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Research Article

Performance Assessment of Kawasoti Water Supply and Sanitation Project, Nawalparasi, Nepal

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Abstract

The Government of Nepal aimed to provide adequate basic supply of safe drinking water to all its citizens by 2023(15th Adhar Patra, National Planning Commission). Although the national level of water supply and sanitation facility coverage is 88 and 98 percent respectively, only 25.4% of water supply projects are fully functional. The performance assessment of completed piped water supply scheme should to be assessed for the functionality and sustainability of the project. With an example of Kawasoti Small Town Water Supply Project (KSTWSP), performance of the service provider is assessed in terms of physical state, functionality, customer satisfaction, water resource management, financial management and human resource management. The major findings were that bacterial removal efficiency of slow sand filter is greater than 95 % and the turbidity from the outlet of slow sand filter was found to be less than 0.1 NTU. The study of financial data of Kawasoti WUSC shows that operating revenue is sufficient to cover the operating expenses of WUSC. The water demand for the year 2075 to 2086 were found to be (7.32, 7.58, 7.84, 8.12, 8.40, 8.69, 8.99, 9.31, 9.68, 10.07, 10.47, 10.89, 11.33 and 11.79) MLD respectively. The water production was taken as an average of 9.94 MLD. The analysis shows up to the year 2083, the system will be able to meet the water demand. So after 2083, the WUSC might need to make necessary arrangement for additional water sources to meet the water demand. Staff productivity index has been 3.70 from the year 2070 to 2075, which indicates efficient utilization of the staff. Thus the study concluded that the performance of Kawasoti WUSC is up to satisfactory level till this study year 2075.

Keywords:-*Water demand, Turbidity, Bacterial removal efficiency, Staff Ratio.*

1. Introduction

Constitution of Nepal has mentioned the right of access to clean water and hygiene to each people in the article 35 and sub-article 4 [1]. Sustainable development goal aims to achieve universal and equitable access to safe and affordable drinking water for all by the year and improve the water quality by the year 2030 [2]. National water plan 2005 aims to provide basic water supply to coverage of 100% population by the year 2017 and sets its target to provide the medium or high level of water supply service to 50 % of population by the year 2027 [3] . Till date 15thyear plan adhar patra, 88 % of population has been provided with basic level of water supply and 20 % of population has been provided with medium or high-quality water supply. According to the study of National management information project (NMIP) running under DWSS, the water supply coverage is 83.59% [4,5,6] (DWSS, 2014). The data does not cover water quality factors. Study shows the percentage of well-functioning system was only 25.4% up to 2012. One of the major challenges for functionality and sustainability of water supply project is to lack of post implementation management of users committee, lack of financial resources in operation and maintenance [7]. Also, there is lack of documentation, performance indicators as a basis for future planning, for

monitoring and evaluation. Operation and Maintenance activities of water supply system is also related to the issue of technical and issue of managerial, financial, institutional, political and environmental [8].

2. Literature Review

2.1Performance Assessment of Water Supply System in Global Scenario

Performance Indicators are measures of efficiencies and effectiveness of the water utilities with regards to the specific aspects of utility's activity and systems activity. Efficiency measures the extent to which the resources of the water utility are utilized optimally to produce the service. Effectiveness measures whether the targeted objectives are achieved or not. Each performance indicators give the level of actual performance achieved in a certain area and certain period of time and allowing for the clear cut comparisons of the performance with the targeted objectives [9].

The findings show that most of the water utilities in South Asian countries are performing poorly. In the countries like India, Bangladesh, Pakistan water utility does not provides continues water supply to its customer, the average is only 5 hours a day. There is a high percentage of non-revenue water estimated above 40 percent. Operating expenditure far exceeds income in many utilities, and tariffs bear no relation to costs. Most utilities rely on subsidies and ad hoc grants from government. Study shows that greater attention is also to be given to maintenance and revenue management systems, and aligning service outcomes with the needs of citizens. This requires effective accountability mechanisms and governance systems [10,11]

2.2Performance Indicators used in International Practice

Some of the performance Indicators used in Africa for the Assessment of water utilities is as follows [12]:

Water Supply coverage: Median water supply coverage in low income countries 61 percent, compared to 82 percent in low middle-income countries, 93 percent in upper middle-income countries , virtually 100 percent in high income countries.

Water consumption: It shows the diverse pattern between income groups and different regions, depending upon economic growths and differences in real tariff developments. Median water consumption was 158 liters per capita per day.

Staff Productivity index: Measured as the number of staff per 1,000 connections, where higher productivity is reflected fewer staff per 1,000 connections. Staff productivity varies widely from about 11 employees per 1,000 connections in low-income countries to slightly more than 3 in upper middle income countries.

Operating cost coverage ratio (OCCR): defined as the ratio of total annual billed revenues to total annual operating costs (excluding interest and depreciation). Utilities in low-income countries have a median OCCR of 1.09, compared to 0.99 in lower middle-income countries, 1.12 in upper middle-income countries, and 1.42 in high-income countries.

Key financial indicators are important to find the financial health of the system and to determine whether it needs to make adjustments to its rates, and they should be calculated annually when financial statements are released. One important financial indicator is operating ratio, which measures the ratio of annual operating revenues to annual operating expenses. The natural benchmark for operating ratio is 1.0, or break-even, but often a higher number is desired. To be a true enterprise fund that is self-supporting, a system should strive to have at least as much operating revenue as it has operating expenses, if not more. Otherwise, the system would be

operating at a loss.

Operating revenue includes any money the system receives for its services, including income from rates, tap/connection fees, penalties, and other sources. Operating expenses include items such as salary, benefits and employee taxes for staff, supplies, treatment chemicals, filters, utilities, insurance, lab and testing fees, minor repairs and regular maintenance, and, if applicable, the cost of purchasing water from another system. These are the costs of running the system day in and day out [2,13].

Staff productivity index was calculated whether current number of staff is enough for running the organization according to present water connection. Staff productivity is expressed as staff per 1000 connections. Higher Productivity is indicated in fewer staff per 1000 connections. It is one of the effective indicators to identify the efficient use of manpower. The value of staff productivity varies from 11 employees per 1000 connections in low income countries. Tyan and Kingdom proposed a benchmarking of 5 per 1000 connections for the developing countries [12,14].

2.3 Need of Performance Assessment

Performance assessment helps in measuring the quality of service and utility's effectiveness and efficiency. It helps to solve one of the major problems of the sector. Performance assessment can be done by different performance indicators which are accepted and in standard format.

Some of the Performance indicators developed by the Sector Efficiency Improvement unit (SEIU) are:

1. Water supply coverage (%) = $\frac{\text{population served with water supply services}}{\text{total population under the service of the utility}} \times 100$
2. Staff Ratio (No.) = $\frac{\text{Total no.of staff}}{\text{Total no,of tap connections}} \times 1000$
3. Metered Ratio (%) = $\frac{\text{Total no,of tap connections with operating meter]}}{\text{Total no,of tap connections}} \times 100$
4. Revenue collection efficiency (%) = $\frac{\text{total annual revenue (NRs.)]}}{\text{total annual billing (NRs.)}} \times 100$
5. Water Production Rate (lpcd) = $\frac{\text{Avg.daily water supplied to the distribution system}}{\text{Population covered by water service}}$
6. Non-Revenue Water (%) = $\frac{\text{Avg.daily water production} - \text{Avg.daily water usage}}{\text{Avg.daily water production}} \times 100$
7. Production Cost (NRs/m^3) = $\frac{\text{Annual Operational Cost}}{\text{Avg.daily water production}} \times 365$
8. Operating Ratio = $\frac{\text{Annual Operational Cost}}{\text{Annual Sales Revenue(Billing)}}$
9. Service Hours (Hrs./day) = [Avg. hours of service per day from water supply]
10. Water Quality (%) = $\frac{\text{Number of sample meeting standard}}{\text{Number of samples tested in supply point] (SEIU,2015)}} \times 100$

2.4Water Quality Standards in Nepal

According to National Drinking Water Quality Standards (NDWQS) 2005, the standard limits allowed by NDWQS,

Table 2.2 List of Parameters and concentration limits

CATEGORY	PARAMETERS	UNITS	CONCENTRATION
physical	Turbidity	NTU	5 (10)
	pH		6.5-8.5
	Color	TCU	5 (15)

	Taste and odor		Non-objectionable
	TDS	mg/L	1000
	Electrical conductivity (EC)		1500
Chemical	Iron	mg/L	0.3 (3)
	Manganese	mg/L	0.2
	Arsenic	mg/L	0.05
	Cadmium	mg/L	0.003
	Chromium	mg/L	0.05
	Cyanide	mg/L	0.07
	Fluoride	mg/L	0.5 (1.5)
	Lead	mg/L	0.01
	Chloride	mg/L	1.5
	Ammonia	mg/L	250
	Sulphate	mg/L	250
	Nitrate	mg/L	50
	Copper	mg/L	1
	Total Hardness	mg/L as $CaCo_3$	500
	Calcium	mg/L	200
	Zinc	mg/L	3
	Mercury	mg/L	0.001
	Aluminium	mg/L	0.2
	Residual Chlorine	mg/L	0.1-0.2
	Escherichia coli	CFU/ 100 ml	0
Micro-Biological	Total Coli form	CFU/ 100 ml	0 in 95% samples

Values in ( ) refers the acceptable values

Physical Parameters: These are the parameters that affect the physical characteristics of water. It includes Ph, turbidity, color, taste, odor, Total Dissolved Solids (TDS), Electrical conductivity (EC).

Chemical Parameters: These are the parameters that affect the chemical characteristics of the water. It includes Iron, Manganese, Arsenic, Cadmium, Chromium, Cyanide, Fluoride, Lead, Ammonia, Chloride, Sulphate, Nitrate, Copper, Total Hardness, Calcium, Zinc, Mercury, Aluminum, Residual chlorine.

Micro- Biological Parameters: These are the parameters that affect the biological characteristics of the water including Escherichia coli and Total Coli form[4,5].

In case of Nepal water suppliers they are responsible for water quality monitoring. Ministry of Health and population and its line agencies are responsible for surveillance of drinking water quality. The water suppliers should keep the records of regular monitoring test and analyses. The technical support will be provided by DWSS[5,6].

In most of the aquifers in Terai region of Nepal, there is a greater risk of arsenic contamination. The contamination of Iron and Manganese are likely to be low in the shallow groundwater where the aquifers

are aerated. The concentration of Iron is high in the deep anaerobic aquifers of Terai Region and Kathmandu valley [13,14].

3. Study Area

Kawasoti Municipality is one of the Municipalities of Nawalparasi (Bardaghat Susta Purba) districts which is located at the foothill of siwalik range with elevations between 180 to 235m above the mean sea level sloping down gently from north to south. The service area covers 1611 Hectares consisting 816 Ha forest area, 54 Ha built-up areas, 524 Ha agriculture areas and remaining are grazing and water bodies [12, 13]. According to Financial Appraisa Report of TDF, the project was designed to serve a total population of 14660 in base year 2006 and 34077 in design year 2020. Kawasoti is an emerging town and economy of service area is predominately commercial and service based.

4. Results and Discussions

4.1Bacterial Removal Efficiency of Slow Sand Filter

The Treatment plant of Kawasoti water supply comprises of 3 units of slow sand filter and Sedimentation tank. Its working efficiency was studied with the removal of E coli as the indicator. According to the literature slow sand filter, well designed treatment plant removes pathogens up to 90-99 % with the biological mechanisms with the formation of hypogeal layer on the top of the surface of slow sand filter and its process of metabolizing contaminants present in raw water. Also according to the design report, major water quality problems in source water of study area were turbidity and microbial contamination.

The value obtained from the field data showed that slow sand filter of Kawasoti water supply and sanitation project removes fecal coli form more than 90 percent and turbidity from its outlet is less than 5 NTU. According to the design report and literature review, removal of bacteria should be more than 90-99 % and turbidity less than 5 NTU from the well-designed slow sand filter. Thus these data showed that treatment plant is working efficiently.

4.2Satisfaction Level of Respondents of the Study Area

Consumer are greatly benefited through availability of desired quantity of water supply at scheduled time and frequency of supply saving tremendous of time and energy in their daily life which help them to do other possible activities in saved time.

Study showed that 83.33 % of the respondents believes that they are getting 24 hours supply, 15.38 % of respondent believes they are getting more than 12 hours supply, 1.28 % of the respondent believes that they are getting intermittent supply and none of the respondents believes that they are getting no supply at all. Water availability (more than 12 hours/day) in the study area is more than the average Nepal service provider which is about 10.7 hours per day in dry months.

5. Conclusions

The objective of the study was to assess the performance of Kawasoti water supply and sanitation project. Performance was assessed not only in terms of functioning of the water supply system but the management aspect was also accessed and financial analysis was done in order to find whether Kawasoti WUSC is able to sustain their systemor not. A brief study was conducted in the year 2015 by the team of DWSS. So, this study was focused on the changes occurred in the performance of Kawasoti water supply and sanitation project between the period 2015 and 2019. It is concluded that performance of awasoti Water.

Supply and sanitation project is more than average till the study period 2075 B.S. But in the near future, there is need for making proper planning for their financial management because they should be

prepared for system rehabilitation. It should also set new water rate to increase its revenue. The study also shows the great possibility of increasing the population as it is one of the emerging town resulting in the increase in the water demand. Thus, WUSC should make necessary planning for water supply management for meeting the growing water demand. The election and general assembly must be held on a regular basis.

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