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Evaluation of Customer Service and Performance in Community-Managed Water Supply Systems in Jhapa District, Nepal

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ABSTRACT

Ensuring access to clean and safe drinking water is a fundamental human right, particularly in developing countries where centralized infrastructure is limited. In Nepal, community-managed water supply systems play a crucial role in providing water services to rural and peri-urban areas. This study aims to evaluate the satisfaction of customer based on five community-managed water supply systems in Jhapa District, Nepal, focusing on key performance indicators such as service coverage, water quality, and user satisfaction. Data was collected from five community-managed water supply systems: Pathivara-Lakhanpur, Gauradaha, Goldhap, Shree Bhawani, and Baniyani. The analysis focused on service coverage, and water consumption. Service coverage varied significantly across the systems, from 42.38% in Baniyani to 98.49% in Shree Bhawani, with an average coverage of 67.9%. Water Consumption Per capita water consumption was below the national standards, averaging 18.58 Liters Per Capita per Day (LPCD), with Shree Bhawani having the highest at 21.92 lpcd and Goldhap the lowest at 13.7 lpcd. Satisfaction levels varied, with Goldhap achieving the highest satisfaction rate of 93.94% and Shree Bhawani the lowest at 78.69%. On average, 86.45% of users were satisfied. The performance of community-managed water supply systems in Jhapa District varies significantly. While most systems perform well in terms of user satisfaction, service coverage.

Keywords: community-managed, service coverage, water quality, user satisfaction, financial sustainability

Introduction

Access to clean and safe water is a fundamental human right recognized by the United Nations (UN) and plays a critical role in ensuring public health, social well-being, and economic development (Joshi et al., 2020). In many developing countries, including Nepal, water supply systems are predominantly managed by communities through various community-managed approaches (Mishra, 2021; Mishra et al. (2022). These community-based systems have been instrumental in providing water services to rural and peri-urban areas where centralized infrastructure is limited. However, the effectiveness and sustainability of these systems are often uncertain, leading to challenges in providing reliable water services to the population. .

Against this backdrop, this thesis aims to conduct a comprehensive performance analysis of community-managed water supply systems in Jhapa. Jhapa District is selected as the study area due to its unique characteristics, including a significant reliance on community-managed systems and ongoing discussions regarding the potential involvement of the private sector and the government in water supply management. By examining the performance indicators of these systems, such as reliability, availability, affordability, and water quality, this research will provide valuable insights into the strengths and weaknesses of community-based approaches. Mishra (2018) conducted a sustainability and risk assessment of the Salyankot water supply project in Nepal, focusing on its performance in the post-earthquake scenario. The study highlighted the importance of integrating risk management strategies to enhance the resilience and sustainability of water supply systems in disaster-prone areas (Joshi et al., 2009).

In their exploration of urban poor experiences, Joshi et al. (2009) highlight the challenges of access to health, hygiene, and sanitation in urban areas. Their findings suggest that the lack of adequate water supply significantly impacts both public health and the perceived reliability of water services, especially in marginalized communities.

Ferguson et al. (2018) offer an overview of water supply and sanitation services in Uganda, examining the regulatory and policy frameworks that shape service delivery. Their work emphasizes the need for strengthening institutional capacity and improving management practices to enhance the performance of water supply systems, particularly in resource-constrained settings.

Brown et al. (2009) focus on urban water management, discussing the evolution of water management strategies from historical to contemporary approaches. Their research underscores the importance of adaptive management practices that incorporate both technological and social dimensions to improve water supply in growing urban areas.

In their literature review, Whittington et al. (2014) assess various financing models for urban water and sanitation services. They suggest that finding sustainable funding mechanisms is critical to maintaining high-performing water supply systems, particularly in developing regions where financial resources are limited. .

Reed (2008) discusses the role of stakeholder participation in environmental management, emphasizing the need for inclusive decision-making in water supply management. This participatory approach, which includes community members, is vital for ensuring that water systems meet local needs and are sustainable in the long term.

Fewtrell and Colford (2005) conducted a meta-analysis on water, sanitation, and hygiene interventions, demonstrating the significant health benefits of improving water supply systems. Their findings suggest that improving water quality and sanitation can substantially reduce waterborne diseases, thereby enhancing overall water supply performance

Yasmin et al. (2024) evaluate the impact of community participation on the sustainability of rural water supply systems in India. They find that community engagement is crucial for ensuring the longevity and effectiveness of rural water systems, as local involvement leads to better maintenance and operation of water supply infrastructure.

Kooy and Bakker (2008) examine the role of governance in shaping water supply infrastructure, specifically in Jakarta. Their research emphasizes the importance of government and private sector collaboration in the provision of water services, while also addressing the socio-political dynamics that influence water supply management.

Mekonnen et al. (2011) focus on the water footprint of export cut flowers from Kenya's Lake Naivasha Basin. They provide insights into the environmental impact of water use in agricultural production, underlining the importance of managing water resources to balance economic and environmental concerns in areas dependent on agriculture for water supply.

In his work, Mishra (2019) assessed the institutional performance of water supply systems, emphasizing that effective governance and management practices are crucial for improving service delivery and customer satisfaction in community-managed water projects.

Mishra (2019) also explored financial assessments within drinking water supply systems, identifying key financial indicators that impact the sustainability and efficiency of water services. This analysis underscores the necessity for sound financial planning to ensure long-term viability in water supply projects.

In a later study, Mishra (2021) evaluated the transformation of grid electric-powered pumping systems into solar-powered alternatives. This research contributes to discussions on renewable energy integration in water supply projects, promoting sustainable practices that reduce operational costs and environmental impacts.

Mishra and Acharya (2018) provided a performance assessment of the Salyankot water supply project, revealing insights into operational challenges and user satisfaction levels post-disaster. Their findings advocate for continuous monitoring and adaptive management strategies to improve service reliability.

The status assessment of life cycle costing in Baitadi Town's water supply project by Mishra and Shrestha (2020) highlight the importance of comprehensive cost analysis for effective resource allocation and project sustainability. Their work emphasizes that understanding life cycle costs can lead to better financial decision-making in water supply management.

Mishra et al. (2019) assessed the performance of functional and partially functional water supply systems in Sunsari District, providing critical data on system efficiency and user access. This research serves as a basis for improving operational practices in community-managed systems.

In their study, (Mishra et al., 2022) evaluated existing water supply systems, identifying performance gaps and suggesting improvements to enhance service delivery. Their findings contribute valuable insights into optimizing operational efficiency within Nepal's water supply sector.

Lastly, Mishra et al. (2022) examined electric-connected pumping projects in Gandaki Province, assessing their operational status and sustainability. The study calls for strategic investments in infrastructure to ensure reliable water access for communities.

Problem Statement

The satisfaction level was positively related to factors such as water quality, hours and timings of supply, tap pressure, and responsiveness of management as Mishra (2018) and Mishra et al. (2019) highlighted the importance of institutional performance assessment in water supply systems, which can impact customer satisfaction by ensuring effective management and service delivery. Additionally, financial assessments and life cycle costing are crucial for maintaining sustainable water supply systems, which indirectly affect customer satisfaction by ensuring consistent service provision. However, specific studies on customer satisfaction in the context of water supply project of community-managed water supply systems remain uncertain, posing significant obstacles in ensuring consistent access to clean and safe water for the local communities.

Research Objective

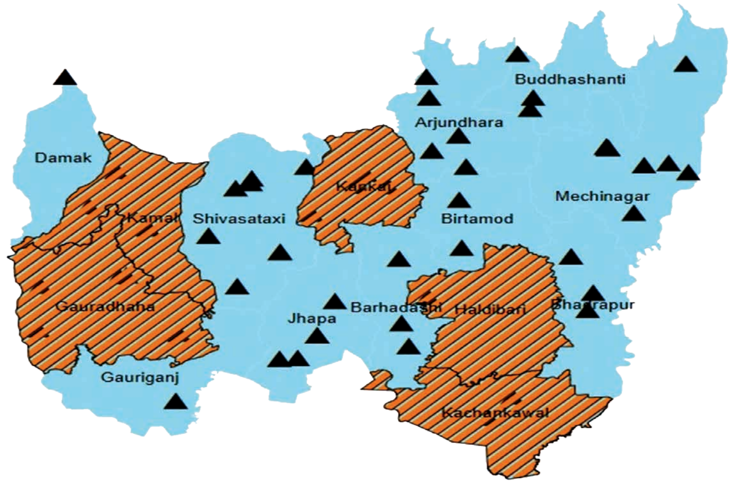
The general objective of this research is to conduct a comprehensive analysis of community-managed water supply systems in Jhapa to ensure customer satisfaction from water supply system.

Methodology

This study employed a mixed-methods approach to assess the performance of community-managed water supply systems in Jhapa District. Five water supply and sanitation projects were selected to represent the district's diverse conditions: Pathivara-Lakhanpur, Gauradaha, Goldhap, Shree Bhawani (Durgapur), and Baniyani (Kachankawal).

Figure 1

Location Map



Data Collection

Key Informant Interviews

In-depth interviews were conducted with community members, Water Supply User Committee (WSUC) representatives, government officials, and private sector actors to gather qualitative insights into system functioning and challenges. Purposive sampling ensured representation from various stakeholder groups.

Household Surveys

Structured questionnaires (n=66 for four projects, n=61 for Shree Bhawani) were administered to households using systematic random sampling. Yamane's formula was used to determine sample size at a 90% confidence level. The questionnaire assessed customer satisfaction, water usage, affordability, and perceived water quality (See Set-3 in Appendix for questionnaire details).

Focus Group Discussions (FGDs)

FGDs (8-10 participants each) were conducted with water users from diverse socioeconomic backgrounds to gain detailed insights into system performance, including technical issues, financial management, and customer satisfaction. Discussions were guided by a semi-structured approach, and thematic analysis was used to identify common issues.

Data Analysis

Quantitative data from the household surveys and water quality testing were analyzed using descriptive statistics. The Content Validity Index (CVI) and Cronbach's alpha were used to validate the questionnaire. Performance indicators (PIs) were calculated to assess technical and institutional performance. The formula for the number of respondents in the questionnaire survey was determined by using Yamane's formula:

$$(n) = \frac{N}{1+Ne^2}$$

Technical Performance Indicators

Keremane et al. (2019) discusses key performance indicators used to evaluate water supply systems, particularly in small towns. The paper focuses on how these indicators can be used to assess the efficiency of customer supply and improve water services in small and rural areas.

Service Coverage

$$= \frac{\text{Number of Households with Access to Water Supply}}{\text{Total Number of Households}}$$

Average Water Supply Duration

$$= \frac{\left(\frac{\text{Total Hours of Water Supply}}{\text{Number of Days}}\right)}{24}$$

Water Consumption per Capita

$$= \frac{\text{Total Water Consumption}}{\text{No. of People}}$$

Production Population (m^3/Person/Day)

$$= \frac{\text{Annual Productive Volume}}{\text{Number of People Served} \times 365}$$

Extent of Metering Connection (%)

$$= \frac{\text{Total Number of Taps connected with Operating Meters}}{\text{Total Number of Taps Cnnections}} \times 100$$

Customer Satisfaction Index

$$= \left(\frac{\text{Number of Satisfied Respondents}}{\text{Total Number of Respondents}}\right) \times 100$$

Equity Index

$$= \frac{\text{Number of People Served in a Specific Socioeconomic Group}}{\text{Total Population}} \times 100$$

Resource Availability Ratio

$$= \frac{\text{Resource of Capacity } (m^3)}{\text{Average Daily Transmission Input } (M^3)}$$

Qualitative data from key informant interviews and FGDs were analyzed using thematic analysis to identify key themes and patterns related to the performance of community-managed water supply systems.

Results and Discussions

Service coverage

Percentage of the population with access to the water supply systems.

$$= \frac{\text{Number of Households with Access to Water Supply}}{\text{Total Number of Households}}$$

Table 1

Service Coverage Ratio

SN	Name of Water Supply Project	Total Number of Households (A)	No of Household With access to Water Supply(B)	Service Converge (B/A)*100
1	Pathivara-Lakhanpur Water Supply Project	1950	1500	76.92
2	Gauradaha Water Supply Project	1738	1690	97.24
3	Goldhap Water Supply Project	1701	920	54.09
4	Shree Bhawani Water Supply Project	530	522	98.49
5	Baniyani Water Supply Project	2400	1017	42.38
	Total	8319	5649	67.90

From the data collected from the all 5 water supply project. Shree Bhawani Water Supply System has highest service coverage of 98.49% whereas Baniyani Water supply system has lowest service coverage of 42.38%. The average service coverage of these water supply system is 67.90%.

Average Water Supply Duration

These indicators measures the customer service level provided by water supply systems. It is the No. of hours the costumer gets the water in their taps. In all of the water supply system studied water is available 24 hours a day.

Water consumption per capita: Average water consumption per person in liters per day.

$$= \frac{\text{Total Water Consumption}}{\text{No. of People}}$$

Table 2

Per Capita Consumption

SN	Name of Water Supply Project	Total Volume of Water Sold in m_3 (A)	Number of People Served (B)	Per Capita Consumption= (A/B)*(1000/365)
1	Pathivara-Lakhanpur Water Supply Project	39000	6000	17.81
2	Gauradaha Water Supply Project	50700	6760	20.55
3	Goldhap Water Supply Project	18400	3680	13.70
4	Shree Bhawani Water Supply Project	16704	2088	21.92
5	Baniyani Water Supply Project	28476	4068	19.18
	Total	153280	22596	18.58

Shree Bhawani Water supply system have the highest per capita consumption of 21.92 lpcd whereas all of the water systems have similar water consumption rate. Due to presence of Tube well in each household, people only used the water from water supply project for drinking use. The average per capita consumption is found to be 18.58 lpcd. Which is below then the standard for urban areas of 100 lpcd of water.

Production Population

This indicator analyze the how effectively water resources are used overall. It is the ratio of Annual total volume of water produced and the annual total population served.

$$= \frac{\text{Annual Productive Volume}}{\text{Number of People Served} \times 365}$$

Table 3

Production Population

SN	Name of Water Supply Project	Annual Production Volume (m^3)	No. Of People Served	Production Population(m^3/ person/day)
1	Pathivara-Lakhanpur Water Supply Project	63875	6000	0.029
2	Gauradaha Water Supply Project	93440	6760	0.038
3	Goldhap Water Supply Project	63875	3680	0.048
4	Shree Bhawani Water Supply Project	63875	2088	0.084
5	Baniyani Water Supply Project	63875	4068	0.043
	Total	348940	22596	0.042

$$\textit{Extent of Metering Connection} = \frac{\text{Total Number of Taps connected with Operating Meters}}{\text{Total Number of Taps Connections}} \times 100$$

Table 4

Extent of Metering

SN	Name of Water Supply Project	Total Taps with Operating Meters	Total No. of Tap Connection	Extent of Metering of Connections(%)
1	Pathivara-Lakhanpur Water Supply Project	1500	1500	100
2	Gauradaha Water Supply Project	1690	1690	100
3	Goldhap Water Supply Project	920	920	100
4	Shree Bhawani Water Supply Project	522	522	100
5	Baniyani Water Supply Project	1017	1017	100

Customer satisfaction index

Measured through surveys or feedback mechanisms

$$= \left(\frac{\text{Number of Satisfied Respondents}}{\text{Total Number of Respondents}}\right) \times 100$$

Table 5

Costumer Satisfaction Index

SN	Name of Water Supply Project	Total Number of Respondents (A)	Number of Satisfied Respondents (B)	Costumer Satisfaction Index (B/A)*100
1	Pathivara-Lakhanpur Water Supply Project	66	57	86.36
2	Gauradaha Water Supply Project	66	60	90.91
3	Goldhap Water Supply Project	66	62	93.94
4	Shree Bhawani Water Supply Project	61	48	78.69
5	Baniyani Water Supply Project	66	55	83.33

Equity Index

Examining whether the water supply services are distributed equitably among different socioeconomic groups.

$$= \frac{\text{Number of People Served in a Specific Socioeconomic Group}}{\text{Total Population}} \times 100$$

Table 6

Equity Index

SN	Name of Water Supply Project	Total Population (A)	Number of people Served In Specific Socioeconomic Group(B)	Equity Index (B/A)*100
1	Pathivara-Lakhanpur Water Supply Project	1950	0	0
2	Gauradaha Water Supply Project	1738	0	0
3	Goldhap Water Supply Project	1701	0	0
4	Shree Bhawani Water Supply Project	530	0	0
5	Baniyani Water Supply Project	2400	0	0

Resource Availability Ratio

It is the ratio of Resource capacity of the watersupply project and average daily water consumption.

$$= \frac{\text{Resource of Capacity } (m^3)}{\text{Average Daily Transmission Input } (M^3)}$$

Table 7

Resource Availability Ratio

SN	Name of Water Supply Project	Resource Capacity (m^3)	Average Daily Transmission	Resource Availability Ratio
1	Pathivara-Lakhanpur Water Supply Project	300	278	1.08
2	Gauradaha Water Supply Project	1650	1253	1.32
3	Goldhap Water Supply Project	225	150	1.50
4	Shree Bhawani Water Supply Project	450	420	1.07
5	Baniyani Water Supply Project	225	150	1.50

Service Coverage and Equity

Machado et al. (2022) explores the factors that influence the long-term sustainability of community-managed water systems, specifically looking at the performance of water supply systems in rural or developing regions. It provides insights into how such systems can maintain consistent service delivery, which directly affects customer supply reliability and quality.

Service coverage varied notably across the studied water supply systems, with an overall average coverage of 67.90%. Shree Bhawani Water Supply System stood out with the highest coverage rate of 98.49%, indicating near-universal access in its operational area. This suggests that the infrastructure and management practices in place are highly effective in providing service to the majority of the population. On the other hand, Baniyani Water Supply System recorded the lowest coverage rate at 42.38%, pointing to significant access gaps within the community. Such disparities in coverage indicate that regions with lower access are likely experiencing challenges such as inadequate infrastructure, financial constraints, or operational inefficiencies. This situation calls for the development of targeted strategies to address access issues, particularly in underserved and remote areas. Tailored solutions, such as expanding network reach, improving infrastructure, and increasing community involvement, could help bridge these gaps and promote equitable service provision.

Water Consumption

Poudel and Adhikari (2018) examines how the local socio-cultural and institutional contexts influence the performance of community-managed water supply systems, focusing on their ability to meet customer needs. The paper highlights challenges that impact water supply reliability and customer satisfaction.

The average per capita water consumption across the studied systems was 18.58 liters per capita per day (lpcd). Notably, Shree Bhawani Water Supply System recorded the highest consumption rate at 21.92 lpcd, which might reflect better service reliability, availability, and user satisfaction. In contrast, Goldhap Water Supply System exhibited the lowest consumption rate at 13.70 lpcd, which could point to several factors such as system unreliability or the prevalence of alternative water sources, including tube wells. The low consumption in some areas suggests that despite the existence of piped water systems, residents may still be relying on non-potable water sources for daily needs, particularly in places with inconsistent or poor service delivery. Improving the availability and reliability of the piped water supply could reduce dependence on these alternative, potentially unsafe water sources, and could, in turn, encourage increased consumption of clean water.

Production Population

The production population, which gauges the efficiency of water resource utilization, varied significantly across the systems. Shree Bhawani Water Supply System demonstrated the highest production population at 0.084 m3/person/day, indicating that this system makes more efficient use of available water resources. In comparison, Pathivara-Lakhanpur reported the lowest value at 0.029 m3/person/day, suggesting that this system may not be utilizing its water resources efficiently. To improve water resource efficiency, it would be beneficial to optimize production and distribution processes. Measures such as adopting more efficient water treatment technologies, upgrading distribution infrastructure, and reducing water losses could significantly improve overall performance in systems with low efficiency.

Extent of Metering Connection

Joshi et al. (2020) examines the performance of a community-managed water supply system in Nepal, focusing on its ability to provide consistent and reliable water to its customers. The paper assesses the physical infrastructure, water delivery capacity, and the overall satisfaction of the customer base, making it highly relevant to customer supply performance.

An important indicator of system efficiency and revenue generation, the extent of metering connection was reported at 100% across all studied systems. This indicates that all water supply systems are effectively monitoring and recording water consumption, which is crucial for accurate billing and ensuring that users pay for the water they consume. A high metering connection coverage suggests that the systems have strong billing practices in place, which could help in maintaining financial sustainability and support system maintenance and expansion efforts.

Customer Satisfaction

Customer satisfaction varied across the systems, with the Goldhap system receiving the highest satisfaction rate of 93.94%. This high satisfaction level likely reflects the reliability and quality of the service provided by Goldhap. In contrast, Shree Bhawani Water Supply System had the lowest satisfaction rate at 78.69%, indicating room for improvement in areas such as service reliability, water quality, or community engagement. Although customer satisfaction was generally high, variability in satisfaction underscores the need for continuous efforts to engage with users, address their concerns, and improve service quality. Responsive management, regular maintenance, and community involvement are key to sustaining positive user experiences.

Equity Index

An unexpected finding was that the equity index across all systems was recorded as zero. This suggests that the water supply systems are either not actively focusing on serving vulnerable or marginalized populations, or that data on this aspect of service provision was not adequately captured. In light of this, there is an evident need to explore further the inclusivity of water service provision and examine whether particular socioeconomic groups are being excluded or underserved. To address equity concerns, water supply systems should implement specific measures that target disadvantaged populations, ensuring that these groups have equitable access to water services. This could involve adjusting pricing structures, improving access in rural and remote areas, or introducing community-based water management models that empower local users.

Resource Availability Ratio

The resource availability ratio, which compares resource capacity to daily transmission needs, varied significantly across the systems. Goldhap and Baniyani exhibited the highest ratios at 1.50, indicating a sufficient capacity to meet demand. In contrast, Shree Bhawani and Pathivara-Lakhanpur had lower ratios, at 1.07 and 1.08, respectively, suggesting that these systems may face challenges in meeting peak water demand. Limited capacity could lead to water shortages during times of high demand, affecting service quality and reliability. Investing in infrastructure upgrades, including expanding storage capacity and improving treatment facilities, would be essential to ensure reliable water supply during peak periods and to increase system resilience to fluctuating demand.

Haque et al. (2020) Comparative analysis of community-based management and public-private partnership models for improving rural water supply sustainability in Bangladesh.

This study compares two models of water supply management: community-based and public-private partnerships. It evaluates how each model impacts the quality and consistency of customer water supply, with a focus on rural areas. The findings offer insights into how governance models affect customer service in the water sector.

Shrestha et al. (2016) assesses the performance of private water suppliers in small towns, with a focus on customer supply. It considers factors such as water quality, reliability, customer service, and financial sustainability. This case study offers valuable insights into how private sector involvement can affect water supply performance.

Conclusion

The analysis of water supply systems across multiple indicators highlights significant variability in coverage, water consumption, and efficiency. While some systems, like Shree Bhawani, are performing well in terms of service coverage and resource efficiency, others, like Baniyani, face substantial challenges in ensuring equitable access. The findings underscore the need for targeted interventions to improve service delivery, ensure equitable access, and optimize resource utilization across all systems. Addressing the challenges highlighted by the equity index and resource availability ratio will be critical in ensuring sustainable, inclusive, and reliable water supply systems for all communities.

Community-managed water supply systems in Jhapa district have some constraints and challenges in physical and other aspects. Some of the indicators in the performance analysis shows that there are some limitations on water usage and equitable water for the consumers.

Customer satisfaction was generally high, with most systems receiving positive feedback from users. The Goldhap system had the highest satisfaction rate, while Shree Bhawani had the lowest, indicating variability in user experience based on system performance and reliability.

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