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Performance Assessment of Water Supply Scheme; A Case of Mangadh Water Supply Scheme, Nepal

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Abstract

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 are fully functional. The reason behind this state of higher percentage of non-functionality and ill performance of developed schemes is a matter of study. Thus, the main aim of this study is to access the overall performance; technical performance, financial performance and institutional performance with implementation status of water safety plan of Mangadh Water Supply Scheme; a water service provider supplying water to population of rapidly growing urban area of Biratnagar Metropolitan City of Nepal. Generating primary and secondary data from questionnaire survey, field visits, laboratory tests, focal group discussion, key informant interviews, journals, articles and annual reports, the performance indicators suggested by different national and international organizations for performance assessment of water service providers wereanalyzed. From data analysis, results regarding technical performance showed that water supply coverage of the scheme was 46.29%. Though the production population was 105 lpcd, per capita consumption was only 65.46 lpcd. The scheme intermittently supplied water for 6.5 hours a day through fully metered connections. The condition of physical structure was good giving a physical structure index of 78.89%. The distribution mains density was found to be 4.39 Km/Km^2 and quality of water supplied was within Nepal Drinking Water Quality Standards, representing good performance in overall technical aspect.Regarding institutional performance, results showed that the functionality index of the system was 90%, staff ratio was 5.81 staffs per 1000 connections, individual capacity of the WSUC members obtained 7.67, 8.0, 8.33 out of 10 in institutional, financial and technical management respectively whereas WSUC staffs obtained 7, 9.67, 8.67 out of 10 in water quality knowledge, office management and technical knowledge respectively. The implementation status of water safety plan was well functioning with high concerns and consciousness of consumers in importance of water quality on public health though more than 46.9% of people directly uses water from tap for drinking, indicating an overall best performance in institutional aspect. In context of financial performance, the personnel cost was 62.33%. The unit production cost was found to be NRs. 12.01 per cubic meter of water but the average tariff was NRs. 12.59 per cubic meter. The operating ratio was 0.95 and a non-revenue water of 37.99% representing satisfactory financial performance.

Keywords: *Performance, functionality, performance indicators, water safety plan, non-revenue water;*

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INTRODUCTION

Background

Safe drinking water is basic necessity for good health of all human beings.Government of Nepal (GoN) had committed to provide basic level water supply and sanitation services to all by 2017, and envisaged to improve the basic level of water supply and sanitation services to medium and higher levels for all by 2027 (GoN, 2014). But the national level basic water supply coverage is limited to only 87.88%(GoN, 2018). This indicates a challenging state for government to achieve the committed target. This is not only the challenge; the greater challenge seems more devastating. More than forty two thousand small and large water supply schemes has been completed but only 28.13% of schemes are fully functional, 38.07% of schemes need minor maintenance and 10.00% of schemes need major maintenance to make them fully operational while, 15.85% of total schemes need rehabilitation and 7.93% schemes need to be reconstructed to take them to service level (GoN, 2018). These figures arises the question regarding the performance, functionality and sustainability of water service providers in Nepal.

Water system are found to be non-functional mainly due to inadequate application of water safety principles, negligence, lack of institutional, technical and financial capacity of the users committee to undertake major repairs and funding issues (Shahi, 2017).So, for the proper functioning and sustainability of the schemes, strong and capable UC and its proper management are important. Along with this, proper design and construction, institutional formation of Water Supply and Sanitation Users Committee (WSUC), technical human resources, necessary tools and materials and required operation and maintenance fund are key components to make scheme functional and sustainable.

Research Objectives

The main objective of the research was to assess the performance of Mangadh Water Supply Scheme in terms of its technical, institutional and financial aspects along with the implementation status of water safety plan.

Literature Review

WASH Sector Development Plan of Nepal

WASH Sector Development Plan of Nepal had been formulated for duration 2017 to 2030 for Enhancing public health and living standard of people by providing safe, plenty, convenient, acceptable and economic drinking water, at any place, at any time and to anyone through hygienic. SDP has categorized 2017-2030 in 3 phases and has been prepared to meet SDG targets. First phase (2017-2020) cover universal access, improved service level (medium 25% and high 15% of population) and reconstruction of basic WASH services while Second phase (2021-2025) covers access to improved service level (medium 40% and high 30% of population) and functionality and sustainability of systems. Third phase (2026-2030) covers improved service level (medium 50% and high 50% of population) and impact evaluation. Beyond the concept of coverage increment, SDP is focused in improvement of system and service for WASH sector of Nepal.

Performance Indicators (PIs)

Performance indicators are measures of the efficiency and effectiveness of the water utilities with regard to specific aspects of the utility's activity and of the system's behavior. Each performance indicator expresses the level of actual performance achieved in a certain area and during a given period of time, allowing for a clear cut comparison with targeted objectives and simplifying an otherwise complex analysis. Performance indicators provide key information to the water utility, allowing for a reinforcement of a pro-active approach to management, as opposed to the more traditional reactive approach, usually relying on apparent system malfunctions. As performance indicators

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clearly bring to light the existing strengths and weaknesses of water utility departments, they are an incentive for the adoption of corrective measures, such as the re-allocation of human resources in order to improve productivity and modernize traditional procedures and routines (Helena Alegre).

The World Bank through its International Benchmarking Network for Water and Sanitation Utilities (IBNET) has been involved in water sector monitoring collecting data on utilities performance and has set a global standard for performance assessment of water utilities based on a variety of performance indicators. Along with IBNET, many other organizations like Japanese Water Works Association (JWWA), IWA etc. have developed their own indicators for examining the performance of water utilities. JWWA has developed hundred PIs for assessing the performance of water utilities and had been applied for performance evaluation of the water supply services.

Water Safety Plan

A Water Safety Plan (WSP) is the most effective way of ensuring that a water supply is safe for human consumption and that it meets the health based standards and other regulatory requirements. It is based on a comprehensive risk assessment and risk management approach to all the steps in a water supply chain from catchment to consumer. The primary objectives of a water safety plan in protecting human health and ensuring good water supply practice are the minimization of contamination of source waters, the reduction or removal of contamination through appropriate treatment processes and the prevention of contamination in the distribution network and the domestic distribution system. These objectives are applicable to all water supply chains, irrespective of their size or complexity (DWI, 2005).

Empirical Review

Mishra, (2019) used the indicators developed by IBNET to analyze the institutional performance of water supply system of Dhankuta district of Nepal through analysis of functionality index, institutional setup, staff productivity index, capacity of WSUC member and staff separately and the implementation status of water safety plan. Through the obtained results, he emphasized on the need of capacity enhancement of WSUC members and staffs. He also performed the financial assessment of a water supply system where Water Accounting System, Non-Revenue Water (NRW), Average Tariff, Personnel Cost, Unit Production Cost, Operating Ratio, Accounts receivable equivalent, Revenue collection efficiency, Cash balance of five fiscal year and Payback period were used as performance indicators and emphasized on NRW reduction for making the system financially strong and viable.

Yadav*et al*, 2014evaluated the performance of water supply services in Ahmedabad City of India using nine performance indicators suggested by Ministry of urban Development, Government of India and they also suggested bringing down of NRW from its current levels to below 20% level to further improve the system performance by establishing effective water audit exercise to check the transmission and distribution losses.

Ishii and Katsumata, (2007)in their research explained how a new project can be easily evaluated using performance indicators. They mentioned that, with the introduction of PI guidelines in water utilities in Japan, the watersupply utilities realized the importance of PIs in clarifying their activities and performance of their management. Their research stated how to make full use of the PI (guidelines) to evaluate the outcome of the water supply service to make a simple case study which makes it easy to compare the results before and after a project. They also verified the numerical importance of PI and how improvement of only one PI makes a chain reaction with the other PIs under certain conditions to enhance the performance of the overall system.

METHODOLOGY

First of all problems were identified and then generated the research questions and objectives.

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Primary and secondary data were collected by different sources.

Study Area

Mangadh WSS is located in northen side of Biratnagar Metropolitan city in Morang district. The project area of Mangadh WSS occupies ward no. 1,3,19 and northern part of ward no. 4 of Biratnagar Metropolitan city and southern part of ward no. 1 of adjoining Budhiganga Rural Municipality.

This scheme was initially initiated in year 1999 as per the policy of rural water scheme in which 80% of the investment was assisted by GoN and 20% by the users committee. Later on, additional constructions works were done in the scheme by Division of Water Supply and Sanitation, Morang, and in year 2005, management, operation and maintenance of the scheme was officially handover to User Committee.

Initially, it was designed to provide service to 11000 population of Biratnagar. It is a scheme managed as private tap model. By 2019 *July,* 36000 populations are being benefitted from 4423 private taps and 50 institutional taps.

The Mangadh Water Supply System is managed, operated and maintained by Birat Water Supply and Sanitation Users Committee. The WSUC was registered in B.S. *2058/09/19* as per Water Resources Act, *2049*. The WSUC is composed of 9 elected members (including 3 women) and 26 staffs are working in the system for its management, operation and maintenance.

Data Collection

The present study is based on both primary and secondary data. The primary data were collected by questionnaire survey, field visits, laboratory tests for water quality, focal group discussion and key informant interviews while secondary data were collected by reviewing published reports, journals, articles and annual reports of users committee.

DATA ANALYSIS, DISCUSSION AND FINDINGS

For the analysis, both quantitative as well as qualitative data and information wereused based on the response gathered. Secondary data and other information were used to interpret the results.

Technical Performance Indicators

Following indicators are analyzed to assess the technical performance of Mangadh WSS:

Water Supply Coverage: This indicator helps to identify the water supply coverage of the command area.

$$\text{Water Supply Coverage (\%)} = \frac{\text{Population served with water supply}}{\text{Total population in the area of responsibility}} * 100$$

The water supply coverage of MangadhWSS is 46.29% which is less than national average of 56%. So demand of increasing population in the service area might be a matter of concern acquiring a large coverage by its service.

Per Capita Consumption: It is the total volume of water used by a person per day for daily uses.

$$\text{Per capita consumption (lpcd)} = \frac{\text{Total water volume of water sold in } m^3 * 1000}{\text{Number of people served} * 365}$$

The per capita consumption of Mangadh WSS is 65.46 lpcd. This is less than the medium service level for urban area (100 lpcd). For increasing the service level the continuity to the supply needs to be increased along with the production.

Water Quality: The water quality tests from the source contained high amount of iron and manganese ranging higher than the National Drinking Water Quality Standards (NDWQS) while quality of water immediately after filtering an the taps were found to be within National Drinking Water Quality Standards. Water safety plans should always be implemented in order to give desired service of supply to the consumers.

Production Population: This indicator measures overall efficiency of water resource use. It is the

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ratio of total volume of water produced throughout the year and number of population served throughout the year.This indicator measures overall efficiency of water resource use and has a national average of 0.09m^3/person/day.

$$\text{Production Population } (m^3/\text{day/person}) = \frac{\text{Annual production volume } (m^3)}{\text{No. of people served} * 365}$$

The production population is found to be 0.105 m^3/person/day. This indicates that the production is higher than the national average but for maintaining a medium service level, even more volume of water needs to be produced. The difference in per capita consumption and production volume indicates a large volume of water being wasted.

Physical Structure Index: The index gives the physical status of the system to sustain the services. There are different physical water supply structures which will be observed and total marks of 10 will be assigned to each of the component.

$$\text{Physical structure index } (\%) = \frac{\text{Overall situation as per scale}}{\text{Total full marks}} * 100$$

The value assignment for various conditions of the physical structures will be scaled as 7-10 for good, 4-6 for satisfactory and 0-3 for bad (as cited in Mishra, 2018).The Physical Structure Index (PSI) of Mangadh Water Supply System was found to be 78.89% indicating a good condition of overall system. But Overhead reservoir had some minor cracks and seepage was seen during field visit so necessary works need to be done for repair and maintenance along with the other components of the system regularly or periodically.

Table-1: Physical Structure Observation Table

S.No.	Structure	Full Marks	Overall Condition	Marks
1	Intake Wells	10	Satisfactory	6
2	Aeration Tank	10	Good	10
3	Filtration Tank	10	Good	10
4	Chlorination Chamber	10	Good	7
5	Pump to overhead reservoir	10	Good	8
6	Overhead reservoir	10	Satisfactory	6
7	Valves, Fittings and valve chambers	10	Good	8
8	Distribution Pipelines	10	Good	8
9	Transmission Pipelines	10	Good	8
	Total	**90**		**71**

Extent of Metering or Metered Ratio: To introduce a volumetric-based tariff structure for water charges, metering all connections is essential.

$$\text{Extent of Metering of Connections } (\%) = \frac{\text{Total Number of Tap Connections with Operating Meters}}{\text{Total Number of Tap Connections}} * 100$$

Mangadh WSS have fully metered connections, the national average being just around 96% (SEIU, 2016). This indicates a balanced environment for monitoring the water supplied and the corresponding volumetric charges.

Continuity of Water Supply: This indicator shows the service level of the water service provider to the consumer. It is the average hours of pressurized water supply provide to the consumers in a day.Mangadh WSS provide water to its consumers

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in three different times for 6.5 hours.The expected value is 8 hours per day with a national average of 6.5 hours per day (SEIU, 2016). So also for increasing the service level to medium category, the supply duration must be increased.

Distribution Mains Density: This indicator represents the length of distribution pipes per service area of 1 km2, which means the extent of physical convenience when consumers apply for water supply.

$$\text{Distribution Mains Density(Km/(Km\^2))} = \frac{\text{Distribution pipe Length (Km)}}{\text{Current Water Supply Distribution Area (Km}^2\text{)}}$$

Mangadhhave distribution pipeline density of 4.39Km/Km^2. In order to cover the scattered households of the area, this value needs to be increased.

Mains Rehabilitation: This indicator represents the percentage of conveyance, transmission, and distribution pipes replaced in a year, that is, the extent to which the replacement is made in order to ensure the reliability.

$$\text{Mains Rehabilitation(\%)} = \frac{\text{Length of Replaced Pipelines(m)}}{\text{Total Pipeline Length(m)}} \text{ X } 100$$

Table-2: Calculation of Mains Rehabilitation

Year	2017/18	2018/19
Length of Replaced Pipelines (Km)	5.165	1.63
Total Pipeline Length (m)	69.50	87.76
Mains Rehabilitation (%)	7.43	1.86

The table indicates that, pipes in year 2017/18 are more replaced or rehabilitated than 2018/19. This indicator directly affects non-revenue water and reliability of the system.

Valves Replacement: This indicator represents the percentage of valves replaced in a year i.e. the extent to which the replacement is made in order to ensure the reliability of water distribution control for pipelines.Mangadh WSS accounts for zero valves replacement but maintenance and replacement of damaged parts of existing valve is regularly done to ensure proper functioning of the system.

Accidental Water Resource Pollution: This indicator does not relate directly to services offered by water utilities or authorities, but they should take flexible measures against any accidents to supply an enough volume of water. It is represents the total number of water quality accidents in a year.Mangadh accounts for zero water resource accident cases but mixing of drain water is seen because of pipe breakings by constructions works of metropolitan city.

Resource Availability Ratio: The purpose of drinking water supply services is to deliver the enough volume of water with stability. To do it, water resources should hold the sufficient volume of water. The ratio of water volume held by the water resources to water volume consumed actually represents the allowance and efficiency of the water resources. Accordingly, this indicator value should be high in preparation for droughts.

$$\text{Resource Availability Ratio} = \frac{\text{Average Daily Transmission Input (m}^3\text{)}}{\text{Resource Capacity or Designed Abstraction(m}^3\text{)}} * 100$$

The resource availability ratio of Mangadh WSS is 79.55%.

Demand and Supply: This is the measure of serviceability of the water service providers. If the demand and supply is balanced, the serviceability will be of desired level and steps can be taken to take the system to higher level. But, if the supply is less than demand, actions and alternatives are to be made to meet the required level.

Since, per capita consumption is less than the desired per capita demand of 100 lpcd for urban

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area, the present supply seems enough for the population being served at the rate of 6.5 hours a day.

Table-3: Calculation of Demand and Supply

Benefitted Households	Served Population	Per capita demand as per urbanization (Lpcd)	Total Demand Monthly (cum)	Available Source Monthly (Cum)	Total Distribution Monthly (Cum)	Total Billing Monthly (Cum)	Existing Supply (Hrs/day)	Difference of Surplus (Cum)
8673	36000	100	108000	114000	105000	71677.25	6.5	6000

Institutional Performance Indicators

Following indicators are analyzed to assess the institutional performance of Mangadh WSS:

Staff Ratio and Staff Productivity Index: Staff ratio is expressed as number of staff per 1000 connections whereas staff productivity index is a measure of the efficiency in human resource management. Staff productivity index is assumed to be low for higher staff ratio and vice versa.

$$\text{Staff Ratio} = \frac{\text{Number of Utility staff}}{\text{Number of Utility Connection (1000)}}$$

The national average for staff ratio is 8.3 (SEIU, 2016) indicating higher staff ratio than the staff ratio of Mangadh WSS.

Table -4: Calculation of Staff Ratio

Year	2016/17	2017/18	2018/19
No. of Staff	15	23	26
No. of Connections	3735	4473	4473
Staff Ratio	4.02	5.14	5.81

The increased staff ratio in consecutive three years indicates decreased staff productivity index thus decreased performance and efficiency of the staffs.

Functionality Index: The functionality indicators focus on whole year supply, adequate staff including technical and administration & tools, registration of WSUC, operation and maintenance fund.

Table-5: Calculation of Functionality Index

S.No.	Indicators	Weightage	Marks Obtained	Status
1	WSUC Registered	Yes (10), No (0)	10	Yes
2	Having own staffs with maintenance workers	Yes (10), No (0)	10	Yes
3	O & M Fund	Sufficient (10), Less (5), No (0)	10	Sufficient
4	WSUC Meetings	Regular Yes (10), Irregular (5), No (0)	10	Regular
5	Efficient water tariff collection	Yes (10), Partial (5), No (0)	10	Yes
6	Record keeping	Proper (10), Random (5), No (0)	5	Random
7	Tools and fittings reserve	Sufficient (10), Inadequate (5), No (0)	5	Inadequate
8	Water safety plan	Functional (10), Partial Functional (5), Non-functional (0)	10	Functional

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9	Reliability (whole year supply)	Yes (10), Nine month (5), Six month (0)	10	Whole Year
10	Accessibility	15 minutes (10), 30 minutes (5), More than 30 minutes (0)	10	15 minutes
Total		**100**	**90**	

(Source: NMIP, 2014)

The functionality status of a water supply system is checked through current functionality index. The Current Functionality Index of Mangadh Water Supply Scheme is 90%. During focused group discussion (FGD), the record keeping was found randomly managed and tools and fittings reserve was inadequate but other indicators of the functionality status being at their best.

Individual Capacity of User Committee Members: The result obtained from the survey on assessment of individual capacity of WSUC members on the institutional, technical and financial management is compiled and analyzed with the help of Microsoft excel which is shown in figure-1.

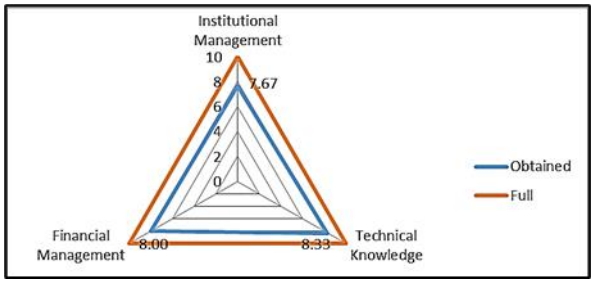

Figure-1: Overall Capacity of WSUC members

The institutional management scored7.67 in weighted score 1 to 10 which showed that the institutional management was almost good. The technical knowledge scored 8.33 and financial management scored 8. During FGD, it was found that, a state of conflict was developed due to different political approach among the members which was creating problems in management. Some trainings and field visits to committee members could enhance the institutional management capacity.

Individual Capacity of User Committee Staffs: The results of survey conducted for the assessment of individual capacity of WSUC staffs on water quality knowledge, office management and technical knowledge are compiled and analyzed which is shown below:

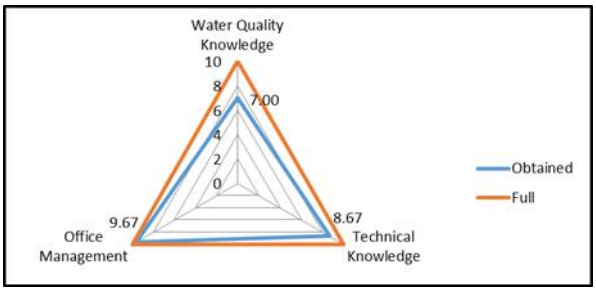

Figure-2: Overall Capacity of WSUC staffs

The water quality knowledge scores 7 out of 10 which show that they have fairly good knowledge in water quality. Frequent trainings on quality requirements could enhance the knowledge of staffs in water quality. The technical knowledge scores 8.67 and office management scores 9.67 out of 10 which shows that they are good in technical knowledge as well but the management skill is best.

Implementation Status of Water Safety Plan: The water safety plan team of Birat WSUC consists of 11 members.WSP has been prepared and is implemented with regular monitoring. The WSP team recommends for the periodic testing of water quality for all the parameters prescribed by NDWQS. Considering the, water safety, Birat WSUC has established its own water quality testing laboratory. Samples from the taps are tested daily for residual chlorine and water samples from each component are tested for pH, temperature, color, turbidity, residual chlorine and iron every month. This WSP team is fully motivated to provide safe and quality water to its consumers.

Table-6:Status of Consumer Satisfaction

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S.No.	Questionnaire	In Percentage (%)	
		Yes/Good	No/Bad
1	Knowledge on importance of quality of water for public health	93.8	06.2
2	Status of water from source to tap	68.8	31.2
3	Problem solved by WSUC as per complain	50.0	50.0
4	Satisfaction with Tariff rate	59.4	40.6
5	Satisfaction with repair and maintenance	59.4	40.6
6	Alternative source for drinking water	50.0	50.0

For the identification of consumer satisfaction a questionnaire was prepared and thirty two consumers participated in the survey. The consciousness about quality of water for public health among the consumer was 93.8%.68.8% of the consumers feel that the quality of water supplied is good and safe while remaining 31.2% find it unsafe because they get mud mixed water sometimes from the tap. 50% of the consumers were not satisfied with the service providers for solving the problem explained by them immediately. 40.6% of the consumers are not satisfied with the tariff rate but 59.4% of the consumers are satisfied with the repair and maintenance by WSUC while other unsatisfied percentage show frustration in late repair and maintenance. Among all the respondent consumers, about 50% of people have hand pumps alternative source of water. Upon the question of method of purification of water, 46.9% of people directly use water form tap for drinking, while 18.8% boil before drinking and about 50% of the population drink only after filteration.

Financial Performance Indicators

Unit Production Cost: It is the cost of production of 1m^3 of water.

$$\text{Unit Production cost (NRs/m\^3)} = \frac{\text{Annual O \&Mcost (NRs)}}{\text{Total annual production } (m^3)}$$

Table-7:Calculation of Unit Production Cost

Year	2016/17	2017/18	2018/19
Annual O & M cost (NRs)	11011359 .21	13558753 .00	16654417 .90
Total annual production (m^3)	803000	1387000	1387000
Unit Production Cost (NRs/m^3)	13.71	9.77	12.01

The average production cost for Nepal is NRs. 12.0/m3 and an expected production cost of NRs. 10/m3. Increased O&M indicates an increase in production cost in year 2018/19. Thus control over O&M fund can bring down the production cost.

Non-Revenue Water: Any volume of water produced that gets lost (either by leakages, overflows, illegal connections or faulty meters) before reaching to the consumers without generating revenue is known as non-revenue water. An increase in NRW shows the problems in operational management of the water supply facilities which is making an unnecessary investment in the production. It also increases the financial burden eventually leading the system non-functional and unsustainable.

$$\text{Non} - \text{Revenue Water (NRW)} = \frac{\text{Total annual production } (m^3) - \text{Total bill consumption } (m^3)}{\text{Total annual production } (m^3)} * 100$$

Lower the NRW, the performance of the water service provider will be higher. The national average

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of NRW is 38% (SEIU, 2016) but expected value is 20%. The NRW in year 2018/19 for Mangadh WSS is 37.99% which was 47.62% in previous year, the decreased value indicating a better performance than previous years.

Average Tariff: The average tariff is one measure of the financial discipline of a service provider and its ability to cover operational costs with revenues from tariffs with prudent expenditures.

$$\text{Average tariff (NRs./m\^3)} = \frac{\text{Total annual billing (NRs)}}{\text{Total annual production } (m^3)}$$

Table-8: Calculation of Average Tariff

Year	2016/17	2017/18	2018/19
Total Annual Billing (NRs)	12471574.00	16301653.00	17465180.93
Total annual production (m^3)	803000	1387000	1387000
Average Tariff (NRs/m^3)	15.53	11.75	12.59

The national average for average tariff is NRs 15.4/m^3 (SEIU,2016); this indicates that Mangadh is providing cheaper water to its consumers in comparison to other water service providers in Nepal. But the average tariff seems decreased in year 2017/18 and then increased in year 2018/19, this might be due to the effect of decreased non-revenue water in year 2018/19 due to which, total annual billing was raised higher than the previous year for same volume of water produced.

Personnel Cost:

$$\text{Personnel Cost (\%)} = \frac{\text{Total annual cost in salaries X 100}}{\text{Total operating cost}}$$

Personnel costs show the ratio of the salaries of the staff to the total operating costs. The ratio of personnel costs of Birat WUSC in 2017/18 was 41.78 % whereas it is 62.33% in 2018/19. The ratio of the personnel costs of the WUSC was higher than the average personnel costs of 56.50% for Nepal (IBNET).This indicates that the WUSC was paying high salaries to its staff probably compromising necessary maintenance and other operating expenses. But from year 2017/18 to year 2018/19 the personnel cost has greatly increased. This indicates to decreased efficiency of WSUC's human resource and decreased performance of WSUC.

Operating Ratio:A low operating ratio means revenues from tariffs (water consumption billings) cover the operation and maintenance costs comfortably. A ratio above 1 means that the service provider does not cover O & M costs.

$$\text{Operating Ratio} = \frac{\text{Annual Operating Cost (NRs)}}{\text{Annual Sales Revenue (Water Billing)(NRs)}}$$

The operating ratio of Mangadh WSS is 0.95 in year 2018/19.A low operating ratio means revenues from tariffs (water consumption billings) cover the operation and maintenance costs comfortably. A ratio above 1 means that the service provider does not cover O & M costs. The national average of operating ratio is 1.3 whereas expected value is 0.5.

Accounts Receivable Equivalent: This indicator is good measure of the effectiveness of a service provider in collecting its receivables or bill payments. For Mangadh WSS, there is no accounts receivable till year 2018/19. Every consumer pays their equivalent with in the defined time period. Reward and fine system had been applied to collect the revenues within the time frame from the consumers.

CONCLUSIONS

1- The overall technical performance of the system is good even though the system was designed for limited number of populations but is supplying water to three times more population at present. Regular repair and maintenance of the components of the system is helpful in decreasing NRW.

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2- The institutional performance of water supply system is good with positive points such as timely meeting, general assembly and audit but despite of this the decreased staff productivity index indicates decreased performance of WSUC and efficiency of WSUC human resource.

3- The financial performance of the system seems just satisfactory. Current income is just enough to sustain the O&M expenses. This is due to increased personnel cost and higher expense on O&M of the components of the system.

RECOMMENDATIONS

1- To increase the physical structure index value, rehabilitation of old source or development of new well should be done along with regular repair and maintenance of the components.

2- Water supply period should be increased in order to increase the per capita consumption.

3- Capacity development programs and trainings need to be conducted for the WSUC members and staffs to enhance institutional and technical knowledge.

4- A long-term business plan should be developed for improving and expanding the water service facilities.

5- To make the system financially strong, measures for reducing NRW are necessarily be implemented. If NRW is not controlled, the higher production cost than the average tariff will create financial crisis keeping other constraints same in upcoming days.

LIMITATIONS

1- Physical performance of the system structures requires both destructive and non-destructive tests with sophisticated instruments, which is beyond the budget and availability of instruments, so physical performance of the system is not studied.

2- The assessment of socio-environmental impact has not been done.

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