Commissioning of Water Supply and Sanitation Projects- A Case from Nepal

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ABSTRACT

Purpose: *Assessment of project commissioning and management transfer of Pakali and Bharaul water supply and sanitation projects were done systematically for assuring smooth operation of the system.*

Design/Methodology/Approach: *Sunsari district with Itahari sub metropolitan and Barahchetra municipality were chosen as the research region because it contains a mixed-race population and is close to the Indian border. Interviews, field perceptions, and surveys were utilized to gather essential information; writing (distribution reports, inspecting reports, records, and information) from both a public and global setting was utilized. The statistical tools used to analyze the adopted process of project commissioning are clustered column, line and bar chart.*

Findings/Result: *Pakali and Bharaul project have been compared on the basis of steps that should be followed for successful project commissioning Both of selected project were found competent in planning and pipe and instrumentation diagrams. In terms of mechanical completion, pre-commissioning, commissioning, start-up, initial operation, and performance testing, none of the chosen projects were deemed competent. Both projects are not handed over yet thus post commissioning is not done.*

For a successful commissioning, it is recommended a management transfer procedure that involves calibrating and sterilizing the system, having the "water operator's standard" document in place, and training the office staff and members of the water user supply committee.

Originality/Value: *The novelty of this research is commissioning analyses the nine elements of successful plant commissioning.*

Paper Type: *Research paper*

Keywords: Commissioning of water supply**,** Mechanical completion, Calibration, Sterilization, Sanitation project, Business plan.

1. INTRODUCTION :

A country like Nepal where budget deficiency without foreign aid seems adequate like many developing countries [1 & 2], projects without proper commissioning may increase liability as infrastructure decide the further path of development. In Nepal, 10.8 million individuals need admittance to better sterilization, while 3.5 million need admittance to essential water services. Despite enormous hurdles such as poverty, tough terrain, and conflict, Nepal has achieved remarkable progress in improving access to water and sanitation during the previous few decades. Ninety-five percent of homes now have better water sources, compared to 46 percent in 1990, and sixty-two percent of households use improved sanitation facilities, up from six percent in 1990. However, water scheme functionality and water quality

remain poor, with Escherichia coli bacteria contaminating 71% of all water sources and 91% of those utilized by the poorest quintile. Only 25% of the water supply is said to be fully operational, with over 40% requiring significant repairs. There is still open defecation [3].

The issue of execution appraisal in water and wastewater frameworks has been tended to, by checking on two of the devices that are accessible to the utilities working in one or the other or the two fields: frameworks of execution markers and specialized execution evaluation through recreation (Cardoso, Coelho, Matos and Akegre, 2004) [4].

2. STATEMENT OF THE PROBLEM :

For fulfillment of water deficiency in that area there may be challenged after management transferred to the water user supply committee so that most extreme water supply project falls flat during the activity and upkeep period. Thus, there is need of project commissioning process is satisfied or not.

There is provided guidance on water and disinfection administration arrangement in country regions utilizing local area drove participatory methodologies by public strategy on provincial drinking water supply and sterilization (2004) [5] yet there is absence of compelling administration move either due to not ready to deal with their framework or not roused.

There is drying up day by day by existing sources thus the alternative source is provided by drinking and installation of a deep tube well. Either the capacity of intake surface and subsurface sources are reduced or the storage ground and overhead tank are not constructed as per population demand.

3. OBJECTIVES :

Let's assess the commissioning and management transfer of Pakali and Bharaul water supply and sanitation project with following specific objectives:

(1) To analyze the adopted process of project commissioning in Pakali and Bharaul water supply and sanitation project in Sunsari district.

(2) To assess the management transfer process in Pakali and Bharaul water supply and sanitation project in Sunsari district.

4. LITERATURE REVIEW :

4.1 Concept:

Water system commissioning is a basic part of any undertaking including a water supply 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 [6]. Commissioning is an essential and important test that verifies that the water system's design and installation resulted in a safe, energy-efficient, and effective system that can operate at peak efficiency. Water system commissioning is done at the end of a project to guarantee that the statically completed installation can be thoroughly checked. The purpose of commissioning is to confirm and verify that a system meets the designers' specifications and that the completed project is as effective and efficient as possible while meeting the design environmental conditions.

The commissioning process ensures that the installation satisfies the design intent and project specifications by performing key checks, flowrate measurement, regulation, and verifications.

(*https://www.comfortservicesgroup.co.uk/commissioning-services/*) [7].

The commissioning process is a reliable way to make sure that structures run to their full capacity, ensuring that high-tech parts and systems meet their technical requirements and function energy-efficiently. Numerous commissioning technologies prioritize fault detection and diagnosis in order to do this, then optimization, design, and data management. Through the use of a tool called commissioning, it is possible to ensure that each stage of a project is carried out gradually and correctly, to implement a feedback process between the various stages of project development, and to ensure that the customer is happy with and accepts the final product (Garcio, Moreno, and Hernandez, 2019) [8, 9, & 10].

According to Kjeruif and Jensen (2020) [11] In order to troubleshoot issues that may arise after contractor's hand over the structure until a steady activity is laid out, it is crucial for new buildings to have specific commissioning procedures in place. However, ongoing commissioning procedures are also crucial to guarantee sustainability. There have ramifications for going further to open the door for

a wide scope of research to assure sustainable performance through commissioning procedures in place across the whole life cycle of buildings.

Engineers Building systems must be documented, checked, and optimized during commissioning to make sure they match a list of predetermined requirements and goals. The Commissioning (Cx) process, as it relates to the built environment, entails point by point arranging, documentation, and confirmation techniques to guarantee that any energy-utilizing building frameworks (air conditioning, Homegrown Boiling Water Frameworks, Lighting, Sustainable power Frameworks, and so forth), and their controls, are introduced accurately and can work and be kept up with as the plan expects [12].

The commissioning process involves testing systems to ensure that both new and updated systems operate and perform as per the particulars of the agreement records. A system is made up of both equipment and its components. Components, equipment, and finally the entire system are all put into service during the commissioning of a system.it is all about thoroughly reviewed and examined. With the conclusion that the system test program was well-prepared, system test results met technical specifications, and the technical problem was solved on time (Yang, 2017) [13].

4.2 Commissioning purpose:

According to Garcio, Moreno, and Hernandez [8], the purpose of commissioning is to provide a facility with written proof that it satisfies functional and performance requirements. The integrated nature of water flow glazing system performance is acknowledged during commissioning. The purpose of commissioning is to demonstrate that systems run and perform based on the requirements and design. The project assurance, performance criteria, and system functionalities must be established and documented during the commissioning process in order to accomplish this. It is crucial to check for and record adherence to these requirements during the design, proof-of-concept phase, construction, and the first few months of operation. The project and the commissioning procedure are complementary. Through the design and construction phases with the design team. It creates a plan for commissioning and the results of the commissioning process. Every project whose goal is to establish, develop, or manage new or existing installations now requires commissioning as a key tool [8].

4.3 Commissioning process:

The project goals are furthered via the commissioning procedure.

Step 1: Planning:

Prior to the commissioning phase, the commissioning documentation is established and prepared. This contains the test plans, test processes, necessary checklists, and drawings that must be carried out during commissioning. In order to precisely document the right introduced arrangement of hardware in the field, the construction team must provide the commissioning team with a precise set of red-line drawings.

Step 2: Factory Acceptance Testing:

Factory Acceptance Testing is a crucial step before equipment is delivered to the site during the project's design and acquisition phase (FAT). Instead of waiting until the equipment is installed on-site to conduct testing, FAT ensures that the equipment is designed in accordance with specifications before it leaves the factory, where any problems discovered can be fixed much more easily and inexpensively.

Step 3: Mechanical Completion:

Once the equipment is mounted, construction is complete mechanically. Before entering the pre-commissioning stage, a deficiency list is created at each mechanical completion and any Type-A deficiencies are fixed.

Commissioning Process Step 4: On-Site Commissioning:

Pre-commissioning tasks for mechanical systems include pipe cleaning and flushing, pressure testing, and leak testing. Pre-commissioning tasks for electrical systems include panel energization, communication checks, loop checks (internal and external), and, if necessary, certification of any wiring to the central control room. System commissioning, in which all the electrical and mechanical

equipment functions as a system for the first time, can start once all mechanical and electrical components have been finished.

Commissioning Process – Step 5: Process/System Startup:
The plant process can now be begun at this point. This could be a power transmission system, a biological nutrient removal system, or any other manufacturing or specialized system found in an industrial plant. The mechanical processes are initiated gradually, and the pipework is set up for the first operational conditions. Flows are initiated and watched to make sure they are operating properly. The electrical connections are checked, and power is gradually increased to operating levels.

Commissioning Process – Step 6: Performance Verification:
A performance guarantee period, during which the plant operations are expected to achieve specific contractual requirements over time, may also be specified in the contract. Depending on the performance level reached, the performance guarantee duration may have business implications. The Final Acceptance Certificate (FAC) is given to the contractor after the performance guarantee period has ended and the commercial implications have been established.

Commissioning Process – Step 7: Operational Readiness:
It is advantageous to the owner to get the operations team ready for the ultimate handover and operation of the new systems as the project gets closer to the in-service date. Usually, the owner has a well-established asset management system. Usually, the owner has a well-established asset management system.

Project Completion:
Complex projects can be broken down and these industry best practices are used at each level if the aforementioned processes are applied to each project. Despite the fact that every project is distinct, the aforementioned phases can be used, and each step can incorporate the particulars of each project. When approached following the aforementioned methods [6, 7, 14, 15, 16, &17].

4.4 Commissioning strategy:
According to Garcio, Moreno, and Hernandez, [8]. It is proposed to use two distinct analysis methods to implement commissioning on all types of buildings. The top-down strategy involves breaking down a building from its overall level to its individual components and then passing via some subsystems. The initial task of this method is to assure the interactions between its components and subsystems are adequate or fall within the "normal" range. The bottom-up strategy, which starts with an investigation of a single component and gradually advances to the level of the entire building. The operation of every part of the building cannot be managed. Prioritizing the investigation of representative samples of those components for which a failure is either likely or would have the most impact on the building's properties must thus be done before the bottom-up strategy is put into practice.
Both new low-energy buildings and older buildings can use these strategies. New construction commissioning may be implemented throughout the design process, ensuring the building owner and the design engineer's freedom of choice. However, design and functional data are frequently unavailable, imprecise, or wrong when commissioning existing structures. Although it is possible to provide thorough documentation or install multiple sensors to gather data for analysis, the cost is deemed too high for this to become the norm in buildings that are already in use. As a result, technologies for existing buildings frequently rely on data that is already available or that can be gathered inexpensively. As a result, the appropriate analysis method (top-down or bottom-up) for an existing building is chosen depending on the accessibility [6, 7, 9, & 10].

5. METHODOLOGY :

5.1 Study Area:
Let us express the study area with help of figure 1.

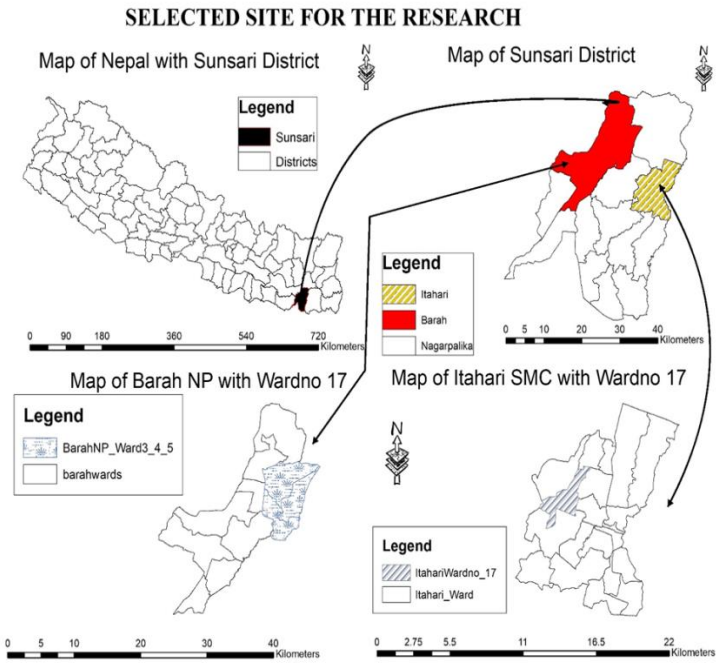

Fig. 1: Study area

5.2 Source of the study's data:

The research information is gathered by the WUSC chairman, pump operators, and manager (management head of the WUSC). The WUSC chairman, pump operators, and manager are in charge of gathering vital data. The WUSC members who represent all wards of the water supply project were surveyed using a questionnaire.

Table 1: Data from the Khanepani division of the Karyalaya SUNSARI was used as a source of information

Name of the water supply project	Pakali WSSP	Bharaul WSSP
WUSC chairperson	1	1
Pump Operator	1	2
Management head	1	1
WUSC members	11	9

5.3 Data Collection method:

The researcher has attempted to collect data accurately.

5.3.1 Collection of primary data:

The research's foundation is primary data, and the actual statistics were gathered from primary data to aid in the study's precision. The following procedures are employed in the collection of primary data:

a) Interviews - The data from the WUSC interview, as well as the pumping operator's interview on the project's state and present management procedures, was gathered.
b) Field Observations — A field observation of the project was conducted to determine the project's present physical state, record the WSP co-ordinate using GPS, and document WUSC's documentation processes.
c) Questionnaires- A new set of open and closed questions on management and the financial element of WSP was produced for the WUSC chairman, Management Head, Pump operator, and WUSC member.
d) Sampling - Primary data included the collecting of samples from the source. Sampling data were chosen in such a manner that they fairly represented the water quality of the particular site. pH,

Color, Temperature, Turbidity, Chlorine, E-coli, and Total Coliform were all analyzed in the water lab of Itahari Sanghiya khanepani lab.

5.3.2 Collection of Secondary Data

Secondary data was gathered through a review of papers on the adaption of management methods in developing country WSPs. The current status of the selected WSPs, management transfer, commissioning, and infrastructure for the water supply and sanitation projects in Pakali and Bharaul. Another source of data for this study includes published journals, papers, and the internet/websites linked to management techniques in WSPs.

For the study of management practices in different WSPs from different regions of the world, literature (article, report, magazine, records, and data) from a national and international context was collected.

a) The status of the selected projects was examined using institutional management, technical, and financial reports, as well as any other documentation provided by WUSC.
b) Financial statistics were used to examine the economic comparison of the PAKALI and BHARAUL water supply projects.
c) The financial, technical, and management components of the commissioning of the PAKALI and BHARAUL WSPs have been measured by proof documentation.

5.3.3 Questionnaire

Objective sort surveys were utilized for information assortment. Three arrangements of surveys were ready for the three gatherings of designated respondents independently as follows. References from Nepali studies were taken along with global water related projects were studied [18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, & 30],

Water user, WUSC, and WSSDO questionnaires were written in English, but when they were administered, the questions were also given in Nepali for those who needed them.

Table 2: Total number of Respondents

S. N.	Respondent	No. of respondent	No. of project	Total Respondent
1	Water Users	22	2	44
2	WUSC (members)	6	2	12
3	WSST, Engineer and SDE of WSSDO	4		4
		Total		60

5.4 Compilation and analysis of data:

The information was gathered, and it was sorted, tabulated, and grouped into numerous categories. The data from each research has been evaluated independently of the other three. Tables, charts, and graphs were used to display the logically understood results.

Table 3: Management transfer process of Indicators

S. N.	Indicators	Pakali WSSP	Bharaul WSSP	Expected Outcome
1	Calibration of the system	Treatment unit, discharge, velocity and pipe diameter GPS location of all nodes, valves and structure	Treatment unit, discharge, velocity and pipe diameter GPS location of all nodes, valves and structure	Calibration of all components and improved the functionality of the system

S. N.	Indicators	Pakali WSSP	Bharaul WSSP	Expected Outcome
2	Sterilization of the system	Distribution system, right amount of bleaching, post maintenance	Distribution system, right amount of bleaching, post maintenance	Maintain water quality and Improved sanitary condition of system
3	WUSC's " water operators standard" document is in place and WUSC's members and office are trained for it	Documentation and training by National water supply and sanitation training Centre (NWSSTC)	Documentation and training by National water supply and sanitation training Centre (NWSSTC)	Enhanced office operations
4	WUSC's business plan is in place	Business plan development orientation training	Business plan development orientation training	improved financial performance and increased service offerings
5	Access to and use of sanitary toilet	Identify place, estimate of cost and build toilet	Identify place, estimate of cost and build toilet	increased dignity and health
6	Project completion document is handed over to WUSC	Complete the project towards the handed over with complete document	Complete the project towards the handed over with complete document	Project documentation is updated

5.5 Summary of research Matrix:

The methods can be briefly presented as shown in table 4.

Table 4: Research Matrix

S. N.	Objectives	Data Required	Data Collection Methods	Data Analysis
1.	To analyze the adopted process of project commissioning.	Primary and Secondary Data	WSSDO MB, WUSC Documents, Questionnaire survey	Compare DPR, commissioning check list with questionnaire and field
2.	To assess the management transfer process.	Primary and Secondary Data	Questionnaire survey, Official documents	Water test, Technical, financial and institutional calculation

6. SYSTEM OF COMMISSIONING :

6.1 Elements of Successful Project Commissioning:

6.1.1 Planning:

Results acquired from Survey it was tracked down that greater part of Bharaul WSSP is aware about planning compare to Pakali WSSP.

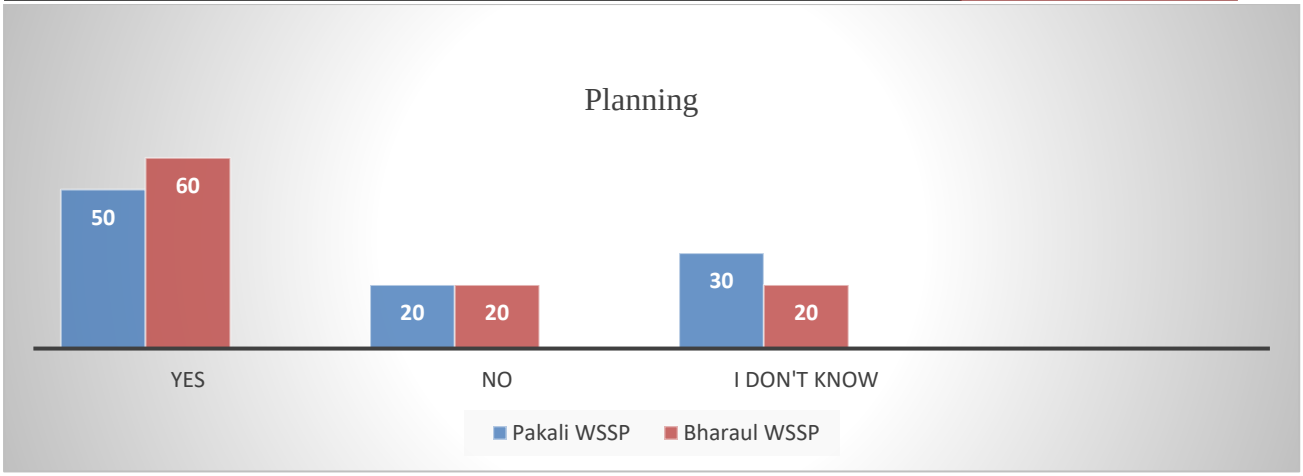

Fig. 2: Percentage of response about planning

In Pakali water supply project fifty percent knows about planning and thirty percent don't know about planning. In Bharaul water supply project sixty percent knows about planning and twenty percent don't know about planning. Thus, both of selected project were found competent in planning the project commissioning as due to enforce by WSSDO, DPR available.

6.1.2 Mechanical completion:

Results obtained from Questionnaire it was found that majority of both Pakali and Bharaul WSSP don't know about Mechanical completion**.**

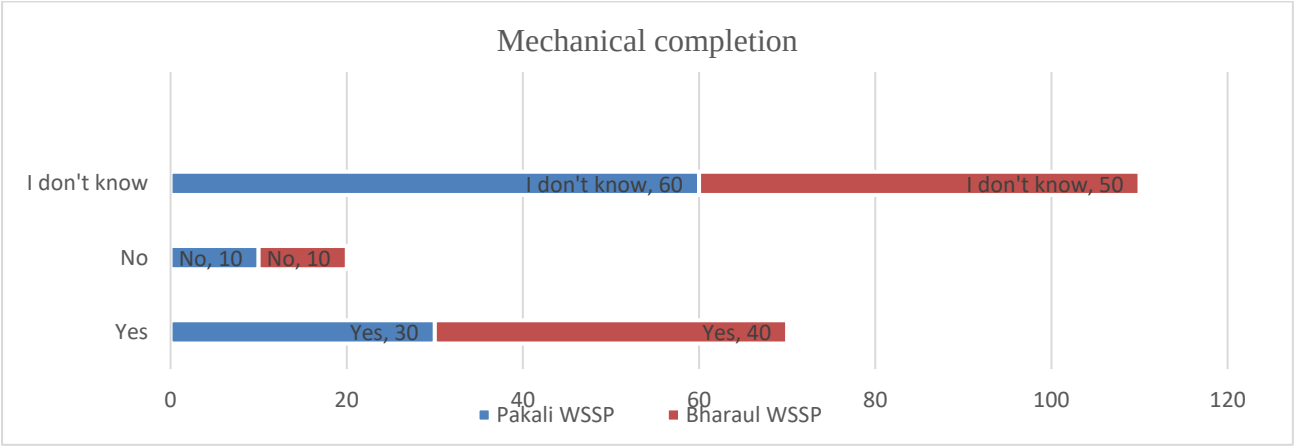

Fig. 3: Percentage of response about mechanical completion

In Pakali water supply project only thirty percent knows about mechanical completion and sixty percent don't know about mechanical completion. In Bharaul water supply project forty percent knows about mechanical completion and fifty percent don't know about mechanical completion. Thus, none of the selected project were found competent in mechanical completion the project commissioning as due to illiterate, ignorant and un-practiced by WUSC's member, lack of training and supervision.

6.1.3 Piping and instrumentation diagram checking:

Results acquired from Survey it was observed that larger part of Bharaul WSSP knows about Funneling and instrumentation graph contrast with Pakali WSSP. As per (Dawidowicz and czapczuk) [15]. The connection between unwavering quality levels, the water supply framework's pipework, and its length was shown utilizing pressure driven estimations and the reliability of a couple of chosen provincial water conveyance frameworks.

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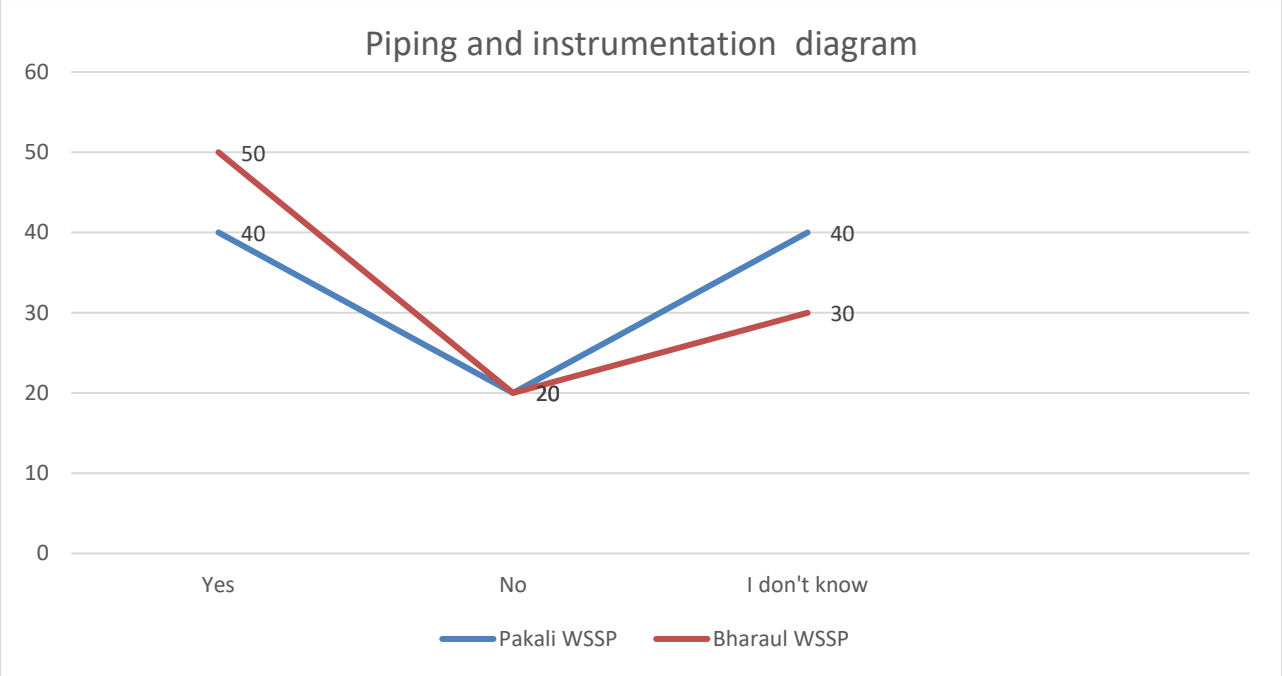

Fig. 4: Percentage of response about piping and instrumentation diagram checking

In Pakali water supply project forty percent knows about Piping and instrumentation diagram and forty percent don't know about Piping and instrumentation diagram. In Bharaul water supply project fifty percent know about Piping and instrumentation diagram and thirty percent don't know about Piping and instrumentation diagram. Thus, both of selected project were found competent in piping and instrumentation diagram checking due to aware about pipe line layout diagram in DPR.

6.1.4 Pre-commissioning:

Pakali WSSP should be made aware about Pre-commissioning compare to Bharaul WSSP.

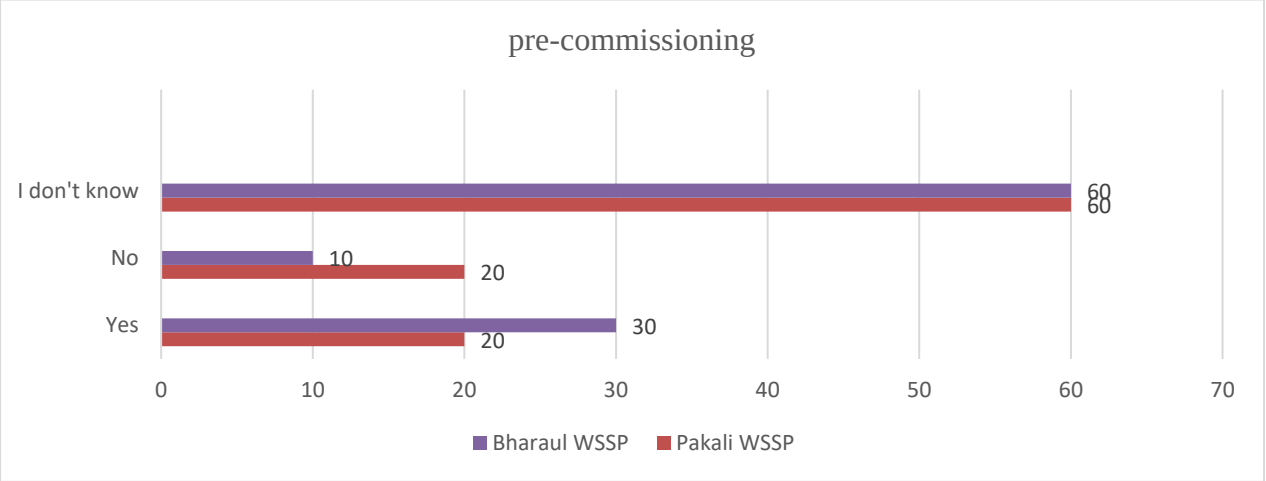

Fig. 5: Percentage of response about pre-commissioning

In Pakali water supply project only twenty percent knows about pre-commissioning and sixty percent don't know about pre-commissioning. In Bharaul water supply project only thirty percent knows about pre-commissioning and sixty percent don't know about pre-commissioning. Thus, none of the selected project was found competent in pre-commissioning the project commissioning as due to unknown about this, lack of training to the technician, lack of government enforcement about commission.

6.1.5 Commissioning:

Results obtained from Questionnaire it was found that Majority of Both Pakali and Bharaul WSSP equally 50 percent respondent don't know about commissioning.

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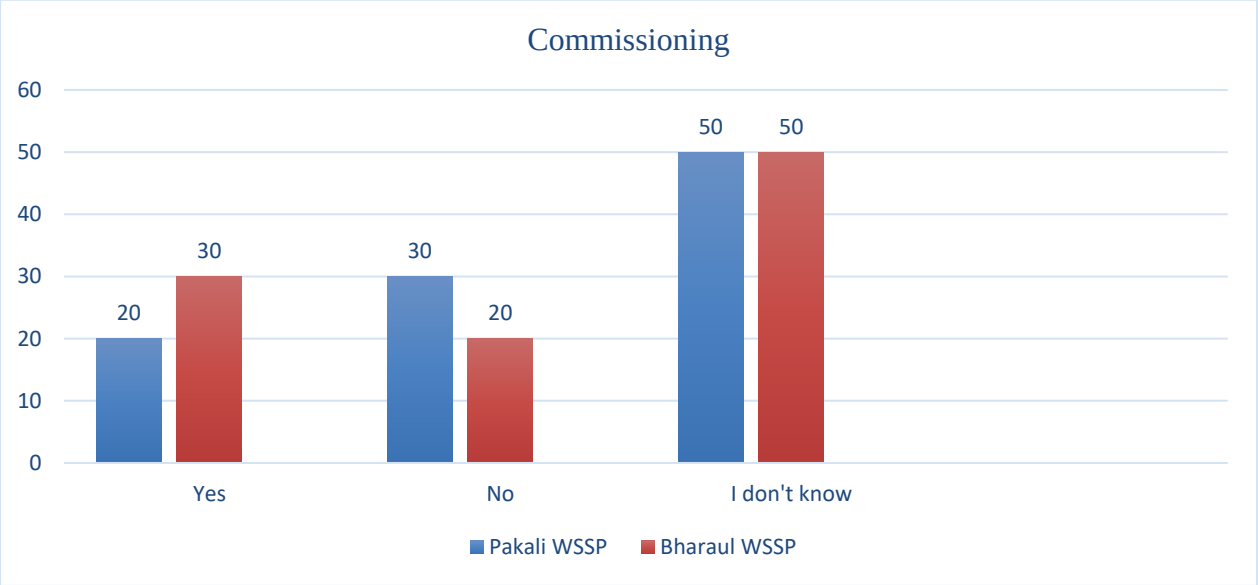

Fig. 6: Percentage of response about commissioning

In Pakali water supply project only twenty percent knows about commissioning and fifty percent don't know about commissioning. In Bharaul water supply project only thirty percent knows about commissioning and fifty percent don't know about commissioning.

Thus, none of the selected project was found competent in commissioning the project commissioning as due to lack of effective and efficient commissioning process, lack of training to technician, lack of government enforcement about commission.

For effective commissioning we can suggest following management transfer process: -

1: Calibration of the system

The accompanying philosophy and jobs were found, per the Master Interview and FGD with WUSC individuals similar to Mishra and Karna [20].

Techniques:

(1) Calibration of parts for their result boundaries (like a treatment unit).
(2) Water Dispersion Network Calibration for Residual Pressure, Discharge, Velocity, Pipe Diameter, and Series
(3) Valve alignment for its opening
(4) GPS location tracking of all nodes, valves, and structural elements

2: Sterilization of the system

The accompanying technique and jobs were found, per the Master Interview and FGD with WUSC individuals.

Methods:

(1) Distribution systems and component inspection and repair.
(2) Compute the whole water volume in structures and dissemination frameworks, settle on the "technique openness" time, add the perfect proportion of blanch, trust that sterilization will occur, and flush the water volume.
(3) After-Sterilization Upkeep
(4) Promote shock chlorination of both residential and commercial building plumbing systems.

3: WUSC's "Water Operators Standard" archive is set up and WUSC's individuals and office are prepared for it.

The accompanying technique and jobs were found, per the Master Interview and FGD with WUSC individuals.

Methods:

(1) WUSC creates WOSs papers in close collaboration with DWSS specialists.
(2) The National Water Supply and Sanitation Training Centre (NWSSTC) offers direction preparing to the WUSC's individuals and office staff; notwithstanding, for explicit working interaction papers, (for example, the SOP of a treatment plant), the elaborate provider conducts preparing nearby.
(3) The WUSC is the owner of and adheres to this quality document.

4: WUSC's Business Plan is in place.

The accompanying technique and jobs were found, per the Master Interview and FGD with WUSC individuals.

Methods:

(1) The National Water Supply and Sanitation Training Center (NWSSTC) offers business plan development orientation training to the secretariat and members of the WUSC.
(2) The WUSC business plan was created in close collaboration with the DWSS specialists.
(3) The WUSC owns the rights to this business plan.

5: Access to and use of sanitary toilet by all in project area.

The accompanying technique and jobs were found, per the Master Interview and FGD with WUSC individuals.

Methods:

(1) Identifying the obstacles and bottlenecks
(2) Focused campaign
(3) Expanding access to credit
(4) Building the toilet

6: Project completion document is handed over to WUSC

The accompanying technique and jobs were found, per the Master Interview and FGD with WUSC individuals.

Methods:

(1) Make the papers that include:
  (a) Licenses, Declarations and Enlistments
  (b) Warranties, Protections, Detailing and claims
  (c) Defects Risk Period - Upkeep
  (d) Project costs
(2) Create drawings and data that is "as constructed"

Table 5: Management transfer process of Indicators

S. N.	Action	Pakali WSSP	Bharaul WSSP
1	Calibration of the system	No water distribution network problem, well-functioning	No water distribution network problem, well-functioning
2	Sterilization of the system	Bacterial contamination from system is removed, sterilized system	Bacterial contamination from system is removed, sterilized system
3	WUSC's "water operator's standard" archive is set up and WUSC's individuals and office are prepared for it.	Management runs under certain operating processes, Standard and transparent management process	Management runs under certain operating processes, Standard and transparent management process
4	WUSC's field-tested strategy is set up	Planned investment is not implemented, not Predictable business growth	Planned investment is not implemented, not Predictable business growth
5	Admittance to and utilization of clean latrine	No open defecation, Healthy and dignified environment	No open defecation, Healthy and dignified environment

6	Project consummation report is given over to WUSC	Not handed over to WUSC	Not handed over to WUSC

In Pakali water supply and sanitation project No water distribution network problem, well-functioning, Bacterial contamination from system is removed, sterilized system, Management runs under certain operating process, Standard and transparent management process, Planned investment is not implemented, no Predictable business growth, no open defecation, Healthy and dignified environment are not handed over to WUSC.
In Bharaul water supply and sanitation project No water distribution network problem, well-functioning, Bacterial contamination from system is removed, sterilized system, Management runs under certain operating process, Standard and transparent management process, Planned investment is not implemented, not Predictable business growth, No open defecation, Healthy and dignified environment, and Not handed over to WUSC.

6.1.6 Start up:

Results acquired from Poll it was tracked down that larger part of Pakali WSSP don't know about Start up compare to Bharaul WSSP.

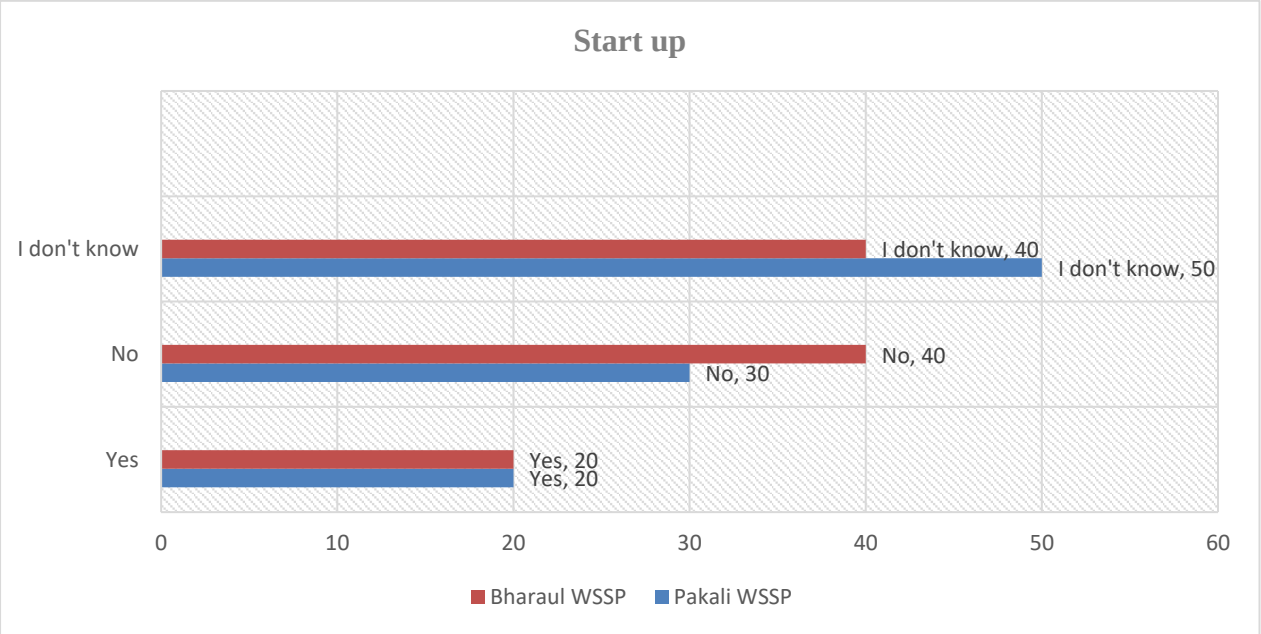

Fig. 7: Percentage of response about start up

In Pakali water supply project only twenty percent know about commissioning and fifty percent don't know about commissioning. In Bharaul water supply project, only thirty percent know about commissioning and fifty percent don't know about commissioning. Thus, none of the selected projects were found competent in commissioning the project commissioning as due to lack of effective and efficient commissioning process, lack of training to technician, lack of government enforcement about the commission.

6.1.7 Initial Operation:

Most of Pakali WSSP doesn't know about initial operation compare to Bharaul WSSP as depicted in figure 8.

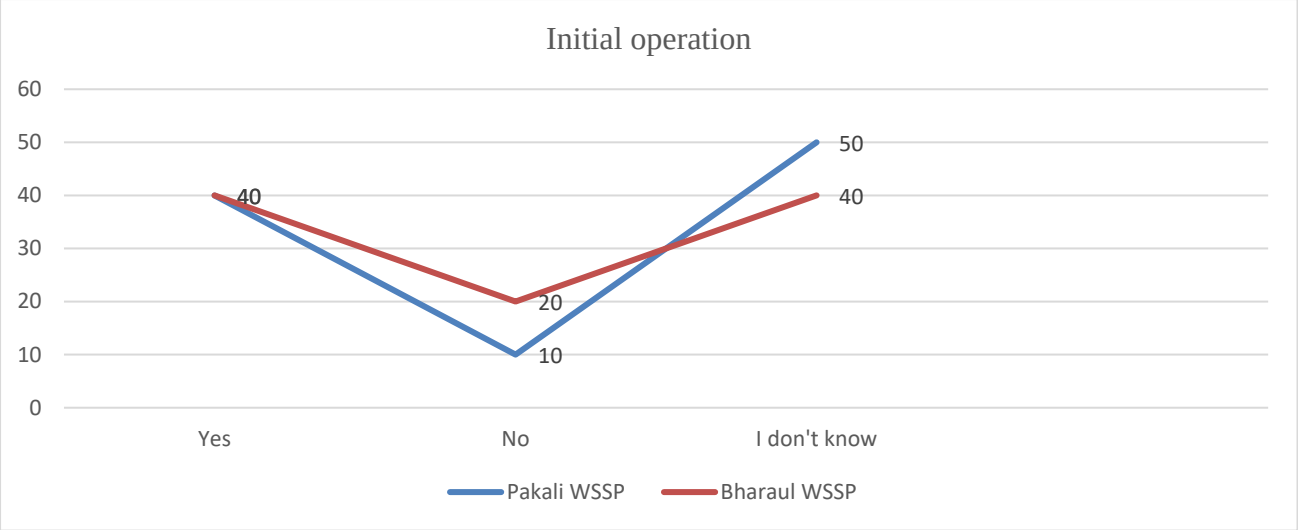

Fig. 8: Percentage of response about initial operation

In Pakali water supply project only forty percent knows about initial operation and fifty percent don't know about initial operation. In Bharaul water supply project only forty percent knows about initial operation and forty percent don't know about initial operation. Thus, none of the selected projects were found competent in initial operation project commissioning as due to lack of delay of technically sound manpower.

6.1.8 Performance testing:

Results obtained from Questionnaire it was found that Both Pakali and Bharaul WSP are poor about Performance testing.

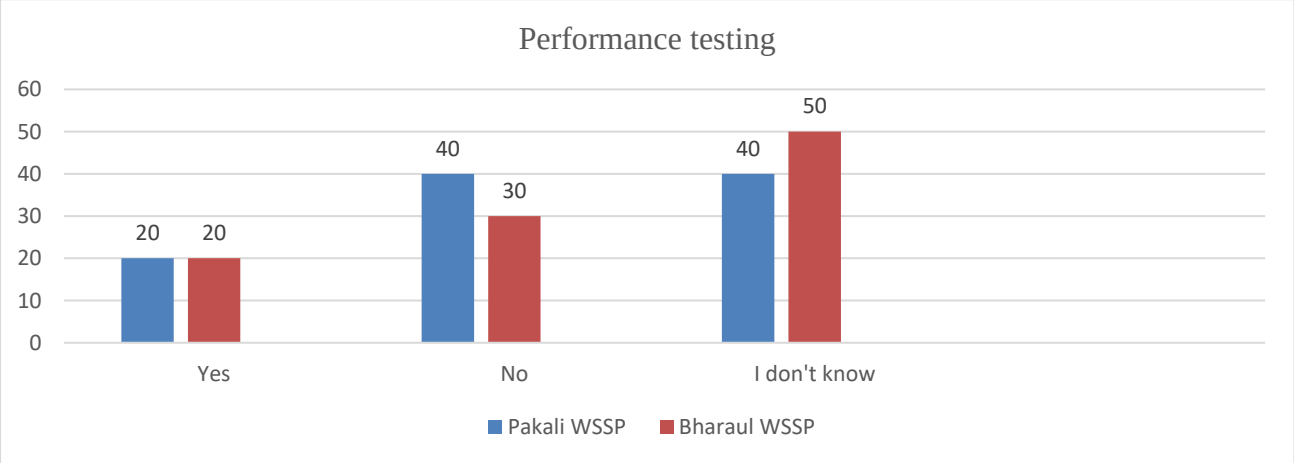

Fig. 9: Percentage of response about performance testing

In Pakali water supply project only twenty percent knows about performance testing and forty percent don't know about performance testing. In Bharaul water supply project only twenty percent knows about performance testing and fifty percent don't know about performance testing. Thus, none of the selected projects were found competent performance testing project commissioning as due to lack of delay of technically sound manpower.

6.1.9 Post Commissioning:

Both Pakali and Bharaul WSSP are not handed over thus the post commissioning is not done yet.

6.2 Management Transfer and Status:

Both of the selected projects were assessed for their status in terms of financial, technical, and

institutional capacity, and management transfer process.

6.2.1 Water Demand and Pressure Maintenance:

I. Water Demand:

Both Pakali and Bharaul WSSP maximum respondents are totally fulfilled and satisfied, i.e., both are functional. The result was verified by field observation.

Due to the rapid population increase, the Pakali Water Supply Project infrastructure was soon expanded to satisfy the water demand. Users of water and elected officials strongly support the systems. An existing Deep Tube well in the Bharaul Water Supply Project failed. There are two deep tube wells in use. Due to the rapid rate of population increase, the system had to be expanded and upgraded in order to supply the water demand. To meet the system's demand, an additional 450 cum OHT and one deep tube well were planned to be built; a new DPR and plan will be created for this. Users of water and governmental officials enthusiastically support the systems. Nepal is rich in water resources and has sufficient potential for electricity production though we face power cut due to lack of proper functioning of hydropower construction project [36]. That is why water supply should be careful with demand, no matter how much water we have but only water that comes from tap generate value.

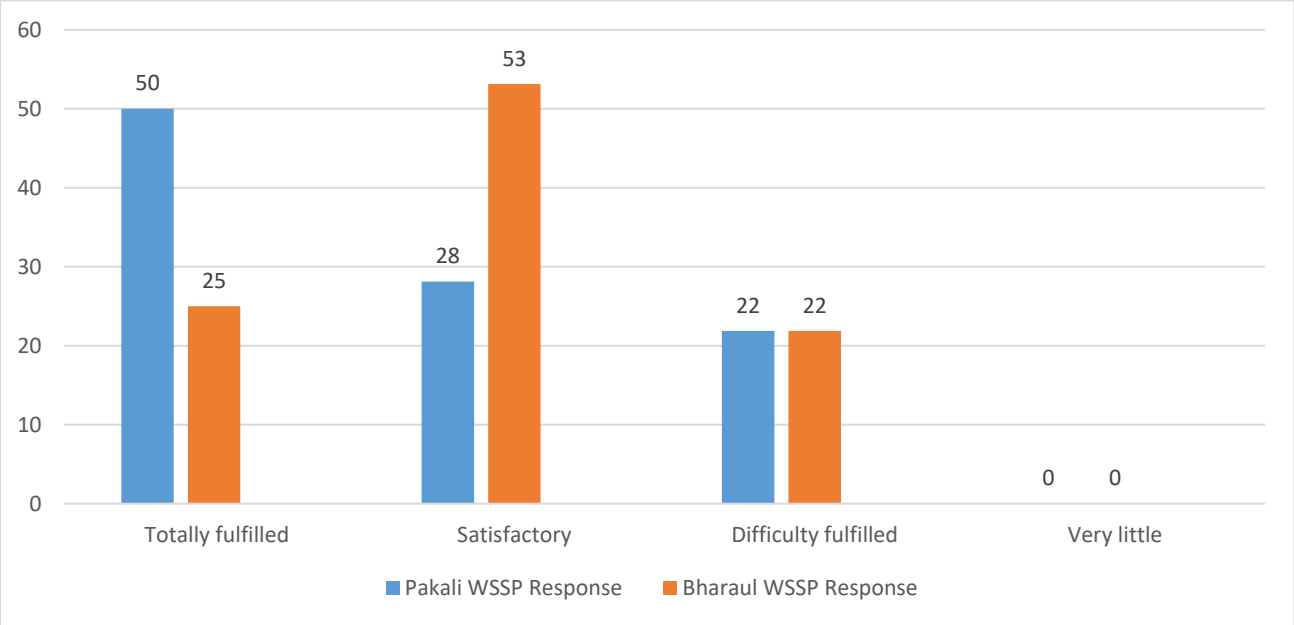

Fig. 10: Percentage of respondents about water demand fulfillment

II. Pressure Maintenance in the systems:

Both Pakali and Bharaul WSSP were satisfied with maximum respondents and very little were not satisfied.

Table 6: Pressure in System

SN	Category of Respondents	Pakali WSSP Response				Bharaul WSSP Response			
		Respondents	Satisfied	Not satisfied	Neutral	Respondents	Satisfied	Not satisfied	Neutral
1	Water Users	22	18	2	2	22	16	4	2
2	WUSC	6	6	0	0	6	6	0	0
Total		28	24	2	2	28	22	4	2
% of response		100	85.72	7.14	7.14	100	78.58	14.28	7.14

The Pakali Water Supply Project routinely assessed the system's pressure. The water pressure remained constant throughout. The management took action to locate a fix when the water pressure began to drop. Regular system supervision was carried out.The system's pressure was routinely tested at the Bharaul Water Supply Project. Since the beginning, the water pressure has not changed. When the water pressure started to drop, the management started looking for a fix. The system was routinely under observation.

III. Maintenance of the Systems:

Pakali WSSP staff response immediately more than Bharaul as of staff perceptions depcted from figure 11.

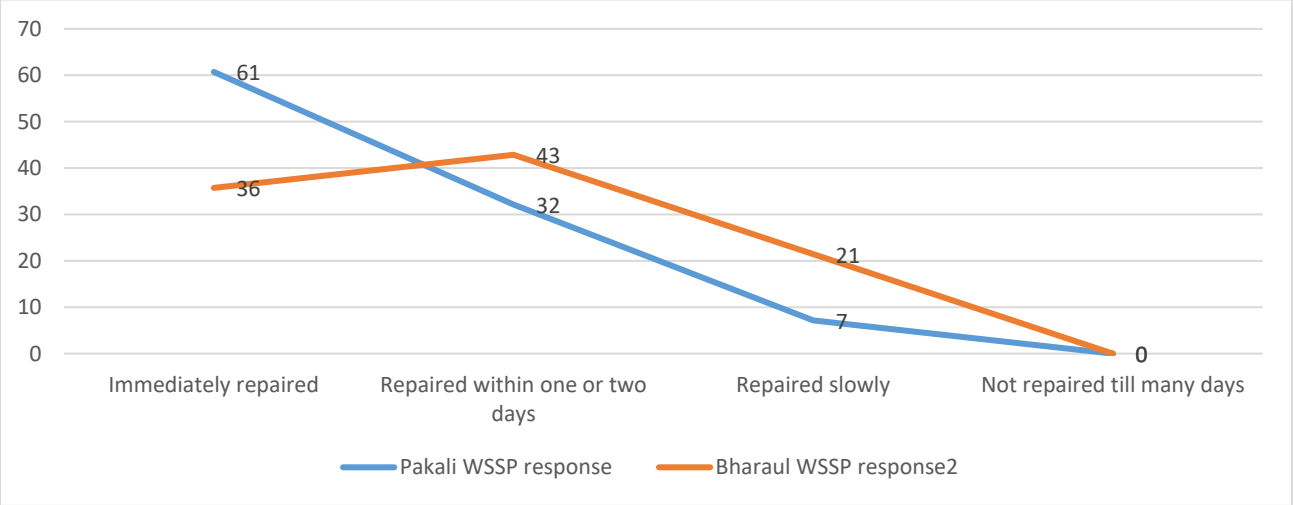

Fig. 11: Percentage of respondents about maintenance of WSSP

The team of the Pakali Water Supply Project is enthusiastic and committed to their work. Because of the organized information system, once an issue was noticed, staff members responded immediately and worked to resolve it.

The workforce at the Bharaul Water Supply Project is enthusiastic and committed to their work. Because of the organized information system, once an issue was noticed, staff members responded immediately and worked to resolve it. The employees in Bharaul are less motivated than those at Pakali.

IV. Pressure testing in the systems:

Reaction of WSSDO Staffs, it was observed that Pressure was tried in Both Pakali and Bharaul WSSP respondents differ about pressure testing in the framework.

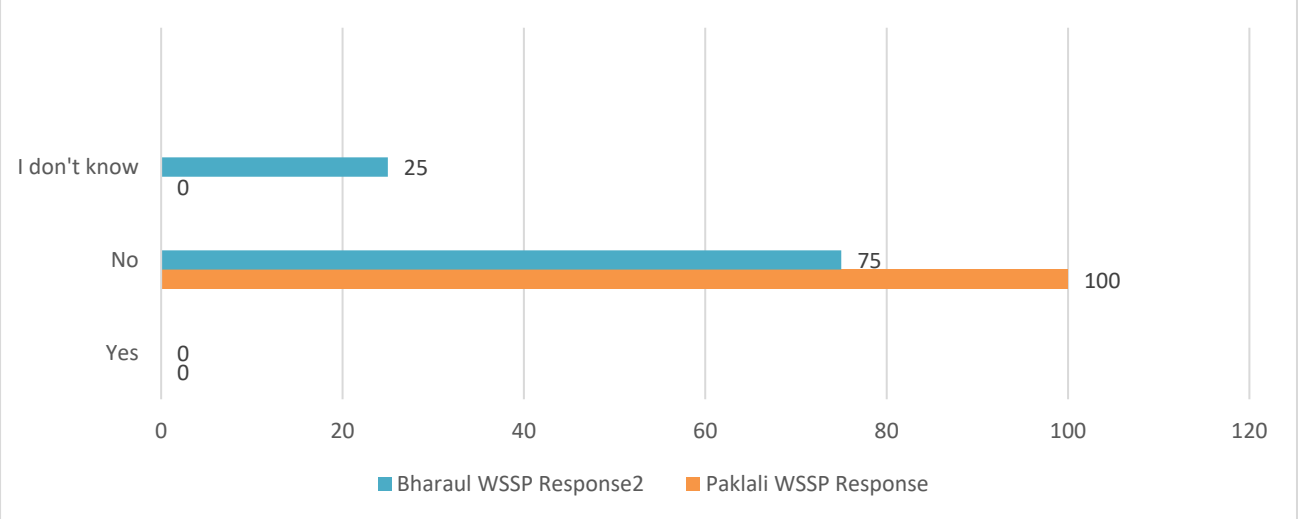

Fig. 12: WSSDO perception on pressure testing in percentage

The system's pressure was not tested at the Pakali Water Supply Project. The user committee staff built the component and installed the distribution pipes in accordance with the engineering design. Water pressures at crucial positions of various clusters were taken into consideration during design
The Bharaul Water Supply Project did not verify the system's pressure. The component was built by the user committee staff, who also installed the distribution pipes in accordance with the engineering design. Water pressures at distinct clusters' important locations were taken into account during design.

6.2.2 Water Quality Status:
Four water tests (source 1, source 2, Tap1 and Tap 2) of every framework were tried in Eastern Locale Water Quality Research center, Itahari. The various boundaries of water tests are displayed in table 7.

Table 7: Water Quality Test Report

S. N.	Parameters	Observed Values in Pakali WSSP				Observed Values in Bharaul WSSP				NDWQ, 2062 BS
		Source 1	Tap 1	Tap 2	Source2	Source1	Tap1	Tap 2	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

** These values show lower and upper limits.*
( ) Values in parentheses refer the acceptable values only when alternative is not available.
The result shows water quality is maintained and it needs to be regularly tested from different sources and even water use behavior needs to be analyzed through continuous visit.

I. Suffering Diarrheal Diseases in the Systems:

Results got from Polls it was observed that 100 percent of respondents were not experienced diarrheal in both WSSP. The result was verified by Field Observations.

Table 8: Response about suffering of diarrheal diseases

S. N.	Category of Respondents	Pakali WSSP Response				Bharaul WSSP Response				Remarks
		No. of response	Many times	Sometimes	No	No. of response	Many times	Some times	No	
1	Water Users	22	0	0	22	22	0	0	22	
Total		22	0	0	22	22	0	0	22	
% of response		100	0	0	100	100	0	0	100	

The Pakali Water Supply Project routinely tests water samples from several clusters. The aftereffects of the water quality test likewise showed that, the boundaries of the water were all inside the scope of Nepal Drinking Water Quality Standard 2062. except for turbidity in source 1, faucal coliform E. coli (CFU/100 ml) in tap 2, and iron in source 1, In any case, when the treatment plant was worked, there could have been at this point not a gamble of diarrheal illnesses.

The Bharaul Water Supply Project routinely tests water samples from several clusters. The water quality test report additionally demonstrated that every one of the boundaries of water were inside the scope of Nepal Drinking Water Quality Standard 2062. Subsequently, the respondent's perspectives were likewise upheld. No gamble of diarrheal ailments existed. Even research conducted earlier shows similar response [31, & 32].

II. Fulfillment of chlorine demand:

The tools referred with modification from earlier studies for developing questionnaire [33,34, &35]. Result got from Poll it was seen that as 67% of respondents were concurred that they satisfied their chlorine interest in both WSSP. There was turbidity in source 1, faucal coliform E. coli (CFU/100 ml) in tap 2, and iron in source 1 of the Pakali Water Supply Project, however these issues were handled well and with consideration for the general public's health. The consequences of the water quality test showed that water tests actually contained some chlorine. Each part of the water met the Nepal Drinking Water Quality Standard 2062. Hence, the respondent's perspectives were likewise upheld.

WUSC has been found to be especially worried about the overall government assistance in Bharaul. WUSC regularly surveys the nature of water refined through traditional treatment and sanitization to decide the nature of drinking water provided to clients. Moreover, WUSC tests for the presence of lingering chlorine in examples of homegrown regular water consistently and depending on the situation somewhere else. The aftereffects of the water quality test showed that water tests actually contained some chlorine. Each part of the water met the Nepal Drinking Water Quality Standard 2062. Accordingly, the respondent's perspectives were likewise upheld.

III. Complaints of water quality:

Results got from Surveys of WUSC individuals shows that that larger part of respondents of Pakali and Bharaul WSSP certain that they have no water quality gripes. The outcome was additionally checked by Field Perceptions.

Public health has been identified to be a top priority at PAKALI WUSC. WUSC routinely assesses the nature of water purged through ordinary treatment and sterilization to decide the quality of drinking water supplied to customers. So, the PAKALI Water Supply Project hasn't voiced any complaints regarding the water's quality.

Bharaul WUSC has been discovered to be extremely concerned about public health. WUSC routinely evaluates the nature of water filtered through traditional treatment and sterilization in order to determine

the quality of drinking water supplied to customers. So, the Bharaul Water Supply Project hasn't voiced any complaints regarding the water's quality.

6.2.3 Financial Differences:

I. Income Expenditure Status:

Table 9: PAKALI&BHARAUL WSSP Income Expenditure Status

Description	Pakali WSSP	BharaulWSSP	Remarks
Total Income per Year RS	1632000	2042924	
Total Expenditure per year, RS.	1210000	1620707	
Total Saving per year, RS.	412000	422217	

In FY 2078/79, Pakali WUSC received a total of RS. 16, 32, 000 from water rates, tap connections, and fines, while spending a total of Rs. 121, 0000 annually. A total of RS. 41200 was saved per year.
In FY 2078/79, Bharaul WUSC's total annual revenue was RS. 2042924, which was derived from the collection of water rates, tap connections, and fines. Its total yearly expenditure was RS. 1620707. Savings for the year totaled RS. 422217.

II. Collection of Tariff:

Results got from Polls it was found that a greater part of respondents of Pakali WSSP said that they pay levy in opportune and they concurred the pace of tax was perfect though in Bharaul WSSP greater part of respondents said that they paid the duty at times delay and concurred the pace of tax is perfect. The outcome was likewise confirmed by Field Perceptions.

Table 10: Response about timely paying tariff

S. N.	Category of Respondents	Pakali WSSP Response				Bharaul WSSP Response			
		No. of response	Yes	No	Sometimes delay	No. of response	Yes	No	Sometimes delay
1	WUSC members	6	3	1	2	6	2	1	3
Total		6	3	1	2	6	2	1	3
% of response		100	50	16.66	33.34	100	33.34	16.66	50

Table 11: Response about rate of tariff

SN	Category of Respondents	Pakali WSSP Response					Bharaul WSSP Response				
		No. of response	Less	Just right	High	Much High	No. of response	Less	Just right	High	Much High
1	Users	22	0	16	6	0	22	4	14	4	0
Total		22	0	16	6	0	22	4	14	4	0
% of response		100	0	72.72	27.28	0	100	18.18	63.64	18.18	0

Up to 10 m^3 are fixed as the base tax with a proper charge of Rs. 150, and on utilization over that, direct volumetric levy is applied by PAKALI WUSC under its executed duty structure. An extra Rs. 20 for

each m^3 is expected for water utilization of somewhere in the range of 11 and 20 m3 for every association. An extra charge of Rs. 25 for each m^3 is to be charged for water utilization somewhere in the range of 21 and 30 m^3 for every association. An extra Rs. 30 for every m^3 is to be forced for water utilization somewhere in the range of 31 and 40 m^3 for each association. Extra Rs. 35 for each m^3 is to be applied to utilization somewhere in the range of 41 and 50 m^3 over the utilization of water per association. Since PAKALIWUSC has been seen as exceptionally aware of the general wellbeing and agreeable water supply administration, the clients were inspired and they confided in about the framework. They paid tax in time and they didn't have protest about moderately high rate tax.
BHARAUL WUSC has applied tax structure on a straight volumetric premise where up to 10 m^3 are fixed as least duty with fixed charge Rs.110 and on the utilization above to that direct volumetric tax is applied. On the utilization between 11 m^3 to 20 m^3 of water for each association, extra Rs.20 per m^3 is to be applied. On the utilization between 21 m^3 to 30 m^3 of water for every association, extra Rs.25 per m^3 is to be applied. On the utilization between 31 m3 to 50 m^3 of water for each association, extra Rs.35 per m^3 is to be applied. On the utilization between 51 m^3 above utilization of water per association, extra Rs.45 per m^3 is to be applied. Since BHARAUL WUSC has been seen as extremely aware of the general wellbeing and acceptable water supply service, the clients were propelled and they confided in about the framework. They paid levy here and there postponement and they didn't have complaints about somewhat high rate duty.

III. WUSC Business Plan:
Results got from Polls it was tracked down that greater part of respondents of Both Pakali and Bharaul WSSP said that they had not a strategy. The outcome was additionally checked by Field Perceptions.

Table 12: Response of WUSC about business plan

S. N.	Category of Respondents	PAKALI WSSP Response				BHARAUL WSSP Response			
		No. of response	Yes	Yes but not implemented	No	No. of response	Yes	Yes but not implemented	No
1	WUSC members	6	0	0	6	6	0	0	6
Total		6	0	0	6	6	0	0	6
% of response		100	0	0	100	100	0	0	100

Both the PAKALI and the BHARAUL WUSC did not yet have a business plan prepared.

6.2.4 Institutional Differences:
I. Organizational Status:
According to Hamchaooui, Boudoukha and Benzerra, (2015) [17], the prior goals of the drinking water delivery service included ensuring customer satisfaction, property sustainability, and effective service administration. The chairperson is in charge of overall staff management, coordination with the executive committee, and various committees set up to support the executive committee and management to offer administrations successfully and effectively and keep up with the offices. The director has the general liability of the board of the staff and coordination with the leader panel for compelling and productive assistance conveyance and O&M of the offices.

II. Self-understood of bill payment:
Results acquired from Surveys it was tracked down that larger part of respondents of Both Pakali and Bharaul WSSP said that they are self-perceived of bill installment. The outcome was additionally checked by Field Perceptions.

Table 13: Self-understood of bill payment

		Pakali WSSP Response	Bharaul WSSP Response	Remarks

S. No.	Category of Respondents	No. of response	Yes	No	No. of response	Yes	No	
1	Users	22	18	4	22	17	5	
Total		22	18	4	22	17	5	
% of response		100	81.82	18.18	100	77.28	22.72	

Since PAKALI and BHARAUL both WUSC has maintained awareness and activeness of member's majority of respondents are self -understood of bill payment.

III. Connection procedure of new tap connection:

Results got from Polls it was seen that as around half of respondents of Both Pakali and Bharaul WSSP said that they have close to zero insight into strategy about tap association. The outcome was likewise checked by Field Perceptions.

Table 14: Connection procedure of new tap connection

S. N.	Category of Respondents	Pakali WSSP Response			Bharaul WSSP Response			Remarks
		No. of response	Yes	No	No. of response	Yes	No	
1	Users	22	10	12	22	10	12	
Total		22	10	12	22	10	12	
% of response		100	45.46	54.54	100	45.46	54.54	

New users encounter difficulties with the new tap connection process since there is a lack of an information system. This suggests that Pakali's and the Bharaul Water Supply Project's information system is weak.

7. CONCLUSIONS :

Pakali and Bharaul project have been compared on the basis of steps should be followed for successful project commissioning Both of selected project were found competent in planning the project commissioning as due to enforce by WSSDO, DPR available. None of the selected project were found competent in mechanical completion the project commissioning as due to illiterate, ignorant and un-practiced by WUSC's member, lack of training and supervision. Both of selected project were found competent in piping and instrumentation diagram checking due to aware about pipe line layout diagram in DPR. None of the selected project were found competent in pre-commissioning the project commissioning as due to unknown about this, lack of training to technician, lack of government enforcement about commission. None of the selected project were found competent in commissioning the project commissioning as due to lack of effective and efficient commissioning process, lack of training to technician, lack of government enforcement about commission. None of the selected project were found competent in start-up project commissioning as due to lack of leadership of WUSC's, WSSDO. None of the selected project were found competent in initial operation project commissioning as due to lack of delay of technically sound manpower. None of the selected project were found competent in performance testing project commissioning as due to lack of advance equipment, lack of training and lack of practice of testing. Due to both project is not handed over y.0et thus post commissioning is not done.

For effective commissioning we can suggest following management transfer process: - Calibration of the system, Sterilization of the system, WUSC's "Water Operators Standard" document is in place and WUSC's members and office are trained for it WUSC's Business Plan is in place, Access to and use of

sanitary toilet by all in project area Project completion document is handed over to WUSC. The government should strongly enforce the project commission through regulatory authority.

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