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Sustainability Analysis of Community-Managed Rural Water Supply Project: A Case Study of Kaski District

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Abstract

After the 1992 International Conference on Water and the Environment in Dublin, a new approach to rural water supply was adopted being that the water should be managed at the lowest appropriate level, with users involved in the planning and implementation of projects. As per the data of DWSSM (2019) even though the basic level water supply coverage of Nepal is 87.22% among the water supply schemes providing service to the people only 28.13% of the schemes are fully functional. The lack of functionality questions the investment of different agencies as projects do not operate throughout project life and the public are facing the problem of not getting safe and reliable water. The main aim of this study was to assess the post-construction status of these projects in relation to their sustainable management. For this, six water supply projects completed over the last five years have been studied. During the study, the data was collected from the structured questionnaire, focal group discussion, Key informants' interviews and field observations. These water supply projects were evaluated based on five main criteria namely economic, technical, social, institutional, and environmental factors. From the study it is observed that the sustainability score of Syaude Lifting WSP is 62.82%, Serokhola WSP is 66.74%, Lumre WSP is 64.25%, Sudame WSP is 54.97%, Bhachok WSP is 63.74% and Chisapani WSP is 76.90%. The economic and technical aspect of sustainability is found poor in all of these water supply projects. The major problem faced by the community is the lack of financial resources and technical capacity-building programs in the construction stage which have ultimately hampered the project's sustainability. Post-construction training, technical and capacity-building training, support policies and programs are important requirements for the sustainable development of rural water supply systems.

Keywords: Economic; Environmental; Institutional; Social; Technical

1. Introduction

Water is essential for all living creatures and humans and life cannot survive without it. After establishing a right to clean water as a moral right in the constitution of Nepal, Nepal's is goal to provide basic water supply coverage to all its people alongside upgrading the quality of service. So, the government has built numerous water supply projects to achieve this target. Despite the efforts, the desired level of service in water supply projects is not satisfactory. Managing rural water supply schemes is a global challenge but becomes more severe in developing countries. A suitable solution proposed globally to solve this problem is engaging Community-based organizations (CBOs) [1]. . In many countries, the challenge of sustaining rural water supplies is entrusted to community organizations, which have difficulties in performing durably the operation, maintenance, and cost recovery of rural water supply systems. [2]. Community involvement in planning, operation, and maintenance has been key to the successful provision of water and sanitation services for more than 700,000 people living in remote and poor regions in Nepal. [3]. During the 1990s, water and sanitation professionals reached a global consensus on a new approach to RWS. This approach is based mainly on two principles that were endorsed by the Nordic donor community at the 1992 International Conference on Water and the Environment in Dublin. They are: a. Water is an economic as well as a social good and should be managed as such and b. Water should be managed at the lowest appropriate level, with users involved in the planning and implementation of projects

The basic level water supply coverage of Nepal is 87.22% and among the water supply schemes providing service to the people only 28.13% of the schemes

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are fully functional [4]. The lack of functionality questions the investment of different agencies as projects cannot deliver their results even throughout the project life and the public is facing the problem of not getting safe and reliable water.

2. Materials and Method

2.1 Literature Review

In the context of rural Nepal, a study showed that using methodologies for drinking water supply projects that involve community members in collaborative planning, implementation, and maintenance allows for location-appropriate systems that are more sustainable and effective than generalized systems. [5] Various research articles and papers have been published regarding the factors for the determination of the sustainability of rural water supply projects. The main sustainability factors generally adopted are economic, technical, institutional, social and environmental factors. [6], [7], [8]. By using 10,789 community-based rural water supply and sanitation programs data in Indonesia using multi-nominal logistic regression [9] concluded in their research that the water supply systems that do not collect water fees from beneficiaries were more likely to be not functioning compared to systems with a tariff system. A study on Niger Delta Region studied by [10] concluded water shortage and also its pollution have been caused by the failure of residents and even the authorities to either replace or repair broken water pipes, the decay of infrastructure and the failure of the available equipment to serve its purpose and suggested rapid response to equipment failure and maintenance of water pipes should be implemented in water agencies to make the system sustainable. The means of interview questionnaires, observation using a checklist and documentary review in a sample size of 98 on the Nyasa District of Tanzania [11] recommended that community members be actively involved in all stages of the project life cycle including decision-making in planning, frequent seminars and workshops for building awareness and empowering women on the importance of participating and budget should be allocated and timely disbursed to facilitate the community participation in water supply projects. The case study by [8] using sensitivity and scenario analysis in Magelang Regency, Indonesia revealed that the performance of the water board and response and support from the community, positively influence the sustainability of the water supply program. A workshop conducted by the Ministry of Water Supply on Rural Water Supply Functionality & Sustainability: Piloting & Knowledge Sharing Workshop on 14th January 2020 concluded that the water tariff fixation and collection has come up as a burning issue in the community as most of the organizations are struggling to regularize it. There is a need to find some way to regularize it and to ensure that people are getting accessible, reliable, and quality services in line with the rights to water and sanitation as incorporated in the constitution as Fundamental Rights, asset ownership by the local level government and community engagement in all phases of planning, construction and post-construction is essential for the functionality and sustainability of water supply schemes and post-intervention phase is essential for the sustainability of the intervention as the community ownership is most crucial for the sustainability of any scheme and at least one to two year or post-intervention phase should be considered for the sustainability and effectiveness of the constructed schemes. Research to assess the performance in terms of its technical, institutional, and financial aspects of the Mangadh Water Supply Project in Biratnagar Metropolitan City, Morang concluded that the technical performance was good with regular repair and maintenance, institutional performance of the water supply system was good due to timely meeting, general assembly and audit but showed decreased performance of WSUC and efficiency of WSUC human resource and financial performance was just satisfactory as the current income was just enough to sustain the O & M expenses [12]. A paper studying 496 different water supply projects constructed under the Rural Village Water Resources Management Project (RVWRMP), in mid and far-west Nepal noted that the prioritization of the schemes by the community, application of quality implementation and user committee management, water safety plans and active maintenance and hands-on technical support and monitoring are the key elements for sustainable functionality of rural water infrastructures. The study also suggested that technical innovations like shock chlorination of water supply systems, digging recharge ditches above sources, building diversion channels above water supply infrastructure, and building a lip around the lid of the reservoir tank will help the source and reservoir tank to be free from contamination. One of the important suggestions made by the study was to include women at approximately 50% in committees, training courses, and other activities as a basic rule because they maintain water safety, proper operation and cleaning of the water tap, and maintain the basic household level sanitation and hygiene activities. The paper also concluded that RVWRMP's step-by-step approach water safety plan, post-construction phase and hands-on support from technical staff led to improved functionality which included quality construction, provision of proper O&M by the users, capacity building of the users and development of local institu-

tions to support the schemes during and after construction.

2.2 Methodology

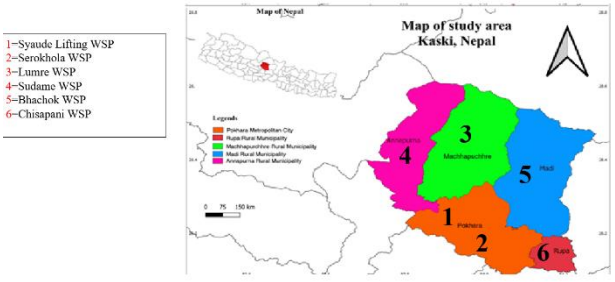
Firstly, the purposive stratified random sampling method was used to select the project to be studied. The completed project of the Kaski district was divided into five strata based on the local government. To include a project sample from each local government, a project from each local government was taken and since Pokhara metropolitan city had a large number of completed projects, to manage the proportionality, two projects were selected from Pokhara metropolitan city. The project list showed that 19 projects from Pokhara Metropolitan City, 3 projects from Machhapuchhre rural municipality, 2 projects from Annapurna Rural municipality, 1 project from Madi Rural municipality and 4 projects from Rupa rural municipality were complete. A project from each local government was taken and since Pokhara Metropolitan City had more completed projects, two projects were taken under consideration for the study. For the study 6 projects, which are funded by the provincial government and have a basic water supply scheme were taken into consideration. The base year population of the selected six projects is 8057. By using the Cochran formula for the population and with 95% confidence level and 5% margin of error, the sample size was calculated to be 367. The sample size was then proportionately divided for each project.

Table 1: Proportionate Distribution of Sample

S.N	Name of Project	Population	Size Of Sample	Feature of System
1	Syaude Lifting Water Supply Project	455	21	Single Stage Lifting
2	Serokhola Pokhara 22 Water Supply Project	3435	156	Gravity with treatment plant
3	Lumre Water Supply Project	610	28	Gravity
4	Sudame Simalbot Sotre Pakha Water Supply Project	234	11	Gravity
5	Bhachok Water Supply Project	658	30	Gravity
6	Rupakot 3 Chisapani Water Supply Project	2665	121	Double Stage Lifting
	Total	8057	367	

In each project, the cluster sampling method was used to collect quantitative data, in which settlements were not evenly distributed but clustered in clusters near water projects. Initially, simple random sampling was applied within clusters, in which the first household was randomly selected to process the questionnaires. After the first household was randomly identified, systematic sampling was used to collect data from subsequent households in the cluster using questionnaires. For focal group discussion and key informant interview, the purposive sampling method was used. Field observation was also carried out to determine the present status of structures of the water supply project. Data obtained were then analyzed using descriptive statistics. MS Excel and SPSS were used to analyze the primary and secondary data collected. A Likert scale was used to analyze mean scores.

2.3. Study Area



3. Results and Discussion

3.1 Economic Factor

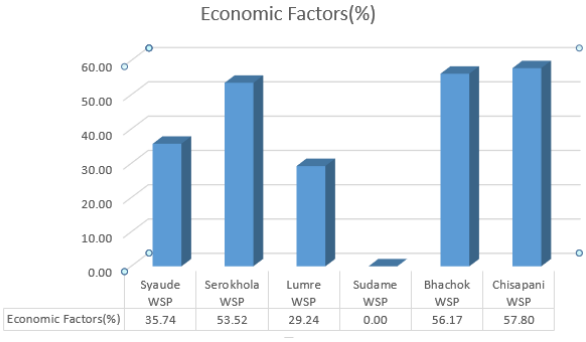


Figure 1: Economic Score

From the figure, it is clear that the economic aspect of this six-water supply system is very poor. It is seen that no water supply project can score more than 60% marks. The self-financing capacity of the above project is null as there is no surplus fund for cost recovery, expanding infrastructure and replacement of the system after the completion of the design period. They used to depend upon the investment agency for any expansion and repair of the project. Sudame Simalbot WSP got 0% marks in economic factor because it did not collect any water tariff at all. This project has the

lowest score and supports the finding of ***[9]*** .

3.2 Technical Factor

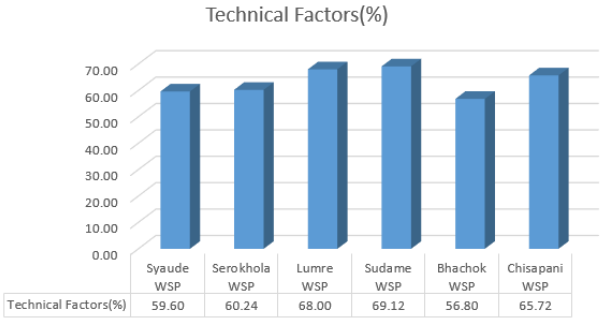


Figure 2: Technical Score

The figure shows that the technical aspects of all the studied water supply projects are average as scores are between 55 and 70 marks. The main reason hindering the technical aspects is the non-availability of spare parts for the repair and rehabilitation of the system as no project has **spare** parts available and only one project has received VMW training. The average marks agree with the findings of [10] that the failure of the available equipment to serve its purpose and suggested rapid response to equipment failure and maintenance of water pipes should be implemented in water agencies to make the system sustainable.

3.3 Social Factor

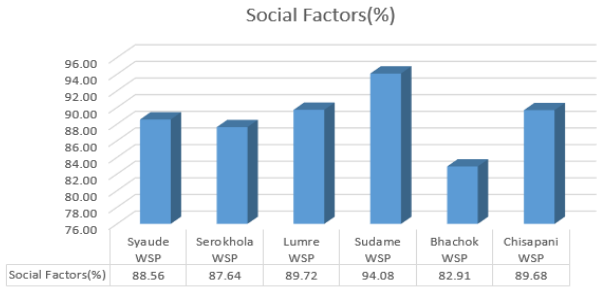


Figure 3: Social Score

Among all the factors, the social factor of the studied projects is highest, this is because of the involvement of the people and also women participation. The respondents claimed that they are actively involved in the construction process, meetings and decision-making. The water supply project links the whole community together as without water people cannot survive. It is even seen that in the two lifting projects when the collected money is not enough to repair the electrical equipment the people collect money and repair the equipment. This supports the recommendation of [11] on the importance of community participation in water supply projects.

3.4 Institutional Factor

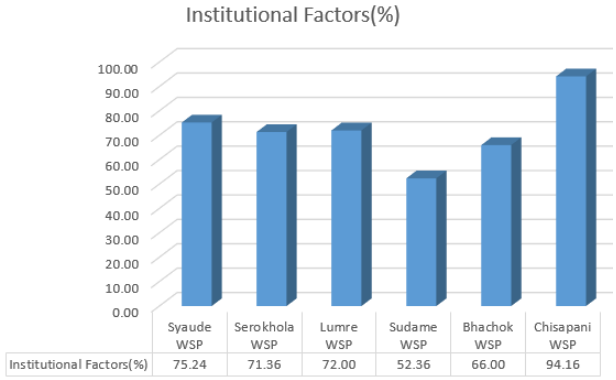


Figure 4: Institutional Score

The institutional factors are more significant for post-construction service delivery. It includes how the social organization is formed and run to provide effective, efficient, timely and impartial service to the people. The beneficiary of the project forms the user committee based on election ensuring the participation of the women in the governing committee. The figure shows that the institutional factor of all the water supply projects is fluctuating. The project with high institutional marks has a high overall score of sustainability as well. This supports the finding of [8] that the performance of the water board and response and support from the community, positively influence the sustainability of the water supply program.

3.5 Environmental Factor

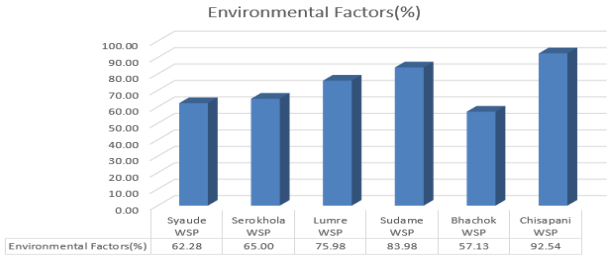


Figure 5: Environmental Score

The results of environmental aspects are average in these water supply systems. The only project with water quality tested has the highest score. People feel that due to the ongoing climate change, the sources are slowly drying up and settling down so the intervention of government is needed in source protection in the days to come. Similarly, the provision of filtration is needed in every project to enhance the water quality

and ultimately to improve the sustainability of the water supply system.

3.5 Overall Score of Sustainability

Table 2: Overall Score of Sustainability

S.N	Name of Project	Eco. Factors (%)	Tech. Factors (%)	Social Factors (%)	Inst. Factors (%)	Env. Factors (%)	Total
1	Syaude Lifting WSP	35.74	59.60	88.56	75.24	62.28	62.82
2	Serokhola Pokhara 22 WSP	53.52	60.24	87.64	71.36	65.00	66.74
3	Lumre WSP	29.24	68.00	89.72	72.00	94.42	64.25
4	Sudame Simalbot Sotre Pakha WSP	0.00	69.12	94.08	52.36	83.98	54.97
5	Bhachok WSP	56.17	56.80	82.91	66.00	57.13	63.74
6	Rupakot 3 Chisapani WSP	57.80	65.72	89.68	99.16	92.54	76.90
	Mean						64.90

Among the studied projects only one project got a score of more than 70% and is sustainable, whereas the other five projects got a score between 30%-70% which showed that the projects are only partially sustainable. The overall mean score of all the projects was 64.90%. Regarding the factors of sustainability, all of the projects are weak in the economic and technical criteria. Similarly, there are some encouraging results in social factors whereas institutional and environmental aspects remain unstable. The highest mark obtained is by Chisapani WSP as it is the only project that has been provided post-construction training as well as village maintenance training which helped them realize the importance of community participation and women's involvement. The score supports the finding of [8].The difference in the collection method of tariff and different rates of tariff support the conclusions of a workshop conducted by the Ministry of Water Supply on Rural Water Supply Functionality & Sustainability.

3.6 Validity and Reliability of Instrument

To find out the validity of the research instrument, the opinions of experts in the field, especially of the supervisor and teaching staff, were asked. This facilitated the necessary revision and modification of research instruments, which increased validity. During this study, the validity was accessed by cross-checking the responses from the public and user committee by asking the same questionnaires, direct field observation, and another audit as well as annual reports. For reliability of the questionnaire Cronbach Alpha was calculated using Microsoft Excel and the following result was obtained.

Table 3: Cronbach Alpha Score

S.N	Factor	Number of respondents	Cronbach alpha	Interpretation
1	Economic Factor	367	0.736	Acceptable
2	Technical Factor	367	0.720	Acceptable
3	Social Factor	367	0.725	Acceptable
4	Institutional Factor	367	0.802	Good
5	Environmental Factor	367	0.808	Good
	Total	367	0.726	Acceptable

4. Conclusions

The participatory approach here is working well involving all stakeholders. The schemes are functional despite the certain number of breakdowns and people are ready to accumulate their available resources in the time of need to resolve the immediate problem. But for the sustainable development and management of these water supply projects, huge and continuous effort should be delivered especially in the sector of the post-construction phase of the project. Post Construction Support programs should be included in plans and policies of the government and implementing agencies. It should include the provision of training to the committee for self-sustaining, emergency funds for repair and replacement of pump, motor and electrical accessories, availability of spare parts, technical and capacity building training and so on. For increasing sustainability step by step approach water safety plan, post-construction phase and hands-on support from technical staff which includes provision of proper O&M by the users, capacity building of the users and development of local institutions to support the schemes during and after construction is required which has also been concluded by the research of RVWRMP project.

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References

[1] Asia, D. Community Participation Key to Water Supply Success. Retrieved from Development Asia An Initiative of

Asian Development Bank, (2016, November 15): https://development.asia/case-study/community-participation-key-water-supply-success

[2] Aslam, M. S. Sustainability of Community-Based Drinking Water. PhD Thesis, McGill University (2013).

[3] D. Daniel, J. P. A System Dynamics Model of the Community-Based Rural Drinking Water Supply Program (PAMSIMAS) in Indonesia. *Journal of Water*, 13(4) (2021).

[4] Department of Water Supply and Sewerage Management. *Water Supply Project Design Volumes (1-12).* See https://dwssm.gov.np/pages/design-guidelines(2023, 2 21).

[5] Gasmi H, K. M. Sustaining community-managed rural water supply systems in severe water-scarce areas in Brazil and Tunisia. *Cahiers Agricultures*, 31 (2022).

[6] GokulDev Joshi, A. D. Performance Assessment of Water Supply Scheme; A Case of Mangadh Water Supply Scheme, Nepal. *Test Engineering & Management*, (2020) 30105-30116.

[7] Kamalesh Panthi, &. S. A Framework to Assess Sustainability of Community-based Water Projects. *First International Conference on Construction In Developing Countries*, (2008).

[8] Longworth, B. Individualized Community-Led Drinking Water Supply Projects in Rural Nepal: A More Effective and Sustainable Methodology than Generalized Approaches. *Crossings*, 2 (2022) 131-138.

[9] Mbunda, S. J. Community participation in rural water supply projects: Influencing factors and challenges in nyasa district. *International Scholars Journal*, (2022). 1-5.

[10] Shaibu Ochoche, &. V. Sustainable Water Supply and Management in Nigeria: Challenges in the Niger Delta Regio. *International Journal of Innovative Science and Research Technology*, 8(2) (2023) 1066-1072.

[11] Syed Ali Akbar, S. M. Collective Responsibility And Community-Based Organizations: Identification Of Social Reasons Behind Dysfunctional Rural Water Supply Scheme. *Pakistan Journal of Social Research*, (2022) 251-258.

[12] T. Pamudji Al Djono, a. D. The effect of community contribution on the functionality of rural water supply. *Groundwater for Sustainable Development*. (2022).