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Status Assessment of Life Cycle Costing in Baitadi Town Water Supply and Sanitation Project, Nepal

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ABSTRACT
Value Management (VM) practice and Life Cycle Costing (LCC) technique is considerably new subject for Nepal. The main objective of this study is to find out the Value Management practices in Nepal studying the Baitadi Town Water Supply and Sanitation Projects on Life Cycle Costing perspective. The study was done with detailed field study of the project area with necessary secondary document related with the project. For the analysis, the Final Detailed Design Report of the project was compared with the common procedure used in world for the application of Value Management and Life Cycle Costing techniques. The status of Life Cycle Costing in Baitadi Town Water Supply and Sanitation Project the result obtained from the analysis of desk study was used. Value Management was not applied on Life Cycle Costing in Baitadi Town Water Supply and Sanitation Project, but risk management of the project was taken Value Management by the professionals, which is also not done appropriately as a result of which there were many risks in the construction phase and time overruns and cost overruns in the project. The project also has financially critical stage there were no significant difference between financial Opportunity cost of Capital and financial internal rate of return due to not selection of the best option of the project alternatives.

Keywords: *Value management, life cycle cost, opportunity cost, water project*

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INTRODUCTION

Projects under down developments are suffering in performance (Mishra et.al, 2018). Projects should be free from defects, right things at right time and the continuously improving.it must ensure no failure cost (Chilwal & Mishra, 2018). Time spent by skilled and unskilled labors in productive work were 56.92% and 55.74% respectively (Maskey and Mishra, 2018). So it needs to manage all level of workforce effectively for high performance of the industry (Mishra, 2018). Value Management is solution for the issue of performance. A construction project design may exist unnecessary costs as projects are usually formed and designed under pressure of meeting with the deadlines the designer will not be able to review it for unnecessary cost within this limited time. The unnecessary costs in a design are not a reflection on designer's abilities as professionals, but rather management problems that reflects in the design of the project and may differ due to individual's judgment on the design. Poor and wrong decisions can be made under the competing pressures of time, budget, and quality, due to which the projects are likely to include unnecessary costs. The challenge is to cut unnecessary costs or to keep at minimum level and provide the maximum user satisfaction. Without the implementation of Value Management

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studies, the unnecessary costs may not be identified and removed. Consequently, the cost of a construction project will be high. Value Engineering is the tool to leave out these deficiencies from the project with maximum level of user's satisfaction [1].

The Second Small Towns Water Supply and Sanitation Sector Project (SSTWSSSP)were designed to improve the health, economic and environmental living conditions of people in small town areas in Nepal. The expected outcome of the Project is improved, affordable, and sustainable water supply and sanitation services, which are governed and managed by locally accountable representative bodies (SSTWSSSP, 2012). The project has been designed in cost recovery model that all the capital cost should be recovered within its entire life of the project.

STATEMENT OF THE PROBLEM

Nepal is one of the Least Developed Countries in the World and the Government of Nepal (GoN) has set a target to reach the country in stats of Developing country till 2022. For this, large amount of budget should be provided in the development of infrastructure facilities of the country as without development of modern infrastructure facilities such as Road and Railways network, development of electricity and medium to high-level water supply to fulfill the needs of the people etc. For the fiscal year 2015/16, Government of Nepal has allocated a total Budget of Rs. 819 billion among which Rs. 208.87 billion is for capital expenditure out of which Rs. 110.92 billion is foreign grants.

To meet the government's target the budget allocated for capital expenditure is not enough, though optimum utilization of the budget can be done using various engineering techniques. Without any special management techniques, the entire allocated budget will be spent out in the definite capital expenditure but the use of Value Engineering techniques in all development projects could save significant amount of budget which can be utilized in furthermore development projects or get optimal utilization of the resource. In the management cost aspect, it would be fruitful in employment aspect also.

The role of the professionals is very important that they can use Value Engineering techniques in the right way for best outcomes. In general, experts do not believe in the formal techniques and they are pleased in the traditional way of doing and thinking. That is why the opinions of Value Engineering experts should be recognized and existing practices on Value Engineering application should be identified. For that, a study should be done to know the ground condition of the professionals in Nepal.

RESEARCH OBJECTIVES

The main objective of this study was to find the status of Life Cycle Costing in Baitadi Town Water Supply and Sanitation Projecton Life Cycle Costing perspective for sustainable operation and management of the project [2].

LITERATURE REVIEW

Application of Value Management

Value Management studies can take place at any stage in the development of a project, however there is the potential for greater savings on investment if it is used at the earlier stages (Che Mat, 2004) [3].Value Management should be performed as early as possible even before the commitment of funds, approval of systems or design as to maximize results as shown in the Figure 1.

The cost of making changes and remedial works will be significantly increased as the time lapsed in the earlier stages. For example, a project is already committed the contractor has already been engaged and then the client decides to review the design by using Value Management

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technique, some recommendation can be put forward by variation orders that leads to the potential loss and expenses claim by the Contractors which decreases the total savings in the project.

Life Cycle Costing Techniques in Construction Projects

Life cycle costs can be determined in the design stage (UNEP, 2004) [4], and hence, LCC is particularly useful for estimating the total cost in the early stage of a project (Mishra, 2019) [5]. Research works has been actively undertaken to develop methods and tools to assess the sustainability of a project [6]. It is described in Figure 2.

In performing a VE study, LCC analysis is performed in the development phase of the VE job plan to determine the least costly alternative. The value of a project includes not only consideration of what the costs require it, but also the cost to use it or the cost of performance to the user for the user needs and which is determined by the users. Therefore, one measure of value to the user is to calculate the cost of ownership or its use. In addition to capital cost, costs of repairs, operations, preventive maintenance, logistic support utilities, depreciation and replacement, all reflect on the total value of a product to a user. Calculation of LCC for each alternative during performance of a VE study is a way to judge whether product quality is being maintained in enough degree of necessary reliability, performance, and maintainability.

The concept of economic analysis, which is used in LCC, requires that comparisons be made between things similar in nature (PBS-PQ250, 1992) [8].For example, one cannot compare the LCC of a bus to a car on a product basis, nor can one compare a house to a school on a product basis. In VE all ideas can be compared on an LCC basis if all alternatives were defined to satisfy the same basic fiction or set of functions.

In addition to comparable functions, economic analysis requires that alternative choices be considered on the same: (1) Time Frame (2) Quantities (3) Quality Level (4) Levels of Service (5) Economic Conditions (6) Market Conditions (7) Operating Conditions

Once a decision has been made to undertake a project, LCC analysis provides a comprehensive means to select among two or more alternatives to accomplish the project. According to U.S. Department of Transportation (2002), the LCC analysis process steps are listed below. The steps are ordered so that the analysis builds upon information gathered in prior steps [9].

Step One: Establish design alternatives
Step Two: Determine activity timing
Step Three: Estimate costs (Project and O&M)
Step Four: Compute life-cycle costs
Step Five: Analyze the results

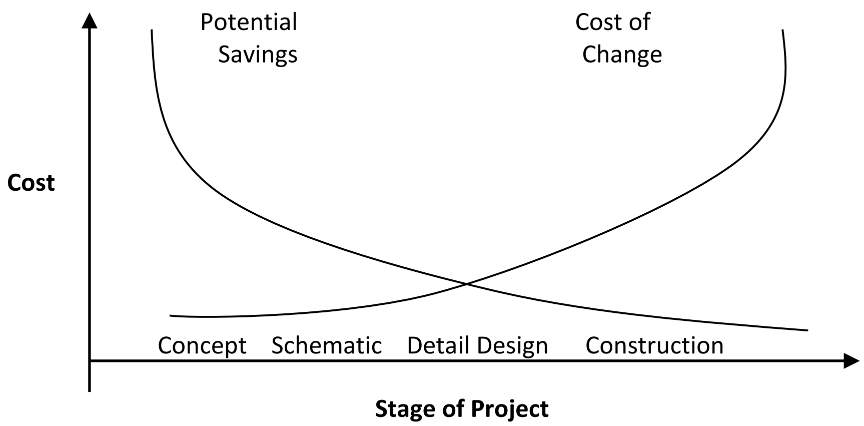

Fig. 1. *Stages of project and saving potential. Source: Che Mat, 2004.*

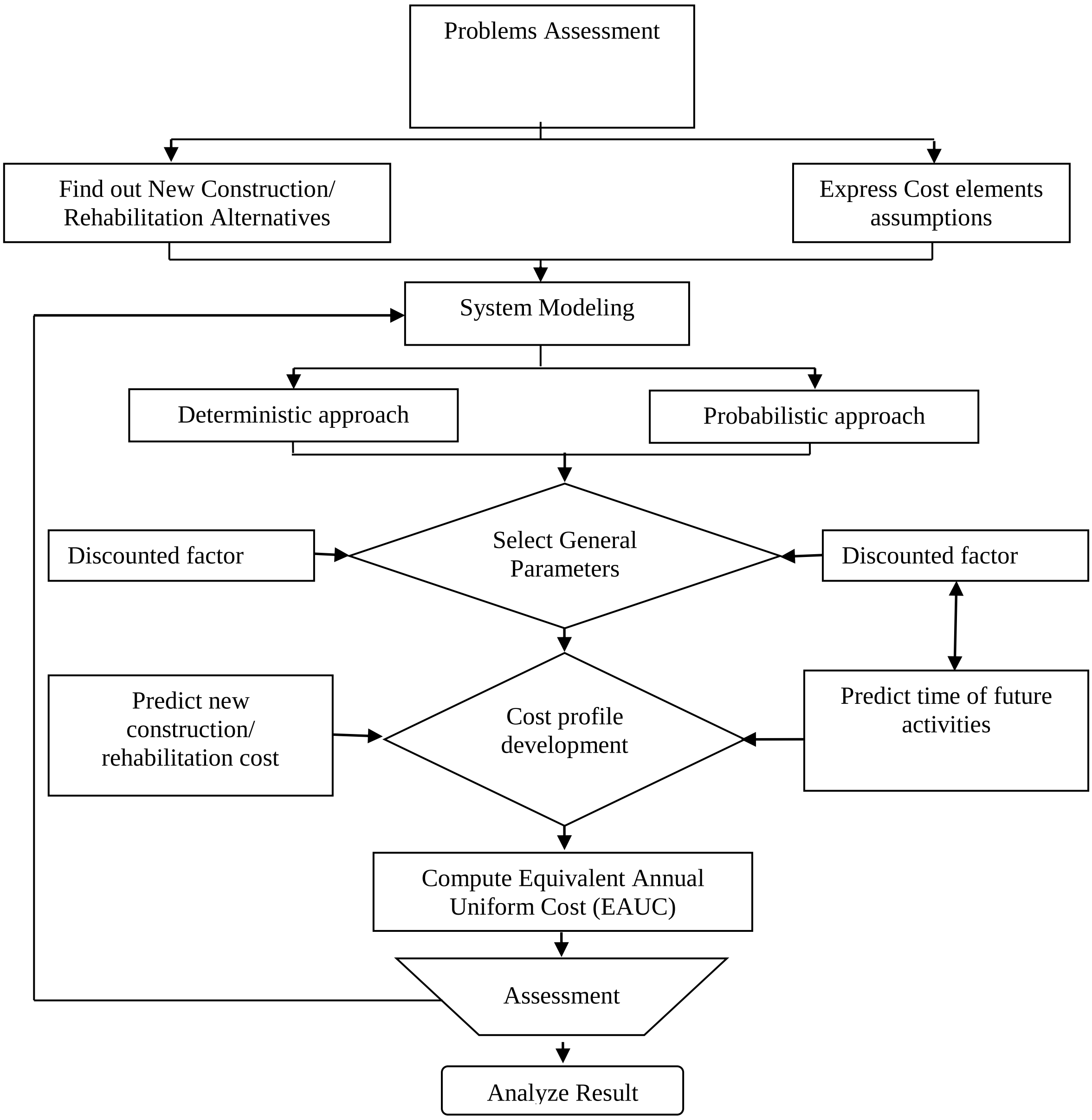

Fig.2.*Life cycle cost procedure. Source: Adopted from Shahataand Zayed, 2008* [7].

Step One

Different project alternatives will likely require different operation, maintenance and rehabilitation activities. Typically, the identification of operation, maintenance and rehabilitation activities is based on historical practice, research, and agency policies.

Step Two

Just make operational schedule in detail.

Step Three

LCC analysis requires all agency costs and users' costs associated with each alternative be calculated that demonstrate the differences between alternatives need be explored.

Step Four

All design alternatives should be evaluated over equivalent analysis periods in order to yield fair comparisons of life-cycle costs. LCC analysis is the concept of the time value of money i.e.; a given amount of money received today has a higher value than the same amount received later. All costs at different times must be converted to their value at a common point in time mostly recommends the present value (PV) approach, but the Equivalent Uniform Annual Cost (EUAC) approach is also commonly used.

There are mainly two approaches to preparing an LCC analysis: deterministic and probabilistic. The methods differ in the way they address the variability and uncertainty associated with LCC analysis input parameters such as activity cost, activity timing, and discount rate.

Deterministic Approach:The deterministic approach assigns each LCC analysis input variable a fixed, discrete value. The analyst determines the value most likely to occur for each input parameter. A deterministic LCC computation is straightforward and can be conducted manually using a calculator or automatically with a spreadsheet. However, it fails to convey the degree of uncertainty associated with the PV estimate [10].

The results of deterministic analysis can be enhanced using a technique called sensitivity analysis. The input variables may be ranked according to their impacts on the bottom-line conclusions. This information is important to decision-makers who want to understand the variability associated with alternative choices.

CAPEX (capital expenditure) or initial cost (IC)
Computation of PV of IC

$$PV = \frac{A(1 + i/100)^{(n-1)}}{(1 + d/100)^{n}}$$

n is the year on which PV will be calculated,
Interest rate, d,
Inflation rate, i.

OPEX (operational expenditure) or (O&M cost)
Computation of PV of O&M cost
Total O&M cost = P+E+O+M+C

PV of O&M cost at nth year,

$$PV = \frac{O\&M\ cost(1 + i/100)^{(n-1)}}{(1 + d/100)^{n}}$$

Personal Cost, P,
Energy Cost, E,
Operation Cost, O,
Maintenance Cost, M,
Chemical Cost, C,
Interest rate, d,
Inflation rate, i.

PV of O&M cost and cumulative O& M cost at different year can be calculated by using the formula, and the addition with the present value of initial cost gives the LCC of the project for that year.

Probabilistic Approach: Probabilistic LCC analysis allows the value of individual analysis inputs to be defined by a frequency (probability) distribution. For a given project alternative, the uncertain input parameters are identified, and possible values is developed by a sampling distribution. Simulation programming randomly draws values from the probabilistic description of each input variable and uses these values to compute a single forecasted PV output value. This sampling process is repeated through thousands of iterations. From this iterative process, an entire probability distribution of PVs is generated for the project alternative along with the mean or average PV for that alternative. The resulting PV distribution can then be compared with the projected PVs for alternatives, and the most economical option for implementing the project may be determined for any given risk level.

Step Five
LCC should be compared based on deterministic or Probabilistic approach but preference is given to deterministic as PV results in single value rather than distribution of PV.

The alternatives are often compared chiefly on agency costs. If the lowest-agency-cost alternative also has a disproportionately high user-cost impact, the analyst may use this information to revisit that alternative to mitigate user costs or may recommend that an alternative with somewhat higher agency costs, but much lower user costs be pursued in preference to the lowest-agency-cost alternative.

The result of the LCC can be plotted in a graph to show clear picture of the different options of alternatives.

Analysis of Deterministic LCC Analysis Results

The most basic analysis of a deterministic LCC analysis is to compare the agency and user cost PVs among alternatives. Application of sensitivity analysis can reveal where analysis results may be subject to uncertainty. Deterministic sensitivity analysis is helpful in determining the "most likely" scenario where the selected input values are most likely to occur. Ideally, the "best" alternative will have the lowest PV in the most likely of "what-if" situations.

Analysis of Probabilistic LCC Analysis Results

Probabilistic LCC analysis attempts to report on the full range of possible PV outcomes. It also shows the estimated likelihood that any given outcome will occur. The analyst can array this information so that the underlying uncertainty of each project alternative is reflected in the PV output results.

When interpreting the probabilistic LCC analysis, decision makers must define the level of risk with which they are most comfortable. For example, those with a low tolerance for risk prefer less variability in the results. The decision-maker may select an alternative with a somewhat higher PV but with much lower risk of cost overrun.

COST COMPONENTS OF LCC ANALYSIS

CAPEX or Capital Expenditure (Project Costs)

Project costs, sometimes referred to as initial or first costs, include both "hard" or construction costs: labor, materials, equipment, furnishings, etc. and "soft" costs: design fees, permit fees, etc. (Stanford University, 2005) [11].

OPEX or Operational Expenditure (Operation and Maintenance Costs)

Energy Costs

For a project with pumping system require electrical as well as other source of energy. The rates and units for the systems should be calculated.

Operation Cost

Generally, O&M cost of water supply project can be estimated while designing the project using the past experiences in similar projects. Where O&M data is not available, a percentage of capital cost is used as an estimate. Higher energy (mechanical) components have an annual O&M cost of 15% of capital costs. Other low energy components have an annual O&M cost of 5% of capital costs. Pipelines have an annual O&M cost of 2% of capital costs. Where scenarios require elevated storage, 15% of the cost of the tank is added to account for the costs associated with the construction of the supporting structures (Jones et al., 2012) [12].

While if best practices for certain aspects of technical, financial, and environmental sustainability are not followed, a system is likely to fail, following those best practices does not ensure that the resulting water system will be sustainable (Jones et al., 2012). Using a life-cycle approach to determine the cost and environmental LCI for the alternatives is difficult because there is limited data available for such systems and water system design is very dependent on the local context but, the results may be helpful to decision maker prioritize the feasible alternatives that are most sustainable from an environmental and cost perspective (Jones et al., 2012).

Numbers of man powers such as maintenance worker, meter reader, plumber, electrician, *chaukidar*, etc. are required to operate a water supply project smoothly and these required costs.

Leakage Cost

Leakage is one of big issue, which occurs at joints and perforations and also from burst resulting into big loss.

Maintenance Costs

Maintenance refers to the costs incurred to keep the system running properly. The four categories: preventive, reactive, planned, and deferred are required to analyze. These data should be based on historical data provided by facilities operations.

Preventive: Preventive maintenance is routine, scheduled activity intended to keep a system running at its best. This maintenance is performed whether there are any problems with a system. It is designed to prevent breakdowns. Preventive maintenance costs associated with equipment and systems should be incorporated into LCC analysis calculations.

Reactive: Reactive maintenance is performed in response to problems. Reactive maintenance is unpredictable. In theory, if systems are running well and all required preventive maintenance is performed, then reactive maintenance should be minimal. In practice, unplanned failures will occur and will require repairs.

Planned: The planned maintenance can be referred to larger-scale maintenance that is not addressed under preventive maintenance. Planned maintenance is the replacement of components of the system at the end of their useful lives.

Deferred: Deferred maintenance represents a backlog of planned maintenance. It is require keeping deferred maintenance to a minimum, but at present deferred maintenance does exist.

Besides the standard analysis steps of LCC, Davis Langdon (A UK based Consulting Company) summarized the steps of for LCC analysis who was appointed by the European Commission in 2006 to undertake a project to develop a common European methodology for Life Cycle Costing in construction. The project put forward the recommendations for the establishment of the Sustainable Construction Working Group to help take forward key elements of the Competitiveness study. The recommendations proposed that the Task Group be established to prepare a paper on how Life Cycle Costing could be integrated into European policy making. The Task Group's paper recommended the development of a common LCC methodology at European level, incorporating the overall sustainability performance of building and construction. Mishra (2019) summaries the steps to be followed in LCC analysis [13].

There are various computer models for calculation of life cycle cost of various types of projects. The Australian based Commonwealth Scientific and Industrial Research Organization (CSIRO) undertook the research and designed LICAN; a Windows interactive software program, to be a simple computer–based model that illustrates the impact of selecting alternative materials for municipal pipes on the total cost over their whole life (Ambrose et al.,2008) [14]. The Life Cycle Analysis of Water Networks (LICAN) model calculates potential future costs for the collection of pipe assets over a defined forecast period (typically one hundred years) [15].

APPLICATION OF VALUE MANAGEMENT

The International Federation of Consulting Engineers (FIDIC, 2002)Condition of Contract (2002) has provision of Value Engineering in Clause 13.2 in which, a proposal or Value Engineering Change Proposal (VECP) submitted by contractor after contract agreement to improve efficiency or lower the overall cost without degrading performance, reliability, maintenance, or safety, which is an incentive clause that can be provided for procurement contracts and the cost benefits are shared among client and contractor [16]. Trial mix design technique should be promoted so that the construction activity could become more economical without compromising the quality (Mishra and Chaudhary, 2018 a). Batching plants should be used in sites for achieving good control in quality of concrete while mixing relative ingredients of concrete (Mishra and Chaudhary, 2018 b) [17, 18].

A Value Engineering Change Proposal (VECP) is a proposal submitted by a contractor related to the client after the contract has been awarded to that contractor, provided their contract contains a VM/VE clause. It gives a financial incentive to get contractors and subcontractors to reduce the cost of projects, systems, supplies, and services for contracts in-progress though it is not the interest of contractor.

For over four decades, the VECP has had a notable history as an effective savings program for the US Department of Defense (2004). Two aspects of the VMCP make it unique in achieving its purpose that results in a contract modification, and an incentive paid to the contractor for reducing costs [19].

Value Engineering role was extended in the National Highway Systems Act of 1995 With different modifications. By applying the value engineering methodology to construction projects, USA highway and transportation departments claim to have saved U.S. taxpayers $750 million in 1998.

Malaysia has introduced Value Engineering in 1986 and registered Institute of Value Management Malaysia (IVMM) in 2000 to promote greater awareness of the VE techniques and its benefits [20]. Economic Planning Unit (EPU) of Malaysia has developed guidelines on Value Management's application and Government has endorsed that any projects and programs of RM50 million and above must go through the process of Value Management. Likewise, Malaysia Airports Holdings Berhad (MAHB) and Tenaga National Bhd (TNB) have adopted Value Management as mandatory requirements for project above RM0.3 million and RM10 million respectively resulting remarkable success in optimizing cost for their projects in both organizations (Che Mat,2004).

The Institute of Value Management Malaysia, together with Construction Industry Development Brand (CIDB) established an accreditation program for certifying the competent Value Management Practitioners as "Certified Value Managers".

In India, Indian Value Engineering Society (INVEST) was established in October 1977 and is serving Indian Industries by disseminating knowledge to the professionals. It organizes awareness training programs and workshops using certified Value specialist (Adhikari, 2011) [21].

Though the concept of VE was developed during World War II and has been applied successfully in construction project as well as in other industries in achieving better value in many developed countries, the concept has not received adequate attention in Nepal from both government and the professional as well (Adhikari, 2011) andwe do not have authentic document to use as reference that provides information related to VE application in the country.

The Standard Bidding Document for the procurement of works National Competitive Bidding (NCB) of Public Procurement Monitoring Office (PPMO)has GCC 28 for the acceleration of work. If client desire to complete the project before intended completion date, the contractor can propose priced proposals for achieving the necessary acceleration and treated as variation. The amount would be paid as per GCC 48 as bonus amount stated as GCC 48.1, though it cannot be said Value Engineering Incentive Clause.

SOME EXAMPLES OF VALUE MANAGEMENT APPLICATION CASES

In one study, (Che Mat,2004) on the condominium development project in Malaysia, the design proposed the floor to ceiling height of 10'0". After the designer being asked by the Value Management Team what is the purposed of the project and function of that, they responded that it was for marketing purposed, but the Building Bye-Laws only requires 8'6" floor to ceiling height. However, it was then decided to go for 9'0" in height. The purposed building was12 stories of 12 blocks. There was a saving of RM1.0 Million per block with the overall saving of RM12.0 Million.

In another study, the development of Institute Aminuddin Baki (IAB) Sarawak Branch Project in Malaysia was designed with the approved the budget of RM237.5 million. The aim of the project was to enhance the quality of leaderships of school headmasters and their deputies. After Value Management Team Studied the real purpose of the existence of the IAB with interpretation and design philosophy, forty-five ideas were generated and with implementing best option, there were 32.2% cost saving in the project, the details of the cost is shown in Table 1 (Che Mat,2004).

In India, Value Engineering is reported to have been applied in number of organisations. Some of these studies are:

- Design of a soldier's food container for the Indian Defence Forces.
- Water treatment plant at Bokaro for the Steel Authority of India.
- Institute of Pathology Building, New Delhi for the Indian Council of Medical Research.
- A refinery Expansion Plant for Bharat Refractories Ltd.
- A Housing Complex for Delhi Police at Model Town, Delhi.

METHODOLOGY

Introduction of the Baitadi Town Water Supply and Sanitation Project

Project Area

Dashrath Chand Municipality is the district head quarter of Baitadi district of the Far-Western Development Region of Nepal as depicted in Figure 3. It is linked to East West Highway at Attaria by a 205 km long black topped road. The altitude of service area varies from 1650 meters to 1000 meters mean from sea level.

Demographic Characteristics of Project Area

The Dashrath Chand Municipality have population of 16791 on 3788 household as per the census report 2012 of Nepal, among which the project serves 6652 populations of 987 households of ward no. 1 (Gadhi, Gothalapani and Sahilek), part of ward no. 2 (Madkot), part of ward no. 4 (Pallo Chaudoli), parts of ward no. 5 (Baskot), parts of ward no. 6 (Simail) and part of ward no. 9 (Tripura) of the municipality.

Table 1. *Summary of VM study for IAB Project.*

Phase	Before (RM m)	After (RM m)	Saving (RM m)	%
Budget Ceiling	237.5			
VM Study		172.2	65.3	27.5
VM Post Study		161.1	11.1	6.4
Overall Saving (from original estimate prior to VM Study)			76.4	32.2

Source: Che Mat, 2004

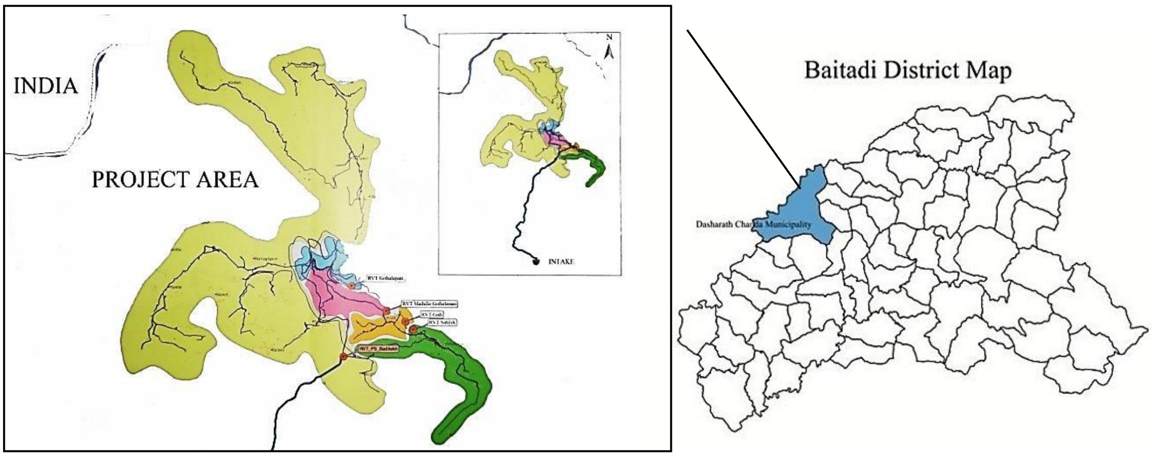

Fig. 3. *Map of Baitadi District showing the Study Areas. Source: ERMC, 2014.*

Table 2. *Population of project area.*

Ward No.	No of HH	Population				Rented Population	Total Population	%
		Male	*Female*	*Total*	*%*			
1	602	1709	1887	3596	60.01	656	4252	63.92
2	60	158	173	331	5.52	4	335	5.04
4	22	54	64	118	1.97		118	1.77
5	117	339	407	746	12.45		746	11.21
6	106	337	362	699	11.67		699	10.51
9	80	238	264	502	8.38		502	7.55
Total	**987**	**2835**	**3157**	**5992**	**100**	**660**	**6652**	**100**

*Source: ERMC, 2014***.**

Based on Table 2, the most of settlement of service area are predominantly quite scattered and looks like hilly rural village type of livelihood except the main market area in ward no. 1 of the municipality as it is the main market place of the district. So, the service area has mixed rural and semi urban characteristics.

Implementation Modality of the SSTWSSSP

The financing of town project, water supply systems is being financed by WUSCs (50%) and the Government (50%). The initial cash contribution of WUSCs may range between 5% and 15% of the civil works contract, including a 5% upfront cash contribution, depending upon its willingness and capability, with the remaining 35%–45% to be borrowed from the Town Development Fund (TDF). The TDF will lend the funds to WUSCs at an interest rate not exceeding 5% per annum with a maturity of 20 years including a grace period of 5 years (ADB, 2010) [22].

IMPLEMENTING AGENCIES

There are major three stakeholders who are liable for execution of the Value Management and Life Cycle Costing in the project.

Project Management Office

PMO is responsible for the overall project planning and management established in the DWSS. There is a project management consultant's team for management and technical support to the office.

- Study the Feasibility Study and Detailed Engineering Design Reports prepared by DSC's and comment about the shortcoming point.
- Monitoring and Evaluation of the implementation work.
- Organize workshop and training programs as required.

Water Supply and Sanitation Division Office (WSSDO), Baitadi, Project Implementation Unit Office (PIUO)
WSSDO under the guidance of the PMO has adopted following approach

- Assist the PMO to prepare Pre-Feasibility Report, Socio-Economic Study and implementation of the project.
- Quality control of construction materials and structures and monitoring and evaluation of the progress.
- Assist the WUSC in operation and maintenance of the project, management of operation and management cost, fixing monthly tariff, necessary support to manage fund for loan repayment after completion.

Design and Supervision Consultant (DSC)
The DSC's are assigned to design the town projects and supervise the construction of the project and they had to follow the following steps (SSTWSSSP, 2012)

- Prepare feasibility study report and fix the project area after consultation with WUSC's and field investigations.
- Prepare Detailed Engineering Design Report (DED Report) according to the fixed Guidelines. While preparing DED report, possible all alternatives should be presented to the users and the approved alternative should be finalized.
- Supervise and control the quality of the construction work of the project.
- To assist the project for timely completion.

WUSC are responsible for O&M of the water supply and sanitation facilities constructed. Local governments, i.e., VDCs and municipalities, are responsible for ensuring effective and efficient operation of the system by WUSCs and will facilitate the access of WUSCs to a TDF loan as well as the loan recovery from the WUSC to the TDF. The TDF provides financial, technical, and institutional support to the institutions engaged in town development.

METHOD AND SOURCE OF INFORMATION

Primary Data Collection

Consultation

The consultation was done to the respective authorities/professionals who were involved in the project. The Consultations were done for the activities should be performed at the different phases of the project implementation such as Inception Phase, Feasibility Study Phase, Project Design Phase, Procurement Phase, Construction Phase and Post Construction Phase and what were main activities and what would be the main focused as a project leader.

Focused Group Discussion

Three focused group discussion was carried out in the project area with eleven members of Water User's Committee and one from the Project Implementation Unit Office. The main agenda of the discussion were about the activities performed by the consultant team and the project office at the different stages of the project and the possible operation and maintenance cost in the and their minimization during operation of the project

Desk Study

Literature and other relevant documents were reviewed with respect to this study in order to fully understand the issues involved in the VM and LCC of projects and their appropriate use in water supply projects. Literature were reviewed on value management techniques, life cycle cost analysis procedures and its importance, cost breakdown structure. The secondary sources such as the project documentations, Feasibility Study Reports, Draft Report on Detailed Engineering Design of the Project, Detailed Engineering Design Report and Drawings, IEE reports of the projects, Contract Documents and reports of official publications, Semi-official publications, and Private publications were studied [23]. The various sources of unpublished statistical data are maintained by private form, business enterprises, various departments and offices of government, research papers etc. and literatures collected are studied.

DATA ANALYSIS AND INTERPRETATION

Content analysis as discussed as consultation and focused group discussion and questionnaire, Significant Mean weight score for attitude assessment was done by T test, relative hindrance index was done for assessment of hindrance factor along with their rank significance through Spearman Rank Correlation Coefficient. The Life Cycle Cost of the Baitadi Town Project was calculated from the operation and maintenance cost and other necessary data from Final DED Reports and the LCC obtained was compared with the LCC of the Draft DED Report as well as LCC of Intrapersonal Water Supply Project of Morang District and Damask Town Projects of Jhapa District. The results were presented in pie chart, bar diagram, tables. It could be summarized as in Table 3.

RESULTS AND DISCUSSIONS

Practice of Value Management in Life Cycle Cost Perspective

In the process of the project initialization or design process there was no any facilitator appointed to organize VM procedures.

Studying various documents such as feasibility study report, Draft report of Detailed Design Report, The Final Report of the Detailed Design Report of the project and bid document, however, some meetings with the WUSC's with the WSSDO are organized at the time of the study period, the organized VM workshops was not organized for the generation of large volume of ideas on different options for the project.

LCC of the Project

Life cycle costing enables managers to make informed decisions on how much to invest today for future economic benefits from the system. Davis Langdon, a management consultant, UK, (2007), describes about the 15-step final methodology of Life Cycle Costing (LCC) as a contribution to sustainable construction, is also the detailed breakdown of the 5-step common methodology of the LCC as U.S. Department of Transportation (2002) [24].

Step One: Establish Design Alternatives

The WUSC, client and consultant team are not identified all possible alternatives of the source, only one option of the source Kansanigad was studied which was 950m down from the, needed 6 stage pumping system with the total project cost of Rs. 186 million, the design year per capita cost of Rs 19,897.50, quite high as the project beneficiaries of 919 households and 9068 design population. This seems the project was not feasible and rejected. Due to scarcity of water at the project area again other options of the source was studied and Madkhola source was proposed for the project. This takes about two years to complete the final design of the project, which is depressing truth for any development projects. Again, the final design is prepared with one set of design of the structures not analyzing other design alternatives of the structures such as design of conventional slow sand filter instead of rapid sand filter or pressure filter for water quality parameters, by which the large area for the treatment plant is required, conventional sedimentation

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tank instead of tube settler or other modular sedimentation tank etc.

Step Two: Determine Activity Timing

Since there were only one alternative was studied, the component activities the project operation, maintenance and rehabilitation were identified the projects operation, maintenance and rehabilitation plan is developed but the alternative operation, maintenance and rehabilitation plan was not developed. This plan results in a schedule of when the future operation, maintenance and rehabilitation activities will occur. The schedule of the plan was done for 18 years with 10% annually for personal and chemical cost, 5% annually for maintenance and energy cost and 2.5% annually for staff cost. Since the loan of TDF should be pay back up to 15 years with 5 years extra grace period, the repayment plan of the loan should be prepared, but the design report does not explain about the plan.

Step Three: Estimate Costs (Project and O&M)

The capital cost (CAPEX) or the total project cost estimate of 119 million with contingency and VAT in which 21.8 million for civil works, 3.9 million for electromechanical works, 58.5 million for pipe works and 7.5 million for miscellaneous works. The details of capital cost of water supply systems are shown in the Appendix A.

One of the major functions of project management is to ensure that water supply projects receive adequate maintenance in order to continue to function efficiently and effectively to up to the design period to fulfill the users demand of water. Maintenance process is a fundamental stage in the water supply systems life cycle.

In the operation costs, personnel cost of Rs. 0.91 million for the salaries given to the eleven members of staff proposed for the operation in year 1. Office expenses were the cost of Rs. 0.1 million incurred for the stationeries, printing works and cost of running the office. Maintenance costs of Rs. 0.2 million were incurred on minor and regular works carried out on the water supply scheme. They included the costs of cleaning slow sand filter and washing of filter media sand, clearing and weeding along the pipe lines, cleaning of washout, repairs on pipe meters etc. The cost of Rs. 0.064 million for chemical required for the chlorination of the water and regular water quality test for the distributed water. Hence the total cost required for the smooth operation of the system needs Rs. 2.06 million in the first running year, which does not include the loan and interest payment cost. The tariff for the water supply system was estimated as Rs.248 per month, which does not enough. For sustainable service delivery there should be full cost recovery.

Since other alternatives of the project are not analyzed, the project cost and the O&M cost was analyzed for only one system only. As per LCC Analysis requires all agency costs and users ‘costs associated with all possible alternative be calculated that demonstrate the differences between alternatives need be explored.

Step Four: Compute Life-Cycle Costs

The actual life cycle costing of the proposed project was not analyzed. However, the economic and financial analysis of the proposed project was done in Draft Engineering Design Report. There was no any economic and financial analysis of the project in the Final Engineering Design Report of the project. For that, the detail calculations were done for FIRR and EIRR, likewise derivation of Average Incremental Costs, AIEC and AIFC of the project for 25 years excluding construction period of 2 years.

The assumptions made for the analysis:

- The replacement cost is 10% of machinery and equipment after 10 years

- Water meters are assumed to be replaced after 7 years
- The social and social opportunity cost of capital is considered at (EOCC) 12%
- The financial opportunity cost of capital is considered at 4%.
- The average household size is 6.74 persons
- 50% of initial capital cost is assumed as salvage value in 25th year of civil structures.

The analysis shows that AIFC was Rs.44.82 and AIEC was Rs.67.49 per cum, likewise the FIRR was 4.04% and EIRR was 66.58% (ERMC, 2014). The financial projection and cash flow analysis was done, and sensitivity analysis was done for increasing cost by 10%, decreasing benefit by 10%, and when increases cost by 10% with benefit decreases by 10%.

After all the calculating all the possible costs, the present values of the future costs are calculated with discounted factor given by FOCC different successive years, the trends of the lifecycle cost of the Final Approved Project (Option 1) and the Draft Detailed Design Report previously prepared which was rejected as not feasible option (Option 2) is as shown as Figure 4 and Appendix B and Appendix C.

The financial and economic analysis was done for the proposed design of the project. Only one option of source Kansanigad was studied before rejection of the project being financially and economically not feasible in the Draft report of Detailed Design Report the project (Option 2) due to which two years of the project period September 2010 to August 2012, the submission date of the draft report and final report of the detailed design report.

Step Five: Analyze The Results

The Average Incremental Financial Cost (AIFC) can be compared with the level of affordability based on estimated household income. Though the Financial Internal Rate of Return (FIRR) of the project was 4.04%, which is more than Financial Opportunity Cost of Capital (FOCC) 4%, shows that was commercially profitable and commercially sustainable. As the EIRR was 66.58%, it shows very beneficial for the project, as it was more than Economic Opportunity Cost of Capital (EOCC) 12%. It shows the project is affects economy of the project area positively (ERMC, 2014) [26].

The sensitivity analysis shows there were no negative cash flows in the first two cases. Though the three consecutive years after 10 years have negative cash flows, the analysis shows that the project was feasible for that project area.

For the calculation of affordability and tariff of the water supply system, the minimum average rate of the water was taken as Rs. 80.00 per cum in Draft DED Report (Option 2) and 32.16 per cum in the final DED Report (Option 1), which is quite high for the rural type of community like Baitadi. The average tariff is one of the financial disciplines of service provider and its ability to cover its operational costs with revenues from prudent expenditure (SEIU, 2014) [27]. Out of 32 service providers more than 75% have average tariff are below Rs. 15.00/cum and maximum tariff was seeming Rs. 30/cum. It plays very important role in the sustainability of the project; more is the tariff less consumption and less revenue collection efficiency. In this project, the higher tariff was taken to show the project is financially sustainable.

In the case of the Baitadi Town WSP, due to lacking of the alternative project analysis in the initial stage of the project the Draft DED Report was rejected as it was not seemed feasible which losses about two years to complete another study for the alternative project considering that the project area has extreme scarcity of water and an competent drinking water project is essential for that area. Considering time value of money for two years, as per 12% EOCC and the given formula;

$$\text{PV (for two years before)} = \frac{F}{(1+i/100)^n} = \frac{119}{(1+12/100)^2} = 94.866 \text{ million}$$

Which shows 24.13 million less amount is required if the project starts two years before. The time value of money is significant for two years for the project; the project must expend 25% expenditure in delay of two years. The economic and financial analysis is not sufficient in analyzing the LCC; professional can manipulate the factors to show the project as feasible condition. The client must invest more the time value of money is significant for two years.

However, economic analysis only is not specifically LCC analysis, different types of economic analysis or capital budgeting techniques, which could be involve in LCC analysis in some cases. There is not structured analysis process followed in the economic analysis of the project that a successful application of an LCC approach requires a team approach incorporating all key players in a project [28].

However, the comparisons of LCC of the project was not done with LCC of the design alternative, the comparisons of the LCC, line parallel with EF with same type of Project with larger population and capital investment cost, Indrapur of Morang district, parallel line with CD and Damak of Jhapa district, parallel line with AB is shown in the Figure 5. Figure 5 shows that the slopes of line AB and CD are greater than the slope of line EF, LCC of the Baitadi WSSP can be said minimum among three projects.

The comparisons of LCC graph Figure 5 with Indrapur and Damak WSSP, the slope of Baitadi WSSP is less than both of two. It can be concluded that the Baitadi WSSP has minimum LCC which may be due to small size of the project and benefitted population than the two however it may not be the least as there no analysis of all alternative design option of the. If the VM and LCC were applied in Damak and Indrapur, the slopes of the projects may be as of the Baitadi.

Besides this, in the implementation phase the project is suffering from Variation Order of 11.1 million (9.21%) of due to inappropriate site selection without assessment with WUSC for the structure components, hard-hitting for the WUSC to allocate extra cost for the additional amount due to inappropriate assessment of the location for the main physical structures of the project. The Variation Order is overburden for the project as users should contribute 50%. WUSC is facing financial gap for the contribution as a result of the inappropriate assessment of the consultant with WUSC and local users.

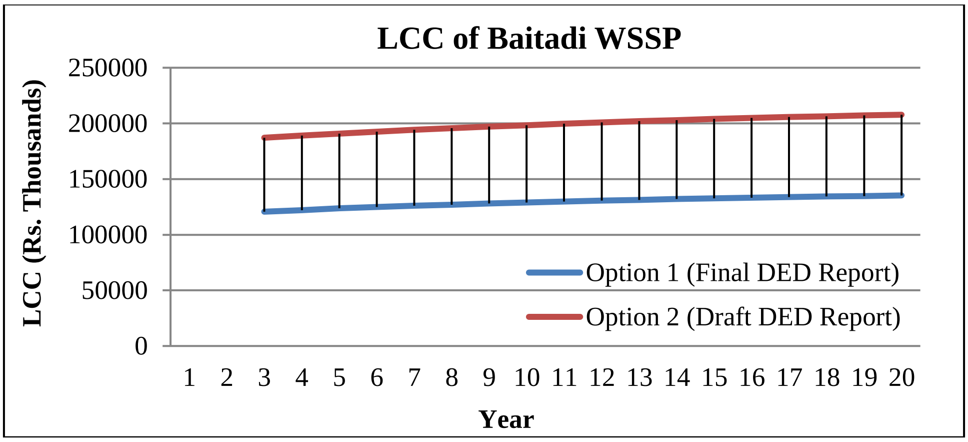

Fig. 4. *Comparison of LCC of Baitadi WSSP.*

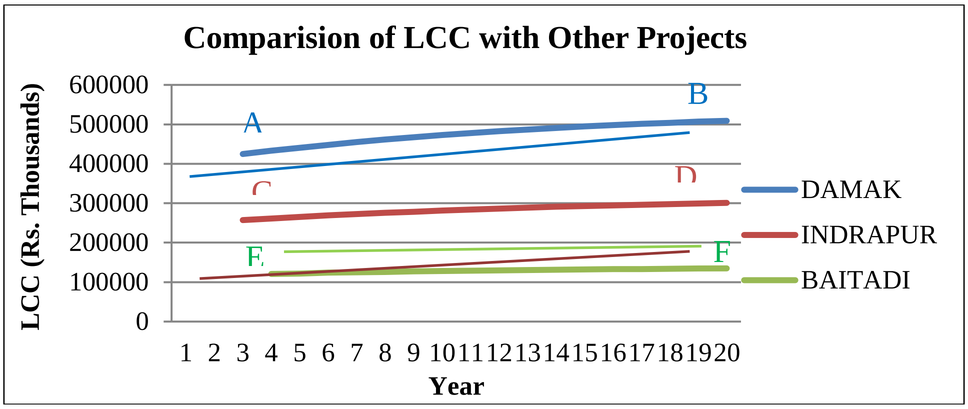

Fig. 5. *Comparison of LCC with Damakand Indrapur WSSP.*

Life Cycle Cost of the designed water supply project for the Baitadi is as shown in Figure 4. At the end of 19th year of operation of the project the total operation and maintenance cost is 16 million which is 16.91% of the initial project cost which is quite big amount for a community as all the O&M cost is the contribution of community. The LCC analysis of alternative project design plays vital role in a water supply projects, small amount of reduction of O&M cost impart significant amount reduction of LCC in long run.

Detailed economic and financial analysis of the selected project was done but as per the LCC procedure, detailed economic and financial calculations of all possible alternative design should be designing to get best result. In this design the FIRR was taken as 4% and from financial calculation the result was 4.04% nearly about the estimated. Which shows the project would be in critical condition that in small change of the condition the project would not be financially sustainable though it seems economically profitable. The project may have more alternatives which can be generated if VM process was introduced to find out financially profitable option of the project.

LIFE CYCLE PERSPECTIVE ANALYSIS THROUGH CONSULTATION

In the inception Phase of the project the project leaders should carry out the best project strategy to clarify the objectives of the project and identify all risk areas. The team leader of the project had clarified the main objective as to supply drinking water to the people of Baitadi, but for that the possible all risk areas were not identified.

Feasibility study phase is the most important phase for a project in which the decision would be taken for the project goes forward for implementation or not. In this phase the alternatives with best value to satisfy the objective of the project would be selected. In case of the Baitadi, the feasibility study was done completed as per the norms and guidelines of the project's requirement as stated by the top management but the unfeasible Draft DED Report was submitted initially by the consultant.

Design Phase of a project is a main part in a construction project in which main blueprint of the project is prepared; all the phases after this would be guided by the design of the project. In this phase the professionals involved in the design should perform value analysis and measures of risk control. Though the project management team have specified that in the design process all the required value analysis and risk control measures were performed, there were many risks were seemed in field such as problem in land acquisition for construction of physical structures, change of design in the transmission pipeline, increment in the distribution pipeline, all the user's not contributing for the project etc.

Right procedure and fair contractual risk allocation between all the parties involved should be ensue in the contractual process of the project. As per the top management of the project fair contractual process was carried out according to ADB's Procurement guidelines as the project was granted by ADB, the major risks seem to be remained towards contractor. There waslacking coordination in fund management of the user's part as they must manage 15% of the total cost among which 6% was contributing by Dashrath Chand Municipality, 4% by District Development Committee and5% by users. However, due to different internal problems, there was deficiency in contribution by municipality and users; the contractor was not getting all the reimbursement as per bill amount.

In the construction phase, all the stakeholders should manage the construction process for the smooth progress of the project and control the risk generated and effects of risk. There was management problem in the construction of the project and suffering from time and cost overrun due to poor management and incomplete assessment of the project in the design phase. Though time overrun was due to negligence of contractor, the cost overrun was cause of the negligence or the inefficiency of the design consultant and the top management of the project. Generally, in a water supply projects, the constructions were carried out from headwork such as intake, transmission pipeline, filter plant, but in the Baitadi town project it was not followed and there were lack of social backing for the project.

In the post construction phase the feedback were collected. As the project has not completed the construction phase there were no feedback.

LIFE CYCLE PERSPECTIVE ANALYSIS THROUGH FOCUSED GROUP DISCUSSION

The most of the user's committee members stated that there was lacking the activities to be performed in a design process of a water supply project. In feasibility as well as detailed study of the project, the users were not consulted by the survey team, mainly in the location of the structures. Likewise, there were lacking in the social involvement in the study. In the construction phase, massive social participation is required as the distribution pipe line work should be done in the public way as well as private properties. Lacking coordination of the local users' frequent disputes were raised in laying of distribution pipeline. The contractor, consultant teams have almost unsuccessful to solve the disputes and wrong blames to the both contractor and consultant team and even the users committee agreed lack of the coordination with all the users. Due to the wrong priority to the construction of components, peoples believe that the project may not be successful as though the long period of completion of reservoir tanks remains empty. Due to the management problems, the project suffers time and cost overruns and users are very depressed for that circumstance [29].

While on the case of operation and maintenance cost, they were conscious of the possible costs in operation of the system but have not any ideas about the minimization of the operation cost which is very important issues of Life Cycle Cost of the project. They know that the minimum monthly tariff of water service may be more than Rs. 248, there are some probability in not collecting 100% revenue as they have no any tariff collection system at present situation. They have not any contingency plan in the case of the operation cost exceeds the tariff collection, desires financial support from the local governments DDC and the Municipality (Figure 6).

Fig. 6. *Focus Group Discussions with WUSC and PIUO.*

In the Baitadi Town Water Supply Project, there was lack of coordination between project stakeholders mainly with consultant and users committee during inception to implementation phase and with contractor and users committee during construction phase.

Some of professionals have still thought that LCC calculations take extra time, however clients may not pay extra costs and design fees. The encouragements for the engineers, in terms of payment, to perform such analyses are rare. The driver for change is that clients should recognize the added value being provided on the project and, as a result, pay for this service. Until this is done, professional engineers will provide the largest obstacle to use VM and LCC techniques. Therefore, they do not apply LCC calculations in design process, so, the LCC calculations should be compose as a part of design process of any construction project. In order to increase the use of VM and LCC, these two constraints should be addressed.

Most of the professionals are practicing some components of Value Management and Life Cycle Costing techniques such as generative alternative ideas, financial and economic analysis etc. However, modification of the alternative ideas and comparisons are not done. By the introduction of VM study there were not significant cost burden to the client as the literature reviews shows that the cost of VM study contribute around 1% of the project cost but create savings more than 10% of project cost. So, it can be concluded that Introduction of VM in construction projects is feasible technically and financially.

In the first phase of small-town projects completed from 2004–2010, out of 29 town projects more than 50% of the projects are successful in recovery of capital cost and O&M cost and more than 33% projects are successfully operating as per design and partially successful in recovery of capital cost and O&M cost because of some management problem (Sah, R.D. 2011) [30]. This shows, there is Value Management in the water supply projects to some extents, 100% projects possibly will be successful in cost recovery and O&M cost if VM studies was done in that projects.

The functionality issue in the water supply sector is very important that only 25.4% of the water supply schemes are well functioning, remaining have different problems in smooth supply of water whole year (NMIP, 2014) [31]. The reason for the many failures of such systems is that the outcome of the design decision depends in large part on the response of the system’s users and other stakeholders over the life cycle of the system (Jones, Anya, Stacey and Weir, 2012). Providing sustainable water systems in resource-limited nations remains at the forefront of national agendas, expenditure of large amount of investment on the rehabilitation and reconstruction before design period is wasting of national resources.

Since there is lacking proper guidelines for the introduction of VM in the project, the TOR of the consultant, Bid Document and Contract Document with contractors have not any clauses for the proper application of VM service in the SSTWSSSP and the Baitadi Town WSSP.

In the second specific objective, 12% clients and 15% of consultants seems that VM cannot be introduced in low cost project, but in collectively the Second Small Town Water Supply and Sanitation Sector Project have total cost of $71.7 million. As per literature review, Malaysian Government has endorsed that any projects and programs of RM50 million and above must go through the process of Value Management. Likewise, Malaysia Airports Holdings Berhad (MAHB) and Tenaga National Bhd (TNB) have adopted Value Management as mandatory requirements for project above RM0.3 million and RM10 million respectively. So, the introduction of Value Management in the projects like SSTWSSSP may be possible as the threshold of the Malaysian institutions were smaller than the total project cost of SSTWSSSP.

As per literature review, generally Value Management can get average savings of 10%; if the project has applied Value Management in the project there may have savings not less than $7.17 million, which amount would be enough for the implementation of two or three similar type of project which may be very fruitful in context of Nepalese scare resource.

Nepal facing economic problems that the GDP cannot raise even more than 4% since last three years (MoF, 2015). So, in that case the utilization of the national resources should be optimized, and Value Management techniques may be one of the best solutions. In total budget of Nepal capital expenditure not more than 25% of the total budges. As per governments target, to reach the government target as to develop country as developing countries till 2022 AD, huge amount of capital expenditures should be provided due lack of resource it was difficult to manage resources. As the case of the Baitadi Town Water Supply project, instead of cost optimization in the project there is higher value of variation orders which is burden to the governments.

Value analysis as a staff function, can be assigned to either technical manager or planning manager. Since Value Analysis needs inter-departmental cooperation at all levels for the success, Planning Chief, who performs the role of the project coordinator, can be perform the value analysis function as he works in close conjunction with engineering, design, production and purchase departments. If the project is large, it may be worth it to appoint an independent value engineer working directly under project manager. Irrespective of the position or the type of organization chosen, the Value Engineer must be appointed as a part of the project management team.

CONCLUSIONS

Value Management techniques are not practiced in Baitadi Town Water Supply project. As per professionals the risk assessment of the project should be taken as Value Management, as purpose of the procedure of VM are likely as the purpose of risk management. However, in the Baitadi Town Water Supply Project has not practiced risk management as well as Value Managements as there are numbers of risks was found in the construction phase. As a result of not analyzing Life Cycle Cost of all the possible alternatives of the project has variation order as per required in the project.By the use of Value management techniques as per literature reviews, the average cost saving of 10% would be achieved but in the case of Baitadi Town Water Supply Project was different that extra 9.21% resources are required for the completion of the project. According to users committee one of the main reasons of the cost overrun is due to the lack of coordination of the consultant with users committee during design phase of the project.

So, it can be concluded that adopting of VM with LCC perspective is beneficial related to water supply projects because the total cost for operation and maintenance of projects. Even a very small improvement within the operation phase will have large economic benefits for society. Though the initial investment can be somewhat higher when performing LCC calculations, it may economical for the service provider in long run of the project due to cost savings during operation and maintenance.

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Appendix A

Capital Cost of Water Supply Systems						
S.N	**Particular of Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Remarks**
A	**CIVIL WORKS**					
1	Stream Intake	Nos	1	1065248	1065248	
2	Collection Chamber	Nos	1	227004	227004	
3	Plain Sedimentation Tank	Nos	1	4594512	4594512	
4	Slow Sand Filter	Nos	1	6463011	6463011	
5	RCC Circular Retention Tank (150m3 capacity)	Nos	1	1718223	1718223	
6	RCC Circular Retention Tank (50m3 capacity)	Nos	2	737330	1474660	
7	Sump Well	Nos	2	108584	217168	
8	Pipe Crossing	Nos	2	10113	20226	
9	Thrust Block of Sizes					
	1000x1000x1000 mm	Nos	15	30048	450713	
	900x900x900 mm	Nos	25	22845	571115	
	700x700x700 mm	Nos	30	14538	436136	
10	Break Pressure Tanks	Nos	12	52041	624616	
11	Valve Chamber for Air Valve	Nos	2	36765	73529	
12	Valve Chamber for Washout Valve	Nos	1	48560	48560	
13	Pipe Valve Chamber	Nos	85	2377	202056	
14	Office cum Guard House (at Badilekh)	Nos	1	1259778	1259778	
15	Guard House at Treatment site	Nos	1	554119	554119	
16	Boundry Wall at Different Places	Rm	202	2394	483588	
17	Steel Gate in Wall at Different Places					
	4m Wide	Nos	1	24689	24689	
	2m Wide	Nos	3	13802	41407	
18	Site Development at Various Places	Nos	5	100000	500000	
	Total Cost of Civil Works				**21844531**	
B	**Electromechanical Works**					
	Supply, Installation, testing and commissioning all complete of pump and electromechanical Accessories in Pumping	Job	1	1968577	1968577	
	Supply and Installation of 11 KV Electric Power Line, Pumphouse lighting, and stand by steel generators	Job	1	1842263	1842263	
	Tools and Equipments for O&M	Job	1	97500	97500	
	Sum of Electromechanical Works				**3908340**	
C	**Pipe Works**					
1	Pipe Cost	Job	1	37886566	37886566	
2	Pipe Transportation to Site	Job	1	766853	766853	
3	Supply and Installation of Pipe Fittings as per Attached sheet	Job	1	2864287	2864287	
4	Pipe Laying and Jointing of Different types of pipes	Job	1	1703372	1703372	
5	Excavation and Backfilling	Job	1	6421086	6421086	
6	Community Stand Posts(Connection only)	No	14	9672	135405	
7	House Connection	No	900	9672	8704578	
	Sum of Pipeline and Structures				**58482147**	
	Sub Total				**84235018**	
D	Miscellaneous					
1	General Item Works	Job	1	5088000	5088000	
2	Days Work Cost	Job	1	348620	348620	
3	First one year O&M Cost	Job	1	2065584	2065584	
	Sum of Miscellaneous Cost				**7502204**	
	Total Cost				**91737221**	
E	Physical Contigencies 10%				9173722	
	Price Contigency 5%				4586861	
	Total				**105497805**	
	VAT 13%				13714715	
	Grand Total				**119212519**	

Source: (ERMC, 2014)

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Appendix B

LCC of Baitadi WSSP(Option 1) Rs. in Thousand

S.N.	**Years**	Discounting factor $1/(1+12/100)^n$	Future O&M Cost at n^{th} year	PV of year	Total PV incurred	**PV of Initial Cost**	**Total LCC**
3	2012						
4	2013						
5	2014	0.712	2066	1470	1470	119212	120682
6	2015	0.636	2155	1369	2840	119212	122052
7	2016	0.567	2943	1670	4510	119212	123722
8	2017	0.507	2347	1189	5699	119212	124911
9	2018	0.452	2451	1109	6807	119212	126019
10	2019	0.404	2561	1034	7842	119212	127054
11	2020	0.361	2677	965	8807	119212	128019
12	2021	0.322	2799	901	9708	119212	128920
13	2022	0.287	2929	842	10550	119212	129762
14	2023	0.257	3065	787	11337	119212	130549
15	2024	0.229	3210	736	12073	119212	131285
16	2025	0.205	3363	688	12761	119212	131973
17	2026	0.183	3526	644	13405	119212	132617
18	2027	0.163	3698	603	14008	119212	133220
19	2028	0.146	3881	565	14573	119212	133785
20	2029	0.130	4075	530	15103	119212	134315
21	2030	0.116	4281	497	15600	119212	134812
22	2031	0.104	4500	467	16067	119212	135279

Appendix C

LCC of Baitadi WSSP as per Draft DED Report (Option 2) Rs. in Thousand

S.N.	**Years**	Discounting factor $1/(1+12/100)^n$	Future O&M Cost at n^{th} year	PV of year	Total PV incurred	**PV of Initial Cost**	**Total LCC**
1	2010						0
2	2011						0
3	2012	0.712	3015	2146	2146	180430	182576
4	2013	0.636	4000	2542	4688	180430	185118
5	2014	0.567	3579	2031	6719	180430	187149
6	2015	0.507	3780	1915	8634	180430	189064
7	2016	0.452	3990	1805	10439	180430	190869
8	2017	0.404	4206	1699	12138	180430	192568
9	2018	0.361	4440	1601	13739	180430	194169
10	2019	0.322	4682	1507	15246	180430	195676
11	2020	0.287	4934	1418	16665	180430	197095
12	2021	0.257	5193	1333	17997	180430	198427
13	2022	0.229	5460	1251	19249	180430	199679
14	2023	0.205	5739	1174	20423	180430	200853
15	2024	0.183	6031	1102	21525	180430	201955
16	2025	0.163	6265	1022	22547	180430	202977
17	2026	0.146	6530	951	23498	180430	203928
18	2027	0.130	6828	888	24386	180430	204816
19	2028	0.116	7168	832	25218	180430	205648
20	2029	0.104	7345	761	25980	180430	206410
21	2030	0.093	7645	708	26687	180430	207117
22	2031	0.083	7924	655	27342	180430	207772