPWH, and DSWD KALAHI-CIDSS to ensure technical assistance, funding, and policy alignment. Furthermore, the DILG must institutionalize conflict resolution mechanisms and community dialogues to address grievances and maintain cooperation.

The **Department of Social Welfare and Development (DSWD)** should enhance KALAHI-CIDSS implementation by creating targeted training modules that address challenges in financial management, maintenance, and community relations. Strengthened monitoring and evaluation systems will help ensure project alignment with local needs. Integrating best practices such as clear policies, active participation, and collaboration with other agencies will improve rural infrastructure performance.

Lastly, future research should assess the long-term effects of community participation on the efficiency and reliability of rural water systems. Studies should also explore how smart water management and public-private partnerships contribute to system sustainability. These investigations will provide deeper insights into building resilient, efficient, and community-driven rural infrastructure systems that ensure lasting access to clean and reliable water services.

Concluding Remarks

The research presents an overview of the multiple challenges, together with possible remedies, which rural communities confront when they manage small-scale infrastructure projects for safe drinking water systems. Rural communities possess significant potential for better living conditions through water systems although implementing these systems presents multiple implementation challenges. All crucial obstacles regarding limited funding support and maintenance demands, and infrastructure needs will be addressed through national-local partnerships and active community engagement.

Water system sustainability along effectiveness depends heavily on robust governance and policy clarity combined with active community participation, according to research findings. Purely robust infrastructure projects will not satisfy the population needs of expanding communities because essential supporting system components are absent. Locally based government units, through their partnership with DILG must provide technical assistance and training while solving disputes to deliver success in these projects.

The research demonstrates that financial planning and sustainable practices, together with resource allocation, become vital elements for project success. The collected insights will function as a beneficial roadmap that will assist future intervention programs to ensure the durability of rural water systems when confronted with challenges. The research demonstrates the necessity for extensive cooperation between stakeholders to create rural infrastructure development that addresses contextual complexities.

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