Status of the Water Supply and Sanitation Projects in Pakali and Bharaul of Sunsari District

Pralad Nepali [1], A. K. Mishra [2], Mukti Nath Jha [3] & P. S. Aithal [4]

[1] Pralad Nepali, Madan Bhandari Memorial Academy Nepal, Urlabari -3, Morang, Nepal, Email: nepalipralad2074@gmail.com

[2] D.Sc Research Scholar, Srinivas University, India, and Associate Professor, Madan Bhandari Memorial College, Kathmandu, Nepal, OrcidID: 0000-0003-2803-4918; Email: anjaymishra2000@gmail.com

[3] Technical Officer (Agri. Engineering), Nepal Agricultural Research Council, Nepal. ORCID: 0000-0003-2577-5147; muktinath2043@gmail.com

[4] Professor, Institute of Management & Commerce, Srinivas University, Mangalore, India, OrcidID: 0000-0002-4691-8736; E-mail: psaithal@gmail.com

Subject Area: Project Management.
Type of the Paper: Status Inquiry Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.7857666
Google Scholar Citation: IJAEML

How to Cite this Paper:
Nepali, P., Mishra, A. K., Jha, M. N., & Aithal, P. S., (2023). Status of the Water Supply and Sanitation Projects in Pakali and Bharaul of Sunsari District. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(2), 35-49. DOI: https://doi.org/10.5281/zenodo.7857666

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0173

Received on: 08/03/2023
Published on: 24/04/2023

Status of the Water Supply and Sanitation Projects in Pakali and Bharaul of Sunsari District

Pralad Nepali [1], A. K. Mishra [2], Mukti Nath Jha [3] & P. S. Aithal [4]

[1] Pralad Nepali, Madan Bhandari Memorial Academy Nepal, Urlabari -3, Morang, Nepal, Email: nepalipralad2074@gmail.com

[2] D.Sc Research Scholar, Srinivas University, India, and Associate Professor, Madan Bhandari Memorial College, Kathmandu, Nepal,
OrcidID: 0000-0003-2803-4918; Email: anjaymishra2000@gmail.com

[3] Technical Officer (Agri. Engineering), Nepal Agricultural Research Council, Nepal,
ORCID: 0000-0003-2577-5147; muktinath2043@gmail.com

[4] Professor, Institute of Management & Commerce, Srinivas University, Mangalore, India,
OrcidID: 0000-0002-4691-8736; E-mail: psaithal@gmail.com

ABSTRACT

Purpose: *The paper is aimed to compare the current Status of the projects in Pakali and Bharaul water supply and sanitation projects in Sunsari district.*

Design/Methodology/Approach: *The effectiveness of the water user supply committee, the project's productivity index, the payback period, and the operating ratio of the chosen projects were analysed.*

Findings/Result: *The functionality status of Pakali and Bharaul water supply projects is found good but needs better by increasing the business. The operating ratio of the Pakali and Bharaul water supply projects was found 0.8 and 0.72 respectively which means they can bear their operating and maintenance cost. The selected projects are found technically feasible, and economically viable. Projects have profitability indices that are more than 1, indicating the potential to be implemented. Both water supply projects are water user supply committee registered, having own staff, Operation and maintenance fund, efficient water tariff collection, reliability, and accessibility but lack of water user supply committee meetings, and record keeping proper in Bharaul compared to Pakali whereas lack of water safety plan in both projects.*

Originality/Value: *The study will be a benchmark for continuous performance improvements of the systems and a reference for the department for assessing the performance of any system of water supply.*

Paper Type: *Status inquiry Research*

Keywords: Water Quality, Functionality Index, productivity index, Operating Ratio, Payback Period.

1. INTRODUCTION :

Water supply and wastewater disposal systems are the most ancient systems in any city. Skillful management of network assets in any waterworks organization has a significant impact on the quality of decisions and influences greater market competitiveness in the present period of civilization [1]. Community water supply is subject to context as Sri Lanka takes in a number of minimum connections 25 residents annually (Obosi, 2021) [2] whereas Piegdon, (2019) [3] takes as quantity, quality, and needed pressure to be maintained with convenient. Water system commissioning is an important aspect of any project involving a water system or the construction of a structure that contains one, since it ensures that the designers and end user's environmental criteria and conditions are followed. The purpose of commissioning is to demonstrate that the water system's design and installation resulted in a safe, energy-efficient, and effective system capable of running at peak performance. Water system commissioning is done in the last stages of a project to guarantee that all tests on the statically completed installation may be accomplished. The goal of any commissioning project is to

get a system from a state of static completion to full operational status in accordance with the defined goals and specifications (https://www.comfortservicesgroup.co.uk/commissioning-services/) [4].
Following the exchange of the board to the WUSC, the satisfaction of water lack in such regions might be challenged, bringing about the greatest water supply project coming up short during the activity and support period. As a result, it is necessary to determine whether the project commissioning process is complete or not.

2. STATEMENT OF PROBLEMS :

There is a lack of effective management transfer, either because they are unable to manage their systems or because they are not motivated. Existing supplies are rapidly depleting, therefore drinking and the building of a deep tube well provide an alternate supply. The capacity of surface and subterranean intake sources.
Using UNICEF experience around half of the world's population lacks access to adequate sanitation. Hand washing facilities with soap are unavailable to three billion people. Despite this, 673 million people defecate in the open [5]. Water lab tests revealed that the supplier's and consumers' understanding of water quality was low. Traditional water management is being implemented in the community, and the water source is being cleaned (Tamrakar, Sapkota and Shakya, 2017) [6]. In the Sunsari district, there are a number of projects available, but we have chosen two: Pakali and Bharaul water supply projects, which have similar structures but different surveyed DPR dates, both have not been handed over; we must verify the process of commissioning and infrastructure study. According to (Omar and Aly, 2021) [7], the flow reduction increased the amount of water that had to be reused. The WSQI consequently showed a significant level of water insecurity. The suggested actions reduced water shortages resulting insecurity. According to the study's findings, water security and the future water system in QENA Governorate can both be improved through adaption strategies. The study aids in the exploration and analysis of the current state of both projects, current management practices, and project issues in terms of management, technical, and economic aspects, thereby strengthening water user supply committee's capacity to effectively manage the system. It will be beneficial to decision-makers, policymakers, and programmers. This work focus on the study of the issues that are advantages for water user supply committee and Department of water supply to follow the standard commissioning process for effective management transfer.

3. OBJECTIVES :

The paper is aimed to compare the current Status of the projects in Pakali and Bharaul water supply and sanitation project in Sunsari district.

4. LITERATURE REVIEW :

4.1 Historical background:

In Kathmandu, the first Birdhara system (1891–1893) was established in 1895 A.D. by Prime Minister Birsumsher, the then-rana., marking the beginning of Nepal's piped water delivery system development. The system also resulted in the construction of *Panigoshwara adda* (Water Supply Office) and the provision of limited private and community standpipes in a few designated areas of Kathmandu. The water supply was subsequently eventually extended to a few other major locations such as Amlekhgunj, Birgunj, Palpa and Jajarkot Khalanga, where the rana kings or their family/relatives lived.
Since the First Periodic Development Plan of 1956-61, the sector has been given a fair importance. However, until the Department of Water Supply and Sewerage (DWSS) was formally founded in 1972, the sector's activities were remained under the Department of Irrigation. The Department was headquartered inside the Ministry of Water Resources at the time. The industry was mostly driven by the policies and initiatives outlined in the government's periodic and yearly development plans. There were no industry policies or laws in existence. The water supply sector was brought under the newly founded Ministry of Housing and Physical Planning (MOHPP) in the mid-eighties, which was renamed the Ministry of Physical Planning and Works after a few years (MOPPW). During this time, the industry was successful in developing important policies and laws. In the meanwhile, sanitation has received equal attention to water delivery. The idea of integrated water supply and sanitation programs (WATSAN) was presented, as well as a stand-alone sanitation program. Later on, hygiene became recognized as an important component of water and sanitation treatments (WASH)

(https://dwssm.gov.np/en/introduction/) [8]. Water is owned by the state under the 1992 Water Resource Act, and usage rights are granted through licensing. Priority has also been placed on utilizing water resources; when it comes to the use of water resources, drinking water takes precedence.

4.2 Water Supply Efforts by the Government:

The water supply and sanitation sector were opened to National and International Non-Governmental Organizations (I/NGOs) in the eighth five-year plan, and many additional donors were welcomed to assist the government in this sector. As a result, on the one hand, national coverage rose significantly, and on the other hand, community contribution via voluntary kind contributions increased significantly. The National Water Supply Sector Policy of 2004 marks yet another turning point in the sector's development.

This strategy introduced a new method that highlighted the involvement of recipients, local governments, and government facilitation. NGOs are participating in the scheme's implementation. It also underlined the importance of integrating sanitation and water supply services to reach the greatest number of people. Poverty alleviation was a major objective of the fourteenth plan. Through empowerment, human sector development, security, and targeted initiatives, the plan aimed to reduce water-borne diseases, poverty among women, untouchables, people from distant areas, and the severely backward sector, while also boosting economic level and development prospects [9, 10, 11, & 12].

4.3 Policy on Rural Energy Subsidies:

As per the policy, a maximum subsidy of up to 60% of the total expenses, but no more than NRS 1, 50, 000 per system, will be given to PV drinking water pumping systems that are administered by a community or private firm. A further NRS 4000 per household subsidy will go to the "designated recipient groups."

The National Sector Development Plan for Water, Sanitation, and Hygiene (WASH) is a strategic framework for ensuring the effective, efficient, and long-term supply of WASH services. The goal of the SDP is to provide universal access to WASH services while improving sector governance and effectiveness through a national WASH program that is coherent, uniform, and harmonized and is integrated with government policies and initiatives. The SDP's scope encompasses health, education, and local development, with a 15-year time horizon beginning in fiscal year (FY) 2016-17. The plan will be updated every five years and is divided into three periods [8, 10, & 13].

4.4 Community management and water supply system:

The water supply users' committee manages the majority of the water supply networks in Nepal (WSUC). The water supply system's technical performance is deemed to be inadequate. Even if the water supply at the source is sufficient to fulfill demand, a large amount of water is lost owing to reservoir leakage (Mishra, Sudarsan, Suribabu and Nithiyanantham, 2022) [14]. Weaknesses in the water delivery system included declining functioning, declining water quality, and lost data. The user's committee needed to strengthen their ability for the system's smooth operation, and the primary considerations they needed to make were the absence of a standard procedure, open defecation, and financial concerns (Mishra and Karna, 2019) [15]. The framework for a more complete investigation of the CBM model's ongoing usage as a primary development strategy by concentrating on community management of rural water stations (Whaley and Cleaver, 2017) [16]. A good construction practice for any construction project means that it is devoid of flaws, that the appropriate things are done at the right time, and that the project is continually improved. It is determined by the project's duration, cost, quality, and safety. The majority of initiatives fall short of their deadlines, budgets, or both. Time overruns appear to be a big problem for government undertakings. The considerable time overruns in the projects under investigation were caused by the fact that the project's ideal completion time was allocated during the contract agreement [17]. Fittings should be changed and high density polythene pipe must be grounded correctly to reduce the danger of leakage in transmission and distribution pipelines. To make society feel serviced, a tariff should be collected from all water users' households and institutions, with the goal of conserving water and improving financial conditions (Mishra, 2018) [18 & 19]. The irrigation ratio to water use suffered during the drought. Supplies and performance were significantly impacted. Assuming we think about water, land, and water supply efficiency signs

of our review region and the results of finished examinations out by the IWMI in various countries all over the planet, they could be to be correct (Mengu and Akkuzu, 2015) [20]. Water supply network the board ought to now be supported by the reception of IT programs (network observing or GIS frameworks) that help administrators in productively working the organization and settling on speedy and exact choices when horrible occasions happen because of the significance of guaranteeing the security and steadfastness of water supply to shoppers [3, 21]. According to the research, there are seven basic factors that either push or drive communities into ODF status. Commitment, cooperation, and communication are among the characteristics that cause the community to establish an ODF zone, while other aspects push the community away from it. The villages in MAHOTTARI district have formed a social code of behavior that includes rewards and sanctions in order to keep the ODF zone designation (Jha and Jha, 2019) [22].

4.5 Strategy for water safety:

Under circumstances of water scarcity, maintaining ecological flow and natural water bodies continues to be of utmost importance. The management and operation of the residential water distribution networks must be enhanced for urban water delivery. In order to address all concerns correctly and promptly, decision-making procedures should rely on trustworthy facts that characterize system operation, such as flows, prospective faults, losses, and/or other difficulties (Tzanakakis, Paranychianakis and Angelakis, 2020) [23].

Currently, 21% of the populace approaches more significant level or mid-standard drinking water offices, while 89% of the populace approaches fundamental drinking water facilities. In recent years, 98% of residents have received access to fundamental sanitation services. The availability of these treatments has led to an increase in life expectancy and a decrease in neonatal mortality. Additionally, it has increased people's productivity hours by improving their health, and it has positively impacted people's social behavior and children's attendance at school.

Numerous natural and human-made processes have led to the depletion of water resources, which has decreased the availability of drinking water. The provision of safe, dependable, or long-term drinking water services has not yet occurred as anticipated. Settlements, rivers, streams, and other water bodies, as well as the environment overall, are becoming more and more polluted as a result of rising urbanization, expanding human activity, and development 253 activities. Additionally, the environment as a whole is polluted due to improper waste management ensuring that all citizens have access to clean and safe drinking water, as required by the Nepalese Constitution, protecting and conserving the dwindling levels of surface and underground drinking water sources, making drinking water and sanitation-related infrastructure disaster- and climate-adaptive, adroitly managing the impact of poorly organized urban settlements on the supply of drinking water, and improving the functionality of all three tiers of government and sanitation sector in accordance with the revised institutional framework, including gathering and processing wastewater produced by human wastes, as well as industrial and agricultural wastes, in cities, towns, and settlements, and its effective management using suitable technology, The altered context suggests identifying, planning, and implementing community-level projects that call for higher levels of accountability; the increased demand for high-quality drinking water and sanitation services as a result of ongoing improvements to the quality of life; the growing public awareness of the importance of protecting water resources like rivers, streams, ponds, lakes, and other water bodies; and the increased demand for reliable and valid.

By the end of the plan, 99 percent of the populace will approach fundamental water supply and disinfection administrations, up from the present 89%, and around 40% of the populace would have access to enhanced (high and medium level) drinking water services. The full sanitation initiative will continue in areas where open defecation is no longer an issue. It will have been treated and at least 20% of the wastewater produced by home, industrial, and other human activities will have been discharged into the environment [13].

4.6 Water Quality in Nepal:

Currently, 88% of the populace approaches essential drinking water administrations, with roughly 20% having access to medium and high-level services. Existing water schemes are still in poor working order. Only 25% of the country's water schemes are said to be fully operational, with 36%

requiring minor repairs and 39% requiring extensive repair, rehabilitation, or replacement. Given the vulnerability of current systems to pollution and poor water treatment procedures, water quality remains a top priority concern. 71 percent of all water sources, including 91 percent of those used by the poorest quintile, are polluted with E. Coli (Escherichia coli), a common cause of diarrhea.
Groundwater contamination with arsenic (As) and heavy metals has reached alarming levels in the country's southern plains. Only 34% of the water supplied is said to be safe to drink, and only 15% of that meets national water quality criteria. In the 1980s and 1990s, the percentage of individuals with access to basic sanitation hovered between 2% and 6%, but by mid-2019, it had risen to almost 99 percent. The Nepali government declared the nation to be "open defecation free" (ODF) on September 30, 2019, and is now rapidly expanding access to safely managed sanitation services as the next priority.

(https://newah.org.np/wash-facts) [9]

Water quality standards are standards for several sorts of water quality criteria. In the year 2005, Nepal's National Quality Standards (NDWQS) went into effect. Prior to 2005, Nepal adhered to World Health Organization (WHO) guidelines.
It was discovered that of the average rainfall in the SUNSARI district, groundwater recharge accounted for 52%, surface runoff 44%, and Evapotranspiration loss 4%. Similar to this, we saw that surface runoff in Dharan was 48%, evapotranspiration loss was only 21%, and recharging was only 31% of annual rainfall average [24].

5. METHODOLOGY :

5.1 Research Philosophy:

This research adopted the pragmatic research philosophy. The most significant determining factor of the research philosophy, according to pragmatism, is the research question. The method uses, a literature review, problem identification, case study, and expert opinion are the approaches used to accomplish the research's goal. Generally speaking, research techniques using both quantitative and qualitative approaches were used. As a study framework, the specifics of the research configuration are portrayed in figure 1 describes the process of the research work in a flow chart.

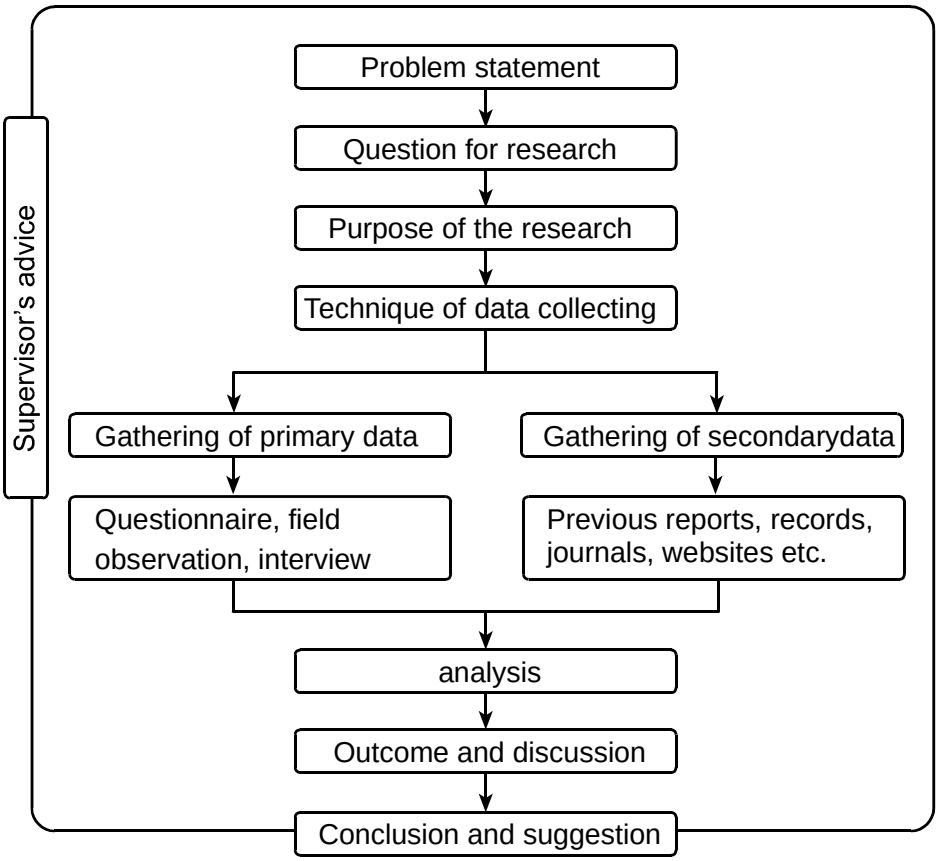

Fig. 1: Research methodology flow diagram of this work

5.2 Research Approach:

Interviews, questionnaires, and WUSC and users of the selected WSPs were utilized in this study to collect information using qualitative and quantitative methodologies via questionnaires. Ex-post facto research was used in this study, which combined qualitative and quantitative research methods. A case study of a few initiatives was carried out.

5.3 Study Area:

Sunsari district with Itahari sub metropolitan and Barahachetra municipality was chosen as the research region because it contains a mixed-race population and is close to the Indian border. The WUSC manages many rural water supply projects in the Sunsari area. Since just 25.4% of water supply projects, according to NMIP statistics, are operating effectively, the rural water supply project in Sunsari district similarly has trouble operating. Only two of these were chosen as examples. The Pakali water supply project and the Bharaul water supply project were two among them.

5.4 Indicator of performance:

To determine the institutional performance of a particular water supply project, the following Indicators are examined.

Functionality Index

NMIP 2014 created certain functionality Indicators for determining the functional condition of water supply projects. The functioning Indicators are focused on year-round supply, sufficient staff (both technical and administrative), WSUC registration, and the operation and maintenance money. For establishing the present functional index, the researcher used 10 indications adopted from NMIP 2014 applied in series of studies of Nepal by Mishra and associates 11, 12, 14, 15, 18. & 19].

6. RESULTS AND ANALYSIS :

6.1 Water Supply and Sanitation Projects' Current Status:

Table 1: WSPs' Current Situation

Name of WSP	Pakali water supply and sanitation project	Bharaul water supply and sanitation project
Service provider	WUSC	WUSC
Supply HRS.	10hrs a day	8hrs a day
Supply system type	Intermittent	Intermittent
Connection type	Public connection	Public connection
the number of connections	650	3000
Automation	Simple for pump operation	Simple for pump operation
System of back-up	1nos stand by pump	1nos stand by pump
Tariff for water	RS.150 per month from each household connection	RS.110 per month from each household connection

(Source: - Official Records, 2022)

A study area is the Pakali WSP. Itahari Ward No. 15 is the project's covering area. According to the Pakali WSP's research, the project provides water for 10 hours each day. The WUSC was determined to be properly registered. Major maintenance and repairs are carried out using funds obtained from customers.

According to the survey, consumers were experiencing serious issues prior to the implementation of this initiative. People used to carry their potters and carry water because no entity supplied basic level water delivery services. There is a metering hookup at each public water fountain. When the service is interrupted, a WUSC member tells the customers they are content because they were able to fill their pots close to home. The operation of the pump was automated simply. The customer paid a water tariff of RS. 150 per unit.

Table 2: Functionality status of selected project

S. N.	Indicators	Weightage	Marks obtained	
			Pakali WSSP	Bharaul WSSP
1	WSUS Registered	Yes (10), No (0)	10	10
2	Having own staffs with maintenance workers	Yes (10), No (0)	10	10
3	O & M Fund sufficient	Sufficient (10), Less (5), No (0)	10	10
4	WSUC Meeting	Regular Yes (10), Irregular (5), No (0)	10	5
5	Efficient water tariff collection	Yes (10), Partial (5) No (0)	10	10
6	Record keeping proper	Proper (10), Random (5), No	10	5
7	Tools and fittings reserve	Sufficient (10), Inadequate (5), No (0)	10	10
8	Water safety plan	Functional (10), partial Functional (5), Non Functional (0)	5	5
9	Reliability	whole year supply Yes (10), 9 months (5), Six month (0)	10	10
10	Accessibility in minutes	15 minutes (10), 30 minutes (5), more than 30 minutes (0)	10	10
Total	95	85		

(Source: - Field Survey, 2022)

WUSC members maintain tariff records. Water is obtained from the Boring, which has been tested and treated in a treatment facility.

6.2 Functionality of selected water supply project:

A research area is the Bharaul WSP. The project's coverage area is Barahchetra Wards 3, 4, and 5. According to the Bharaul WSP's analysis, the project provides water eight hours a day. The WUSC was determined to be properly registered. Major maintenance and repairs are carried out using funds obtained from customers. According to the survey, consumers were experiencing serious issues prior to the implementation of this initiative. There is a metering hookup at each public water fountain. It was discovered that there is no possibility of water waste. Water is used extremely carefully by people. WUSC members believe that they are content since they can fill their pots close to their homes when the water supply is disrupted. The operation of the pump was automated simply. The customer paid the water tariff of RS. 110 per unit. WUSC members maintain tariff records. Boring is the source of the water, and a treatment facility has evaluated and improved the water's quality.

The Current Functionality Index (CFI) is between 85 and 95 percent. According to Mishra and Acharya, [25], The Salyankot Water Supply Project's physical structure index demonstrates that the project's physical structures are currently in satisfactory condition, with an index of 56.81%, and were in good condition before the earthquake, with a value of 95%.

The district water resource committee oversees the registration of all water supply projects. Each project has a sufficient number of employees to operate. The Pakali WSP and Bharaul WSP raise money for their minor upkeep and repairs. The Pakali WSP's WSUC holds monthly meetings. and Bharaul WSP conduct irregular meeting.

The water tax is adequately collected. Pakali WSP's record keeping is accurate, but Bharaul's is haphazard. There are enough tools and the right supplies on hand for maintenance. The water safety program has not yet begun. Every project runs throughout the entire year, and water supply service is available in 15 minutes. According to the estimate, the project is now operating in a functional mode with a CFI range of 85% to 95%.

6.3 Operating Ratio (NRS. / m3):

The operating ratio is the proportion between the project's operating and maintenance expenses and the money the water tariffs bring in. It measures water use, charging covers the operating and maintenance cost easily or not. The yearly activity and support cost and income of Pakali WSP was found in NRS. 840000 and NRS 1500000 including electric connection cost RS 360000 per year. The yearly activity and support cost and income of Bharaul WSP was found in NRS.1200000 and NRS 9600000 including electric connection cost RS 3000000 per year.

Table 3: Operating ratio of Pakali and Bharaul WSP

Projects	Pakali water supply and sanitation project	Bharaul water supply and sanitation project
Operating Ratio = (1)/(2)	0.8	0.72
Annual O& M cost.in Staff salary NRS in (1)	840000	1200000
Cost occurred due to electric connection	360000	960000
Total annual billing in NRS (2)	1500000	3000000

(Source: - Field Survey, 2022)

6.4 Staff Productivity Index:

The number of personnel per 1000 connections is how the staff productivity index is expressed. When the productive index is greater, there are more employees per 1, 000 connections, and when it is lower, there are fewer employees per 1, 000 connections. A significant indicator of a utility's effective utilization of human resources is how few employees there are per 1000 connections.

Table 4: Staff productivity index of PAKALI and BHARAUL WSP

Projects	PAKALI	BHARAUL
No. of Staff (1)	3	3
No. of Connection (2)	650	3000
Formulae for Staff Productivity Index	(1)*1000/(2)	
Staff Productivity Index	4.61	1
Required No of Staff = Round (0.007*connection no.)	5	21

(Source: - Field Survey, 2022)

In Pakali WSP, there are 650 connections, and there are 3 staff members for a total of 3000 connections. In Bharaul WSP, there are 3 staff members for a total of 3000 connections. The staff productivity index (figure 2) for the aforementioned four WSUC projects in 2021/22 is 4. 1 and 1. Staff productivity index scores across the country average 7.2. One of the main responsibilities of WSUC is the effective utilization of human resources. The employees must be motivated and well-trained. Discussions with WSUC employees revealed that they believed the lack of water prevented them from meeting demand and that instead,

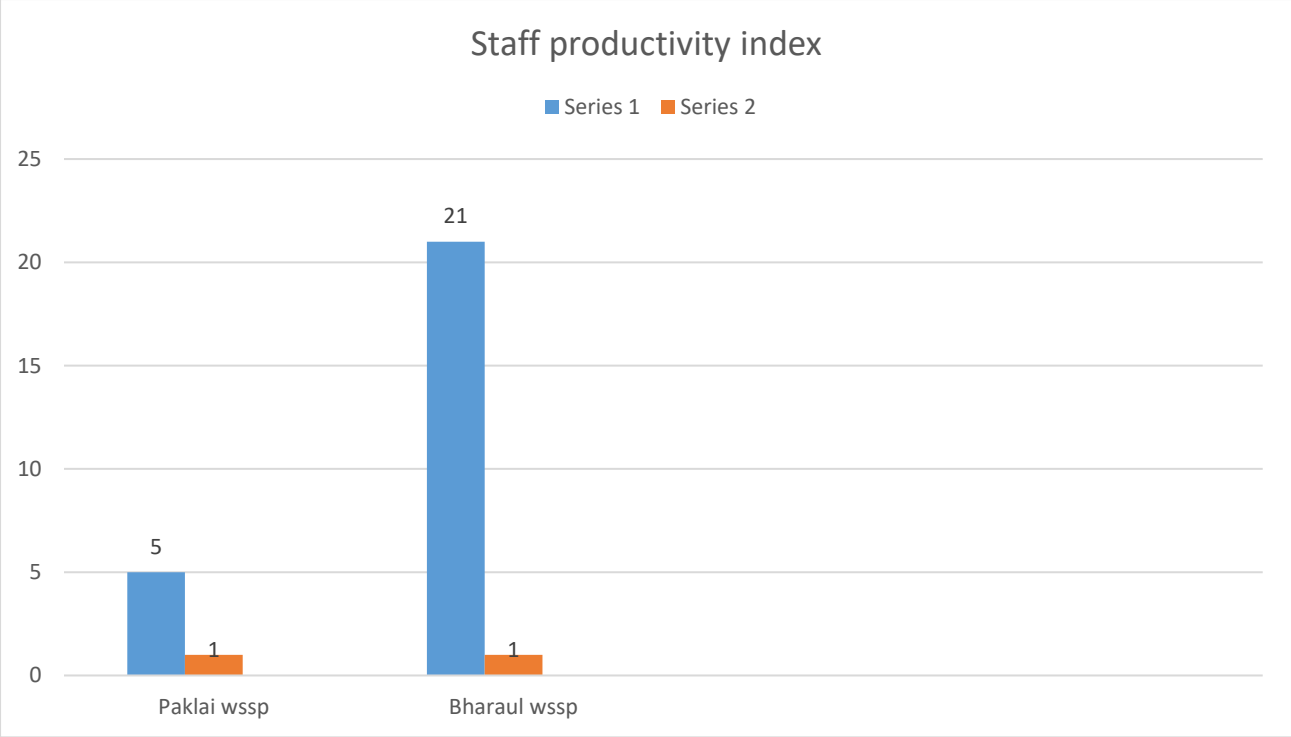

Fig. 2: Staff Productivity Index of WSPs

They needed to manage the water that was available to ensure uniform distribution.

Table 1 Percentage of different cost for operation of WSPs

Projects	Pakali	Bharaul
Electricity bill in NRS.	30000	80000
Electricity bill in %	10	24.24
Manpower cost in NRS.	70000	100000
Manpower cost in. %	23.33	30.30
Repair and maintenance in NRS.	200000	150000
Repair and maintenance in %	66.66	45.45
Total operation and maintenance cost	300000	330000

Source: Field Survey, 2022

In PAKALI 10% cost consumed by electricity, 23.33 % cost in manpower cost and 66.66% for repair and maintenance. Similarly, in BHARAUL 24.24 % cost consumed by electricity. 30.30 n% cost in manpower and 45.45 % for repair and maintenance.

6.5 Feasibility Study of Selected Water Supply Project:

6.5.1 Profitability index

It measures whether the venture has potential for execution or not. The monetary practicality of the undertaking relies on the profitability index. The speculation choice will be made by registering the profitability index. If this index is more than 1, the project is suitable for investment. The profitability index while using electric power and solar power is tabulated below (Table 6 & figure 3).

Table 6: Profitability Index of WSPs using different power

Projects	Pakali WSSP	Bharaul WSSP
Profitability index using electric power	1.03	1.04

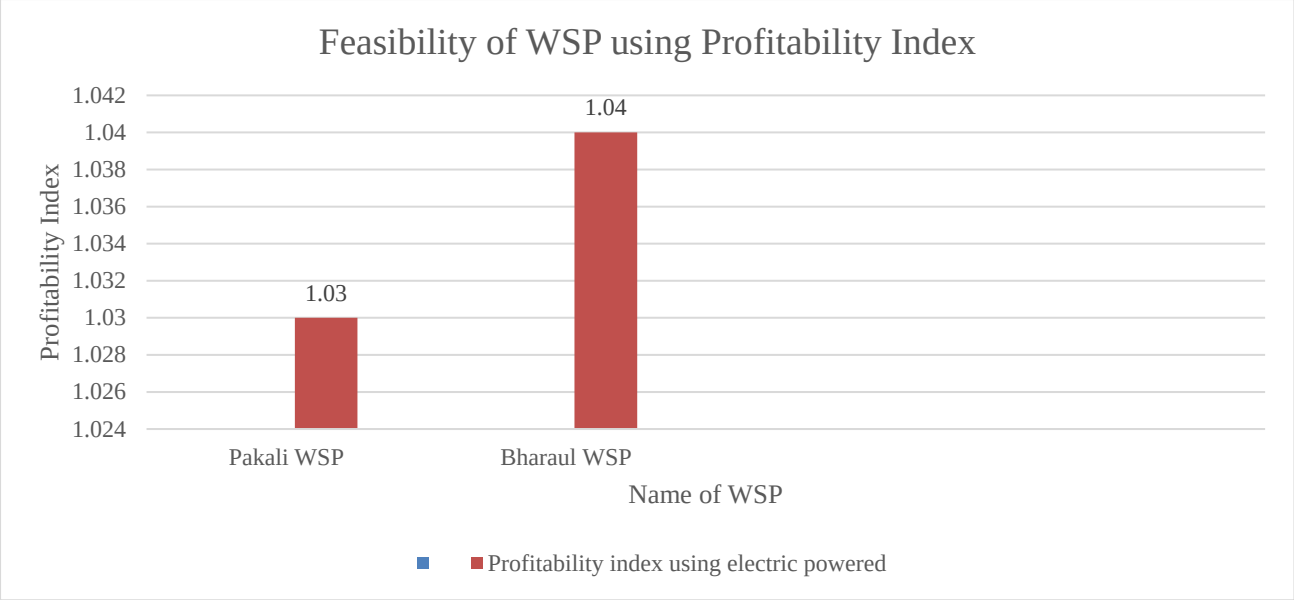

Fig. 3: Profitability index presentation in graphical form

The profitability index using electric power in PAKALIWSP was found 1.03, and BHARAULWSP, was found 1.04. which means all projects are feasible for study.

6.5.2 Payback Period Analysis:

The payback period is the amount of time that it will take for the cash inflows produced by an investment to recoup its initial outlay. It is among the easiest methods for valuing investments (table 7 & figure 4).

Payback period is a sign of project risk because it only considers initial inflows and disregards incomes after the underlying speculation is recuperated. This is on the grounds that income gauges are very precise for periods soon and moderately erroneous for periods in the far-off future because of monetary and functional vulnerabilities. Whether the project generates equal or uneven monthly cash inflows determines the method used to determine the payback time for an investment.

Table 7: Payback period of WSPs

Project	PakaliWSPs	BharaulWSPs
Payback Period of the project in present condition	30.68 years	25.37 years
Expected Payback period after handover	11.55	10.93

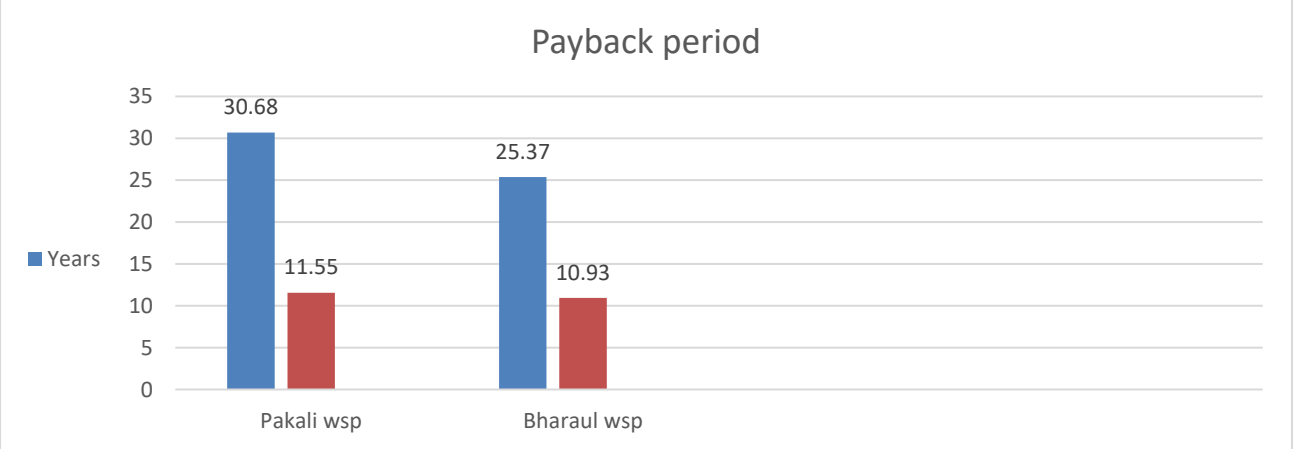

Fig. 4: Payback period in graphical form

The payback period of Pakali WSPs was 30.68 years, Bharaul WSPs is 25.37 years. Since each project was not handed over, thus we can expect better payback period and expected payback period of Pakali was 11.55 and Bharaul was 10.9. According to [14, &15] Payback time was estimated to be three years and a half month when reservoir costs, operating costs, and maintenance costs were taken into account. Similarly, the payback periods for NRW at 0% and NRW for the national average of 21.6%.

6.6 Technical parameter:

Table 8: Different technical parameter of WSPs

Projects	Pakali	Bharaul
Discharge, LPS	12	12
Pumping Head (m)	70	80
Pump module	15HP Submersible	15HP Submersible
No of pumping stage	1	1
Pump availability	yes	Yes
Land availability	yes	Yes
Land facing other than north	yes	Yes
No of cloudy and hazy days in a year	30	15

Data source: Field Survey, 2022

The cloudy and hazy days of Pakali WSP were found 30 days from questionnaire survey conducted whereas 15 days of Bharaul WSP.

6.7 Comparative study of water quality test of selected water supply project:

Table 2 Water quality test of WSP

S. N.	Paramete RS	Observed Values in Pakali WSSP				Observed Values in Bharaul WSSP				NDWQS, 2062 BS
	-	Source 1	Tap1	Tap 2	Source2	Source1	Tap1	Tap2	Source2	
1	Turbidity (NTU)	11.2	4.4	9.2	>20	1.7	_	_	0.5	5 (10)
2	pH	6.9	7.2	7.2	7.0	6.3	6.7	_	6.3	6.5 - 8.5 *
3	Electrical Conductivity (µs/cm)	287	296	293	302	283	295	_	300	1500
4	TDS (mg/L)	192	198	196	202	190	198	_	201	1000
5	Faucal coliform *E.coli* (CFU/100 ml)	0	0	11	0	0	0	_	0	0
6	Color, Taste & Odor	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	_	N.O.	No
7	Free Residual Chlorine (mg/L)	_	_	_	_	_	_	_	_	0.1-0.2*
8	Total Hardness (mg/L as $CaCO_3$)	148	_	_	154	82	_	_	86	500
9	Iron (mg/L)	1.9	0.3	1.0	4.7	0.4	_	_	<0.2	0.3 (3)
10	Calcium (mg/L)	42.3	_	_	40.9	17.6	_	_	19.2	200

11	Arsenic(mg/L)	<0.01	_	_	<0.01	<0.01	_	_	<0.01	0.05
12	Nitrate (mg/L)	0.8	_	_	0.5	1.1	_	_	1.2	50
13	Fluoride (mg/L)	0.2	_	_	<0.2	<0.2	_	_	<0.2	0.5-1.5

APHA: American Public Health Association, Standard Methods for Examination of Water & Waste Water *(Source: - Test Report, 2022)*

**** These values show lower and upper limits.***

From the above result obtained from lab (table 9) we can conclude that water is drinkable for both Pakali and Bharaul WSP but In PakaliFaucal coliform *E-coli*and Iron is morethan limitin tap 2 so that we can suggest treated before supply which is already seen that there is treatment plant**.**
According to (Rak and Urbanik, 2019) [26], the safe operation of the water treatment system is taken into account in compliance with the water quality standard. Over all sustainable water is a continuous researchable issue so new research in its commissioning aspects should be conducted in reference to global literature [27, 28, 29, 30, & 31]. If commissioning found to enhance project performance in water supply projects of Nepal then during contract an exercise of including commissioning should be assured for the effective performance of water supply system to fulfill constitutional rights and human rights for total sanitation target of Nepal [32].

7. CONCLUSIONS :

The functionality status of Pakali WSP and Bharaul WSPs are found good but need better by increasing by business plan. The operating ratio of Pakali WSP and Bharaul WSPs projects was found 0.8 and 0.72 respectively which means it can bear its operating and maintenance cost. The selected projects are found technically feasible, economically viable. The profitability index support for implementation. Both WSP projects are WUSC registered, having own staff, O/M fund, efficient water tariff collection, reliability and accessibility but lack of WUSCmeeting, record keeping proper in Bharaul compare to Pakali whereas lack of water safety plan in both projects. The water quality test shows that there is no turbidity and other chemical cross the required limit but in Pakali Faucal Coli form *E. coli* and Iron is more than limit in tap 2 so that we can suggest treated before supply which is already seen that there is treatment plant. The functionality index of the Bharaul WSPs should be improved by conducting regular meetings of WUSC, implementing a water safety plan, and should adopt the record-keeping system. Pakali WSPs should be improved by implementing water safety plan.

8. ACKNOWLEDGEMENT :

The author is thankful to all the professionals who took part in discussions and Saanvi Lavanya (Betkumar) for being with us as source of happiness. It is an academic exercise conducted at Madan Bhandari Memorial College,

REFERENCES :

[1] Piegdoń, I., Tchórzewska-Cieślak, B. and Szpak, D. (2017). The use of geographical information system in the analysis of risk of failure of water supply network. Environmental Engineering V - Proceedings of the 5th National Congress of Environmental Engineering, (March 2019), pp. 7–14. DOI: https://doi.org/10.1201/9781315281971-3.

[2] Obosi, J. O. (2021) Community Management and Water Service Delivery in Africa Community management and water service delivery in Kenya View Project Community water management View Project Community Management and Water Service Delivery in Africa. www.intechopen.com

[3] Piegdoń, I. (2019). The use of statistical inference in the water supply network managing operation process, *Journal of Konbin, 49*(4), 221–244. DOI: https://doi.org/10.2478/jok-2019-0084.

[4] https://www.comfortservicesgroup.co.uk/commissioning-services/

[5] https://www.unicef.org/nepal/water-and-sanitation-wash

[6] Tamrakar, P., Sapkota, K. and Shakya, S. K. (2017). Water quality assessment of city water supply in Kathmandu valley. *Indian Journal of Environmental Protection, 37*(4), 290–297. Google Scholar↗

[7] Omar, M. E. D. M. and Aly, M. M. (2022). Assessment of water resources system in Qena governorate, Upper Egypt under different hydrological and agronomic conditions. *Water Supply, 22*(3), 3015–3026. DOI: https://doi.org/10.2166/WS.2021.413.

[8] https://dwssm.gov.np/en/introduction

[9] https://newah.org.np/wash-facts

[10] NPC (2019) The Fifteenth Plan (2076/77-2080-81). National Planning Commission, Government of Nepal Kathmandu Nepal. Available at: https://npc.gov.np/images/category/15th_plan_English_Version.pdf

[11] Mishra, A. K. et al. (2022). Performance evaluation of existing water supply system: a case study. *International Journal of Energy and Water Resources*, (0123456789). DOI: https://doi.org/10.1007/s42108-022-00195-z.

[12] Mishra, A. K. (2019). Institutional Performance Assessment of Water Supply System. *Saudi Journal of Business and Management Studies, 04*(09), 698–707. DOI: https://doi.org/10.36348/sjbms.2019.v04i09.002.

[13] GWP-Nepal & JVS (2018).Water Nepal: A Historical Perspective. NPC (2019). The Fifteenth Plan (2076/77-2080-81) National Planning Commission, Government of Nepal Kathmandu Nepal', pp. 1–418. Available at: https://npc.gov.np/images/category/15th_plan_English_Version.pdf.

[14] Mishra, A. K., Sudarsan, J. S. and Nithiyanantham, S. (2022). An assessment of status of selected electric connected pumping water supply projects of Gandaki Province of Nepal-Asia. *International Journal of Environmental Science and Technology*, (0123456789). DOI: https://doi.org/10.1007/s13762-022-04017-x.

[15] Mishra, A. K. and Karna, A. K. (2019). Assessment of Management Transfer Process of Water. *International Journal of Research -GRANTHAALAYAH, 7*(1), 1–24. DOI: https://doi.org/10.5281/zenodo.2550077.

[16] Whaley, L. and Cleaver, F. (2016). Can "functionality" save the community management model of rural water supply?. *Water Resources and Rural Development, 9*(6), 56–66. DOI: https://doi.org/10.1016/j.wrr.2017.04.001.

[17] Mishra AK, Bhandari S, Jha T. (2018). Factors Affecting Performance and Time Extension of ongoing Construction Projects under Town Development Fund, Nepal. *J Adv Res Const Urban Arch, 3*(4), 7-25. DOI: https://doi.org/10.5281/zenodo.7340188.

[18] Mishra, A. K. (2018). Sustainability and Risk Assessment of Salyankot Water Supply Project in Post-Earthquake Scenario. *International Journal of Operations Management and Information Technology, 8*(1), 1–30. Available at: http://www.ripublication.com

[19] Mishra, A. K. (2019). Water Finance Assessment in Drinking Water Supply System. *Saudi Journal of Economics and Finance, 03*(10), 383–394. DOI: https://doi.org/10.36348/sjef.2019.v03i09.003.

[20] Mengü, G. P. and Akkuzu, E. (2010). Impact of Irrigation Management Transfer on Land and Water Productivity and Water Supply in the Gediz Basin, Turkey. *Journal of Irrigation and*

Drainage Engineering, *136*(5), 300–308. DOI: https://doi.org/10.1061/(asce)ir.1943-4774.0000191.

[21] Piegdon, I. et al. (2018). Analysis of selected reliability indicators of water supply network. *Journal of Konbin*, *47*(1), 45–65. DOI: https://doi.org/10.2478/jok-2018-0038.

[22] Jha, D. K. and Jha, T. (2019). Factors Contributing to Management of Open-Defecation-Free Movement of Sanitation in Mahottari District in Nepal. *J Adv Res Busi Law Tech Mgmt*, *2*(1), 21-35. Google Scholar↗

[23] Tzanakakis, V. A., Paranychianakis, N. V. and Angelakis, A. N. (2020). Water supply and water scarcity. *Water (Switzerland)*, *12*(9), 1–16. DOI: https://doi.org/10.3390/w12092347.

[24]Yadav, J. P. et al. (2022). Surface Water and Groundwater Recharge Modeling in Sunsari District using Integrated SWAT-MODFLOW Model. *Journal of Advanced Research in Civil and Environmental Engineering*, *9*(2&2), 12-22. DOI: https://doi.org/10.24321/2393.8307.202202.

[25] Mishra, A. K, Acharya, S. R. (2018). Performance assessment of Salyankot water supply project in post-earthquake scenario of Nepal. *Journal of Advanced Research in Geo Sciences & Remote Sensing*, *5*(3&4): 23–40. Google Scholar↗

[26] Rak, J. R. and Pietrucha-Urbanik, K. (2019). An approach to determine risk indices for drinking water-study investigation. *Sustainability (Switzerland)*, *11*(11), 3189, 01-18. DOI: https://doi.org/10.3390/su11113189.

[27] Cardoso, M. et al. (2004). Performance assessment of water supply and wastewater systems. *Urban Water Journal*, *1*(1), 55–67. DOI: https://doi.org/10.1080/15730620410001732053.

[28] Dawidowicz, J. and Czapczuk, A. (2018). The reliability of rural water distribution systems in relation to the layout of the pipework within the network. *Technical Transactions*, *115*(3), 141-151. DOI: https://doi.org/10.4467/2353737xct.18.043.8305.

[29] Hamchaoui, S., Boudoukha, A. and Benzerra, A. (2015). Drinking water supply service management and sustainable development challenges: Case study of Bejaia, Algeria. *Journal of Water Supply: Research and Technology - AQUA*, *64*(8), 937–946. DOI: https://doi.org/10.2166/aqua.2015.156.

[30] Kjerulf, L. and Jensen, P. A. (2020). Strategies for commissioning processes to ensure sustainable building performance. *IOP Conference Series: Earth and Environmental Science*, *588*(4), p. 042020. DOI: https://doi.org/10.1088/1755-1315/588/4/042020.

[31] Yang, W. (2017). Study on system commissioning test and project application of Lingzhou to Shaoxing UHVDC transmission project. *The Journal of Engineering*, *2017*(13), 2188–2192. DOI: https://doi.org/10.1049/joe.2017.0718.

[32] Bahadur, K. C. M., & Mishra, A. K. (2019). Bidding Trends of Contracts based on Types and Sizes of Projects under Road Divisions Butwal and Shivapur. J Adv Res Const Urban Arch, 4(3&4), 7- 16. DOI: https://doi.org/10.24321/2456.9925.201905.

****