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Challenges and Strategies for Sustainable Operation and Maintenance of Water Supply and Sanitation Infrastructure in Bangladesh

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Abstract

Compared to universal access, Bangladesh has made significant strides in achieving high coverage in safe water supply and sanitation, with impressive statistics reflecting safe water access and open defecation-free status. Despite high coverage, a substantial portion of public water infrastructure remains non-functional due to issues such as lack of proper maintenance, absence of community-based operation and maintenance (O&M) systems, and inadequate institutional arrangements. This paper analyzes the underlying factors contributing to these challenges and provides recommendations to enhance the sustainability of water supply and sanitation services in Bangladesh. The study findings highlight the need for improved community engagement, institutional support, monitoring mechanisms, and strategic planning to progress the effective O&M of the country's water and sanitation infrastructure.

Keywords: *Water supply; Sanitation; Infrastructure; Challenges; Strategies; Sustainability.*

1 Introduction

Access to safe water, sanitation, and hygiene is the most basic human need for health and well-being and, therefore, is a basic human right. In 2022, 2.2 billion people still lacked safely managed drinking water, including 703 million without a basic water service; 3.5 billion people lacked safely managed sanitation, including 1.5 billion without basic sanitation services; and 2 billion lacked a basic hand washing facility, including 653 million with no hand washing facility at all(UN SDG,2023). Again, without better infrastructure and management, millions of people will continue to die every year from water-related diseases, and there will be further losses in biodiversity and ecosystem resilience, undermining prosperity and efforts towards a more sustainable. The progress towards United Nations Sustainable Development Goal (UN SDG) 6 is off-tracked globally in general and is alarmingly challenged in several African and Asian regions in particular. While 73 percent of the global population used safely managed drinking water services in 2022, regional coverage ranged from 94 percent in Europe and Northern America to 68 percent in Central and Southern Asia and just 31 percent in sub-Saharan Africa. Achieving SDG targets in low-income countries will require current rates of progress to increase 6, 13, and 16 times for basic water, sanitation, and hygiene and 20 and 21 times for safely managed water and sanitation services (JMP 2023).For keeping UN SDG Goal 6 on track, it is essential to increase sector-wide investment as well as capacity-building. The capacity building may include promoting innovative and evidence-based action, enhancing cross-sectoral coordination and cooperation among all stakeholders, and adopting a more integrated and holistic approach to water and sanitation management system.

Bangladesh has made remarkable progress in achieving high coverage rates in safe water supply and sanitation. According to the JMP report (JMP 2023), in 2022, the basic water supply and sanitation coverage of the country is 98 percent and 59 percent, respectively, whereas the figures are 59 percent and 31 percent, respectively, for safely managed water supply and sanitation system. The sustainability of this achievement is threatened by challenges related to the O&M of the water and sanitation infrastructure. The inadequate O&M also reduces the lifetime of the infrastructure and leads to ineffective initiative of capital expenditure.

For the last 25-30 years, community-operated and managed technologies have been the cornerstone of Bangladesh's policy for ensuring water supply and sanitation (WSS) services, particularly among the marginalized groups. However, the country's experience in the last two decades has been unsatisfactory in terms of the O&M of these technological options by the community (WBB, 2013). Almost 10% of 1.8 million community-based public water supply options such as pond sand filter (PSF), Tara tubewell, rainwater harvesting systems, rural piped water supply, or reverse osmosis (RO) plants became non-functional and remained so(DPHE, 2019). The situation is more aggravated in hard-to-reach areas due to climate change and disaster effects. A similar observation has been made for public and community toilets(Water Aid Bangladesh, 2017). The Department of Public Health Engineering (DPHE), the mandated Government agency for WSS in the country (except for major cities), installs public WSS facilities through different development projects but is not made responsible for O&M and

does not receive any Govt. budget for that. Instead, the role of O&M is divested to user communities who will also bear the associated cost in accordance with the National Policy for Safe Water Supply & Sanitation 1998 (LGD, 1998).
This paper aims to identify and analyze the key challenges faced in the sustainable O&M of water supply and sanitation system in Bangladesh and proposes strategic actions to address these challenges.

2 Challenges in Sustainable O&M

Critical investigation of the consultation reports of users, caretakers, operators, technology providers, government agencies, LGI leaders, and officials (LGD 2022), as well as the experience of focus group discussion during site visits of some non-functional/non-operational water and sanitation system, this paper identifies several challenges that hinder the effective O&M of water supply and sanitation infrastructure in Bangladesh. The significant challenges are:

Community-Based O&M System: The community-based O&M system, which places responsibility on users and local organizations, faces difficulties due to factors like wrong site selection, absence of a community approach, and lack of technical capacity. High-tech options like reverse osmosis (RO) systems lack proper business plans and tariff structuring for sustainability.

Policy and Responsibility: National policies and strategies assign O&M responsibility to user communities but lack proper enforcement and support mechanisms. This approach has limitations, as some technologies require technical expertise beyond community capabilities.

Coexistence of Multiple Technologies: The coexistence of multiple water technologies in the same area leads to reduced ownership and payment behavior among users. This phenomenon impacts the sustainability of individual technologies.

Lack of Institutional Arrangements: The absence of an institutional framework for O&M results in non-functional infrastructure after community-based systems fail. Government funding focuses on infrastructure development, leaving O&M responsibilities unaddressed.

Water Quality Surveillance: Lack of regular water quality monitoring exposes users to health risks, as contamination and deterioration go unnoticed. Current testing practices lack standardization and are inadequate.
O&M Fund: The absence of a dedicated O&M fund for community-based options and lack of budgetary provision for O&M in government projects hinder major repairs and rehabilitation efforts, leading to non-functional infrastructure.

Lack of Standardization: Variations in design and lack of standardization of technological options hinder the development of a spare market and contribute to non-functional infrastructure.

Monitoring and Regulation: Weak monitoring mechanisms and the absence of independent regulatory bodies for water supply and sanitation contribute to non-functional systems and unchecked private sector activities.
Apart from these overall challenges, some technology and WASH-in-institution-specific challenges have been identified through field inspections, focus group discussions, and Key Informant Interviews. The key findings are summarized in Table 1.

Table 1. Technology-specific O&M issues and challenges

Technological options	Challenges and Issues
Tubewell with No.6 hand pump	• A kind of social challenge in O&M is visible due to wrong site selection and allocation of tubewell to individual households instead of group households being practiced in the GoB system. This leads to a lack of ownership and reluctance to pay O&M costs by neighboring households
Tara pump	• Difficult to repair by the caretakers once it is out of order. No skilled workforce is available locally to repair the Tara pump. • Market size is small, and quality spares are not available in the local market

Technological options	Challenges and Issues
Submersible pump	• Extensive use of the submersible pump for water abstraction at individual and community levels makes the Tara pump abandoned and promotes indiscriminate groundwater use. • No mechanism was established to recover the high replacement cost of the submersible pump after the expiry of the warranty period. • Potential conflict among the users of a stand post about sharing electric bills
Ring well	• Vulnerability of the ring wells towards flush flood and landslide and high cleaning and filter repositioning cost (Tk 8-10,000)
Gravity Flow System (GFS)	• Disruption of intake pipeline due to landslide and high filter cleaning cost • Drying of stream source due to destruction of natural forest, where the GFS is abandoned.
Arsenic and Iron Removal Plant (AIRP)	• The cleaning and maintenance of AIRP is difficult. The sand filter frequently becomes clogged by the iron residues, which requires frequent backwashing and cleaning time. • Reluctance of the caretaker to clean the filter media voluntarily and inactive community-based committee for cost recovery
Manually operated and solar PSF.	• Users take water from the tap but don't operate the manual hand pump to extract pond water in the PSF filter. As a result, the filter media becomes dry and no longer functions as filter media. • Absence of community mobilization, O&M system establishment, and orientation in solar PSF
Managed Aquifer Recharge (MAR) Filter	• Water is odorous. • Absence of caretaking due to non-payment of the tariff; No recharge, and water tastes salty and hence no demand for MAR water
Reverse Osmosis (RO) Plant	• Absence of any business plan for operating the RO plant • Unavailability of Technical repairing services locally
Rural piped water scheme	• Lack of technical backstopping in case of community model • Irregular cleaning of OHT and piped network and ensuring water quality. • Wastage of water in non-metering systems and inequity in tariff payment • Breakdown maintenance
Public toilet	• Not hygienic maintenance • Unhygienic pit emptying and sludge disposal. • Septic tank leakage and environmental pollution • Poor facilities and services not friendly to use by females and disabled
WASH in school	• Like primary school, there is no sleep fund allocation for WASH O&M in high schools. No MHM arrangement was found in schools for the girls.
WASH in Community Clinic	• No allocation for WASH maintenance from GoB. Repair and maintenance are done with contribution collection from the patients

3 Sustainable O&M Models

The sector actors demonstrated different water supply and sanitation O&M models in Bangladesh, each showcasing innovative approaches to ensure sustainable water delivery, operation, and maintenance. These models include a government-led management committee scheme, a Union Parishad-operated system, a community-managed pond sand filter initiative, and an enterprise-driven cluster-based water supply program.

Upazila Complex Piped Water Supply Scheme: The first model examined is a piped water supply scheme operated by a management committee within the Upazila complex of Gowainghat, Sylhet. This scheme supplies treated river water to 500-600 households through 55 tap stands. The management committee oversees operations, and users contribute to a shared tariff. The scheme has successfully maintained financial sustainability and ensured water availability through careful management and community participation.

Rural Piped Water Scheme Operated by Union Parishad: The second model involves a piped water supply scheme in Ranihati Union, Chapainawabganj, implemented through the Union Parishad. Arsenic-free water is provided to over 1,500 households, and a software-based billing system is utilized for tariff collection. Despite

initial challenges, the Union Parishad's efforts to improve collection efficiency have led to the scheme operating at a break-even point, benefiting both water supply and revenue generation.

Community Model for Pond Sand Filter (PSF): The third model showcases a community-driven PSF initiative in Kocha village, Dacope. Implemented by an NGO with community contributions, this scheme covers 350 households with a cost-recovery model. An 11-member committee oversees operations, and regular filter maintenance is carried out. This model has demonstrated the potential for local communities to manage their water sources effectively.

Enterprise Model for Cluster-Based Rural Piped Water Supply: The fourth model explores an enterprise-based approach in partnership with a local entrepreneur and an NGO in providing cluster-based water supply. Operational responsibilities lie with the entrepreneur, who receives incentives based on meeting operation and maintenance key performance indicators. This model has leveraged market development to ensure sustainable water delivery.

Pani Paridarshak Mechanic Model: Lastly, the paper examines the Pani Paridarshak model employed by Union Parishad in Jhikorgacha Upazila. This mechanic is responsible for various WASH-related services, including maintenance and service charge collection. The model's success indicates its potential for replication in other regions.
The comparative assessments of the studied water supply and sanitation O&M models in Bangladesh are presented in Table2.

Table 2. Different aspects of the O&M models

O&M Models	Technological options	Operation	Maintenance	Management	Sources of funds for O&M
Upazila Complex Piped Water Supply Scheme	Piped water supply system	Appointed caretaker	Private technicians (overall) and designated household at tap-stand	Management committee headed by UNO	Monthly tariff and beneficiaries' initial contribution fees
Rural Piped Water Scheme Operated by Union Parishad	Piped water supply system	Appointed staff	Appointed staff	Union Parishad (UP)	Ring-fencing account
Community Model for Pond Sand Filter (PSF)	Pond Sand Filter	Appointed caretaker	Appointed caretaker	Users' committee (community-managed)	Users' regular deposit for cost-recovery
Enterprise Model for Cluster-Based Rural Piped Water Supply	Piped water supply system	Local entrepreneur	Local entrepreneur	NGO and local entrepreneur	Tariff and KPI-based incentives
PaniParidarshak Mechanic Model	Tubewell and other water points	User/Community	Mechanic employed by UP	Union Parishad (UP)	Monthly charge for services

The water supply and sanitation O&M models used in Bangladesh have also been judiciously analyzed for strengths, weaknesses, opportunities, and threats (SWOTs) and presented in Table 3.

Table 3. SWOTs analysis of different O&M models

Upazila Complex Piped Water Supply Scheme	**Strengths**	**Weaknesses**
	• Affordable Tariff (BDT 300 per month per tap stand) • Involvement of households in repair and maintenance, fostering a sense of ownership. • The oversight by a central management committee ensures accountability and effective governance. • Technical support by DPHE enhancing the scheme's operational efficiency. • Financial Reserve by user contributions creating a safety net for unforeseen maintenance needs	• Shared caretaking responsibility by the household on a rotational basis may lead to variations in commitment and accountability. • Piped water is supplied only twice a day, which may not meet the round-the-clock water needs of households, potentially leading to water scarcity and reliability.
	Opportunities	**Threats**
	• Explore ways to increase the supply frequency or improve the water treatment process. • Promoting the benefits of regular O&M among users can enhance the overall effectiveness of the scheme.	• Adverse weather conditions, such as droughts or floods, can affect the O&M frequency and requirements. • Increased connections and use without infrastructure improvements could reduce the system's effectiveness. • Dependence on user contributions for major repairs could pose a financial risk if contributions are insufficient to cover unexpected costs.
Rural Piped Water Scheme Operated by Union Parishad	**Strength**	**Weakness**
	• Provides arsenic-free safe water to households in an arsenic-affected area. • Successful operation by the Union Parishad (UP) for six years. • Direct house connections and metered billing systems enhance accountability. • Plans to introduce a surface water treatment system for further improvement. •	• Previous poor collection rate led to outstanding debts. • Dependency on UP for operation and maintenance. • Limited production capacity might not meet the growing demand.
	Opportunities	**Threats**
	• Potential for expansion and inclusion of more production wells. • Improvement in collection rates. • The introduction of surface water treatment can enhance water quality.	• Financial sustainability challenges. • Risk of water contamination or supply interruptions. • Competition from alternative water sources.
Community Model for Pond Sand Filter (PSF)	**Strength**	**Weakness**
	• Active community participation and engagement. • Reliable source of safe water in a water-stressed area. • Cost recovery model ensures financial sustainability. • No reported technical or social challenges.	• Limited coverage (350 households). • Vulnerable to external factors like extreme weather conditions.
	Opportunities	**Threats**

	• Potential for replication in other water-stressed areas. • Expansion of coverage to serve more households.	• Dependence on the involvement of the community for long-term sustainability. • Competition from other water supply options.

Enterprise Model for Cluster-Based Rural Piped Water Supply		
	Strength	**Weakness**
	• Incentivizes local entrepreneurs for proper O&M. • Co-investment by local entrepreneurs promotes accountability. • Engagement of certified partners for more extensive repairs. • Potential for scaling up with successful replication.	• Reliance on the effectiveness of local entrepreneurs. • Risk of entrepreneurs failing to meet O&M KPIs. • Potential challenges in co-investment.
	Opportunities	**Threats**
	• Scaling up to serve more rural communities. • Attraction of additional local entrepreneurs.	• The financial risk to local entrepreneurs if the scheme fails. • Competition from other water supply models.

Pani Paridarshak Mechanic Model		
	Strength	**Weakness**
	• Mechanic services for community water devices. • Registration, monitoring, and technical support provided. • High potential for replication in other regions. • Service charge collection ensures sustainability.	• limited to specific areas. • Potential dependency on the availability of mechanics.
	Opportunities	**Threats**
	• Expansion to cover more areas and water devices. • Collaboration with other organizations for scalability.	• Limited availability of skilled mechanics. • Competition from alternative service providers.

On the critical analysis of the challenges that arise in the sustainable O&M of the water and sanitation infrastructure and the SWOTs assessment of different water supply and sanitation O&M models in Bangladesh, this paper proposes the following strategic actions:

4 Strategic Actions

Community-Based O&M System:

- Adopt a community approach for site selection and O&M responsibility assignment.
- Integrate community mobilization, demand creation, and capacity building into project design.
- Implement orientation and capacity-building programs for community caretakers.
- Establish institutional arrangements for O&M of technologies beyond community capacity.
- Encourage the private sector to provide local technical support.
- Develop a market mechanism for quality spares and components.

Standardization and Innovation:

- Incentivize technological innovation and upgrade designs.
- Facilitate joint research and development efforts involving manufacturers and market actors.
- Standardize designs of nationally available technologies.

Monitoring and Service Regulation:

- Establish clear distinction between policy, regulation, and service delivery roles.
- Shift DPHE/LGIs from service delivery to monitoring/regulatory roles.
- Engage WatSan Committees in monitoring WASH activities.
- Develop a comprehensive database for effective sector monitoring.

Repair and Rehabilitation:

- Undertake projects for repair and rehabilitation of non-functional WASH facilities.
- Integrate rehabilitation components into new WASH investment projects.

Institutional Linkage in Urban Slums:

- Establish institutional linkage between WASA/City Corporation and CBOs for WASH O&M in urban slums.
- Maintain NGO-controlled CBO WASH funds with limited WASA/City Corporation involvement.

5 Conclusion

Compared to global access, Bangladesh's achievements in safe water supply and sanitation are remarkable. However, the sustainability of these achievements hinges on effective O&M of safe water supply and sanitation system. To address these challenges, a comprehensive approach is required that should involve improved community engagement, policy reform, institutional strengthening, as well as standardization. The implementation of these recommended strategic actions will definitely help to advance the effective O&M of the country's water and sanitation infrastructure, leading to improved public health and overall well-being.

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