

Functionality of Community Managed DWSS: A Case Study of Water Supply Schemes in Simta Rural Municipality, Surkhet, Nepal

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Abstract

Community-managed drinking water supply systems (DWSS) constitute the backbone of rural water service delivery in Nepal. Despite substantial investments and high nominal coverage, the long-term functionality of these systems remains a persistent challenge. This study assesses the functionality status of community-managed DWSS and identifies key factors influencing their performance in Simta RM of Surkhet District, Nepal. A mixed-methods approach was adopted, combining a quantitative scheme-level survey of ten water supply schemes with focus group discussions, key informant interactions, and field observations. Functionality was evaluated using nationally recognized indicators encompassing technical, environmental, institutional, and financial dimensions, while influencing factors were ranked using a RII based on Likert-scale responses. The results indicate that 70% of the surveyed schemes were at no or low risk of functionality failure, 20% were at some risk, and 10% were at high risk. Institutional and financial factors—particularly the activeness of UCs, availability of O&M funds, and presence of trained VMWs—were found to exert the strongest influence on functionality, followed by technical and environmental factors. The findings highlight that physical infrastructure alone does not ensure sustainable service delivery; rather, continuous post-construction support, transparent governance, and adequate financing mechanisms are critical. The study concludes with policy-relevant recommendations aimed at strengthening community management, enhancing post-construction support, and improving the long-term sustainability of rural water supply services in Nepal.

Keywords: Water Supply, Community Managed DWSS

1. Introduction

Insufficient access to clean water remains a significant global public health challenge, responsible for waterborne diseases such as diarrhea, dysentery, and cholera. Despite advancements, 2.2 billion people worldwide still lack safely managed drinking water [3]. The associated mortality is substantial, with one 2020 study estimating approximately 829,000 annual deaths globally from unsafe water. In South Asia, over 134 million people lack access to clean water; notably, Nepal's access rate had reached 89% by 2019, though national averages may mask disparities. However, community water schemes in Nepal face challenges like technical issues, gender equity, cost recovery, and institutional problems. These issues often result in poor service and unsustainable development. The study suggests managing operation and maintenance funds after project implementation and providing training for water committees before project handover [2].

Nepal, a small landlocked country in South Asia between India and China, has a population of 29.16 million and covers an area of 147,516 sq km. It was divided into seven provinces, 77 districts, 753 municipalities, and rural municipalities. Access to clean drinking water and sanitation is considered a fundamental human right in Nepal, with 87.88 percent of the population having access to basic drinking water through pipes, tube wells, and protected sources [1].

2. Materials and Methods

2.1 Study Area

The study was conducted in water supply schemes of Simta RM, located in Surkhet District of Karnali Province, Nepal. The municipality is characterized by hilly terrain, dispersed settlements, and a predominantly rural population reliant on gravity-fed and lift-based community-managed DWSS. Wards 5, 6, and 7 were selected for detailed study due to their relatively high concentration of WSS and semi-urban characteristics.

2.2 Research Design and Data Collection

A cross-sectional mixed-methods research design was adopted. Primary quantitative data was collected through a structured scheme-level survey administered to ten community-managed DWSS. The survey captured information on technical conditions, environmental conditions, institutional arrangements, financial management, and service delivery performance. Qualitative data was gathered through focus group discussions with water users, interactions with WUCs, and direct field observations of system components.

Secondary data were reviewed from municipal records, NwASH, national water sector reports, and relevant policy documents to contextualize field findings.

2.3 Functionality Assessment Framework

The functionality of DWSS was assessed using a nationally recognized functionality scoring framework. Indicators were grouped into:

- **Result indicators (60%)**, comprising outcome indicators (population served by functional taps) and output indicators (functionality of taps in terms of quantity, quality, and supply duration), and
- **Input indicators (40%)**, including institutional and technical conditions such as availability of trained Village Maintenance Workers, adequacy of tools, reliability of water sources, and physical condition of system components.

Based on the composite functionality score, schemes were classified as having no or low risk (≥ 70), some risk (60–69), or high risk (< 60) of functionality failure.

2.4 Analysis of Influencing Factors

Factors affecting functionality were analyzed using a five-point Likert scale. Responses were converted into a RII to rank factors across technical, institutional, financial, social, and environmental dimensions. Descriptive statistics and comparative analysis were used to interpret patterns and relationships.

3. Results

3.1 Overall Functionality Status of DWSS

The composite functionality assessment shows considerable variation across the surveyed schemes. Based on the nationally recognized functionality scoring framework, 70% of the schemes were classified as having no or low risk of functionality failure (score ≥ 70), 20% were categorized as having some risk (score 60–69), and 10% were identified as being at high risk (score < 60). Schemes with higher scores consistently demonstrated stronger institutional arrangements and more reliable operation and maintenance practices.

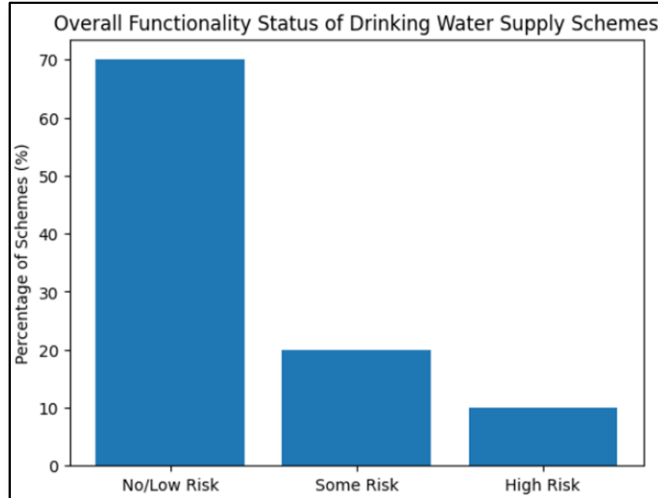


Figure 1. Overall functionality status of surveyed drinking water supply schemes in Simta RM.

3.2 Technical Performance of DWSS.

The technical assessment focused on water source reliability, physical condition of major structures, and pipeline integrity. Most schemes were gravity-fed systems dependent on spring sources. Seasonal variation in discharge was reported in several schemes, particularly during the dry season, affecting service continuity.

Field observation revealed that most intake structures, reservoirs, and distribution chambers were in fair to good condition; however, minor structural defects and leakage in conveyance pipelines were common. Schemes with routine inspection and preventive maintenance reported fewer service disruptions.

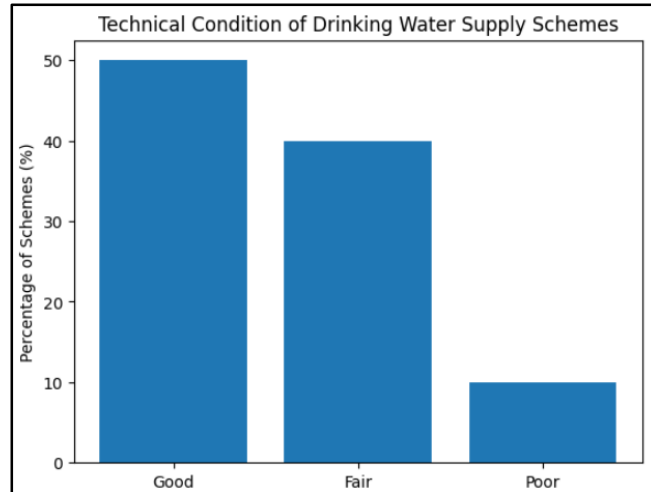


Figure 2. Physical condition of major components of drinking water supply schemes.

3.3 Institutional and Financial Status

Institutional performance emerged as a defining determinant of scheme functionality. Active WUCs with regular meetings, updated records, and transparent decision-making processes were associated with higher functionality scores. The presence of trained VMWs further enhanced system reliability by enabling timely repairs.

Financially, schemes that consistently collected water tariffs and maintained dedicated O&M funds demonstrated greater resilience. In contrast, schemes with irregular tariff collection experienced delayed repairs, leading to gradual deterioration of infrastructure.

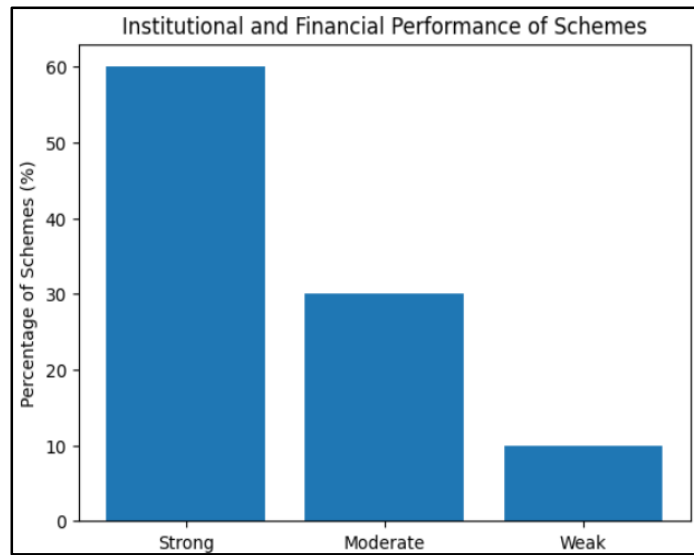


Figure 3. Institutional and financial performance indicators of surveyed drinking water supply schemes.

3.4 Environmental Factors Influencing Functionality of DWSS.

Environmental conditions play an important role in the performance and sustainability of drinking water supply systems. Factors such as climate variability, rainfall patterns, seasonal fluctuations, and extreme weather events directly affect water availability, quality, and system reliability. Areas prone to flooding, drought, or landslides often face disruptions in water infrastructure, while high temperatures and evaporation can reduce storage capacity and water pressure. Additionally, soil characteristics, topography, and natural contamination sources like salinity or mineral deposits can influence the design, operation, and maintenance needs of water supply systems.

Human-induced environmental changes also significantly impact system functionality. Deforestation, urbanization, and improper land use can increase sedimentation, runoff, and pollution in water sources, requiring additional treatment and monitoring. Pollution from agriculture, industry, and domestic waste can compromise water quality, pose health risks and increase operational costs. Understanding both natural and anthropogenic environmental factors is essential for planning resilient water supply systems, ensuring consistent access, and maintaining long-term functionality.

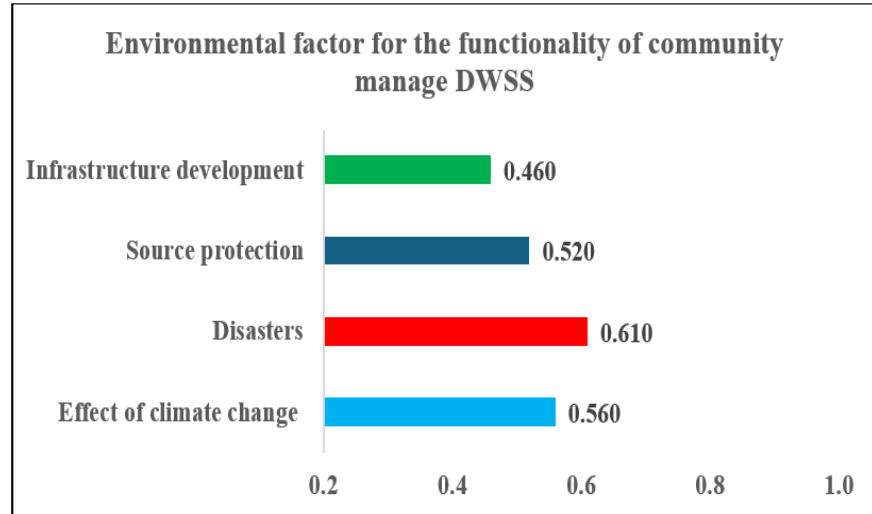


Figure 4. Environmental factors influencing the functionality of DWSS

3.5 Factors Influencing Functionality

Respondents evaluated multiple factors influencing functionality using a five-point Likert scale. RII analysis revealed that institutional factors ranked highest, followed by financial, technical, environmental, and social factors. Key institutional drivers included activeness of WUCs, transparency in fund management, and availability of trained maintenance personnel. Environmental factors such as climate variability, source depletion, and landslide risks were particularly significant for schemes located in vulnerable terrain.

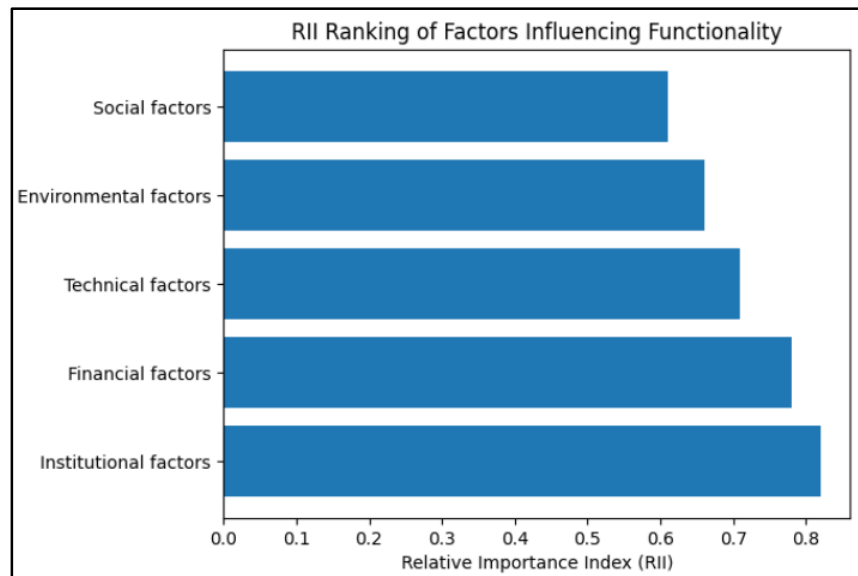


Figure 5. RII ranking of factors influencing functionality of DWSS.

4. Discussion

The functionality assessment of community-managed drinking water supply schemes in Study area provides important insights into the determinants of sustainable rural water services in Nepal. Although most schemes were found to be at no or low risk of failure, the presence of schemes at some high risk highlights persistent structural weaknesses that extend beyond physical infrastructure.

4.1 Role of Institutional Capacity

Institutional capacity emerged as the most influential factor affecting functionality, as reflected by the highest RII scores. Schemes with active WUC, regular meetings, transparent record-keeping, and clearly defined roles were consistently more functional. This finding is consistent with national assessments which emphasize that weak governance and limited managerial capacity are primary causes of scheme underperformance in Nepal's rural water sector.

The presence of trained VMWs significantly enhanced system reliability by enabling timely identification and resolution of technical issues. In contrast, schemes lacking trained personnel often experienced prolonged service interruptions, even when infrastructure conditions were otherwise adequate. These findings reinforce the argument that post-construction institutional support is as critical as initial capital investment.

4.2 Financial Sustainability and Operation & Maintenance Fund

Financial sustainability was identified as the second most critical determinant of functionality. Schemes with regular tariff collection and dedicated operation and maintenance funds demonstrated higher resilience and faster response to system breakdowns. This aligns with previous studies in Nepal and comparable low-income country contexts, which report that inadequate O&M financing is a leading cause of premature scheme failure.

In Simta Rural Municipality, reluctance to revise tariffs and irregular fee collection were observed in less functional schemes, often due to concerns over affordability and social acceptability. While such concerns are valid, failure to recover basic O&M costs ultimately undermines service reliability and equity. Strengthening financial literacy and promoting transparent public auditing could help improve community willingness to contribute financially.

4.3 Technical and Environmental Considerations

Although technical factors ranked below institutional and financial factors, they remain essential for sustained service delivery. Seasonal variability in spring discharge and minor structural defects were common challenges, particularly during the dry season. Schemes that implemented routine preventive maintenance experienced fewer technical failures, underscoring the importance of proactive rather than reactive management approaches.

Environmental factors such as climate variability, source depletion, and landslide risks were particularly relevant in the hilly terrain of Simta Rural Municipality. These findings suggest that functionality assessments should increasingly integrate climate resilience considerations, including source protection measures and contingency planning.

4.4 Implications for Policy and Practice

The findings have significant implications for National Water Supply, Sanitation, and Hygiene (WASH) Management Information System. While local governments are mandated to ensure sustainable water services, their technical and financial capacities remain uneven. The study highlights the need for structured post-construction support mechanisms, including regular monitoring, technical backstopping, and institutional capacity building for Water Users' Committees.

Overall, the results reaffirm that achieving sustainable rural water supply requires a shift from an infrastructure-focused approach to a service delivery-oriented model, where governance, financing, and long-term support are prioritized alongside physical construction.

5. Conclusions

This study assessed the functionality of community-managed DWSS in Simta RM, Surkhet District, and identified key factors influencing their long-term performance. While most schemes were found to be functional with no or low risk of failure, a notable proportion remained vulnerable due to institutional and financial weaknesses.

The findings clearly demonstrate that functionality is not determined solely by physical infrastructure. Strong institutional arrangements, active WUCs, availability of trained VMWs, and reliable operation and maintenance financing are decisive for sustaining rural water services. Technical condition and environmental factors further influence performance, particularly in the context of seasonal water scarcity and climate-related risks are increasing pattern.

To enhance sustainability, it is recommended that local governments prioritize structured post-construction support, including regular monitoring, capacity building of user committees, and technical backstopping. Establishing transparent tariff systems and promoting public auditing practices can strengthen financial sustainability and community trust. Integrating climate resilience measures into scheme design and management is also essential for ensuring long-term service reliability.

Overall, the study contributes empirical evidence to the growing body of literature emphasizing a transition from infrastructure-focused interventions to service delivery-oriented approaches in rural water supply. The insights generated are directly relevant for policymakers, practitioners, and development partners working to achieve sustainable and equitable DWSS in Nepal.

References

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