Factors Affecting Design Review: A Case from Dang Valley, Nepal-Asia

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Subject Area: Project Management.
Type of the Paper: Action Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.6350839
Google Scholar Citation: IJAEML

How to Cite this Paper:

Dahal, Amrit Kumar, Mishra, A. K., & Aithal, P. S. (2022). Factors Affecting Design Review: A Case from Dang Valley, Nepal-Asia. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *6*(1), 160-175. DOI: https://doi.org/10.5281/zenodo.6350839

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

Crossref DOI : https://doi.org/10.47992/IJAEML.2581.7000.0127

Received on: 20/02/2022
Published on: 15/03/2022

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ABSTRACT

Purpose: *There seem some flaws during design by consultants because of time and cost constraints. To deal with this problem there is a need for a design review for those design parts to assess their compliance for implementation. The overall objective of the research is to analyze the causes of the design review of small farmer-managed surface irrigation schemes developed by the Community Irrigation Project (CIP) about Dang Valley.*

Design/Methodology/Approach: *Based on selected fifteen surface irrigation schemes developed by CIP in Dang Valley, a Questionnaire survey, interviews, and observations were done along with the intensive study of Feasibility Assessment Report, project-related datasheets, and As-Built Drawings. These data have been analyzed using the Relative Importance Index (RII).*

Findings/Result: *The study revealed that faulty survey, design, and change in local demand by users are the major reasons to change the design. The major four significant factors to cause design change in small surface irrigation schemes as obtained from the Relative Importance Index (RII) were survey leading to (1) the efficient system, (2) design with cost-effective and sustainable approach, (3) social issues, and (4) unforeseen site condition. It indicates that for the better construction and performance of FMIS there is a need for improvement in the survey, design, and other social issues like the mechanism of distributing equal water to all the beneficiary farmers.*

Originality/Value: *The care against the influence of unnecessary political factors with due consideration of technical, social, environmental as well as the financial viability of schemes will be assured through the provision of a flexible Cost ceiling. Concept of design through extended team will be maintained.*

Paper Type: *Action Research*

Keywords: Irrigation, Cost Effective, Causes, FMIS, Survey

1. INTRODUCTION :

Modernization in irrigation in Nepal was introduced with the construction of Chandra Canal in Saptari district which was planned and designed according to North Indian Irrigation Technology. Many medium and large irrigation systems have been constructed using this technology. In the mid-hills, bottom trash rack type intake structures were constructed during the 1980s and 1990s as an appropriate modern technology, which is suitable for Boulder Rivers with less fine sediments. The status of design review in road and bridge project have been analysed by Mishra and Aithal (2022) [1] followed by Dahal et al (2022) [2] in same project draw further attention to continue their research.

The decision regarding where to place structures and what types of structures to build need to be made with the farmers while in the field (Jacob, 1995) [3]. The pragmatic design of irrigation systems is always a critical issue in a developing country like Nepal. Design is a rigorous process in which various factors such as topography, geology, agricultural aspects, materials for construction, and other management factors need to be assessed in detail. However, in Nepal, coordination between designing agencies and management agencies seems very weak in practice. Due to this reason, the review of design during construction is often taken. So, this type of frequent change in components between design and implementation is one of the problems affecting worldwide in construction industries and mostly in developing countries like Nepal.

2. PROBLEM STATEMENT :

It is a continuous research of Dahal et al [2]. If a design is not reviewed properly inefficient structures cannot function properly for their optimum capacity while if reviewed can take time increasing cost and time along with delay in service delivery. So proper analysis for design review is needed to check whether it is beneficial or not. However minimum design modification with the proper functioning of structure is always desirable. So, finding causes of change and analysis of design review is an interesting topic for the research. To date, there has been very little research regarding the variation of the small-scale irrigation project. Therefore, the need for research in this field is necessary to find the cause of change and narrow the gap between the design and construction activities of small-scale irrigation projects in Nepal. Dang Valley was selected as a study area as it contains hills as well as the Inner Terai region. The findings can be useful to both Terai and Hill areas.

3. OBJECTIVES :

To identify and assess the significant factors affecting in design review.

4. LITERATURE REVIEW :

4.1 Design Review in Construction Projects:

Design review of Takulla Khola bridge in Kalikot district at Ch 183+250 of Surkhet Jumla section was done because of landslide problem in right abutment. After the original design left side abutment was already constructed. During the right-side abutment construction, it was felt that design review is necessary. After the design review foundation depth was increased and footing was also increased from 1.3m to 1.5m (DoR, 2014) [4]. In this case, unforeseen site condition was seen as the main cause for the design review.

Chameliya Hydropower project was undergone for design review due to squeezing of headrace tunnel from Ch 3+100m to 3+900m. The main factor for squeezing was rock mass instability and rock stresses. This problem created cost as well as time overrun to complete the project (Basnet, 2013) [5]. Unforeseen site condition was seen as the major factor to change the design in the construction stage causing heavy cost increment.

4.2 Design review of Badkapath Irrigation Project:

The Badkapath Irrigation Project (BpIP) area was located on the left bank of Rapti River in Deokhuri valley of Dang district of Province no.5. The proposed command area of the project was 4000 ha which covers the cultivable area of Gadhawa rural municipality. The design discharge of the canal is $9m^3/s$ with a canal slope of 1:3500. Geographically, this area lies within 82º32' to 82º47' East longitude and 27º 48' to 27º50' North latitude The intake is located on the left bank of Rapti river at about 1.3 km upstream from the East-West highway bridge at Bhalubang (DoI, 2014) [6]. The scope of works under the present contract covered mainly the following works:

- Construction of Intake,
- 350 m long Main Canal (In 1st package)
- Protection Works.

BpIP in consultation with the DOI had felt necessary to review the design of the project especially the intake and main canal at the head reach before starting the actual construction work. Design Review Report was the outcome of the review of the feasibility study and design of the intake and main canal of the project. The main objective of the work was to review the design of intake, main canal, and associated structures and to prepare a technical design review report (DoI, 2014) [6].

Major design review aspects Badkapath Irrigation Project:

Table1: Design review aspects of BpIP

S.N.	Aspects of design review	Methodology
1	Planning and Design	Aspects of implementation arrangement,contractual provision and farmer friendly design
2	Hydrologic Re-assessment	Flood frequency analysis
3	Review of Hydraulic Design	Checking in compliance with relevant codes,guidelines and good practices
4	Review of Structural Design	Aspects related to loads,design method adopted,materials proposed along with guidelines and codes

(DoI, 2014)[6]

Table 2: Design reviewed structures and their causes

S.N.	Canal structures	Original design	Revised design	Causes	Nature of causes
1	Intake	Skewed intake(122^0)	Frontal intake	Administrative causes	Political causes
		Rectangular orifice	Revision of dimension	To control flow	Technical
			Addition of breast wall	To check flood	Technical
			Addition of height of guide bund	To check afflux level	Technical
2	Main canal upto (0+375km)	Rectangular section	Trapezoidal section with lining	To remove sediment and to prevent from scouring	Technical

(DoI, 2014)[6]

As per DoI (2014) [6] main structures that were reviewed in Badkapath Irrigation Project were intake and main canal which are very common problems in Terai and Inner Terai region. Technical and political causes were dominant to change the design aspects of BpIP in Dang.

For the design of Badkapath intake, 50 years return period flood was considered which comes to be 3,527.05 m3/s from Log Pearson Type-III. The adopted flood of 3,550 m3/s was based on the analysis. In the original design, the adopted design flood was 2,550 m3/s. Hence, the adopted design flood is about 28 percent higher than that of the original design flood. However, on 26 July 2016, the largest flood ever experienced in the Rapti river since 1976. During the flood event, the recorded maximum gauge height was 8.50 m at Bagasoti station (Station no. 350) which is 5km upstream of the headwork site. Using the rating curve developed by DHM in 2009 the maximum instantaneous discharge was 4480 m^3/s. In analyzing with records this flood magnitude is more or less 200 years return period flood magnitude which is verified from Table 3 (CMS, 2016).

Table 3 : Summary of Flood Flow Analysis of Rapti River

Return Period (Year)	Flood Flow, m^3/s				
	Normal	Log Normal	Pearson Type-III	Log Pearson Type-III	Gumbel (EV1)
2	1440.2	1273.72	1316.78	1271.96	1320.35
5	2054.2	1929.85	1991.01	1928.42	1965.09
10	2375.15	2398.02	2417.79	2400.69	2391.96
25	2717.41	3023.29	2936.01	3032.22	2931.32
50	2938.5	3511.15	3304.91	3527.05	3331.45
100	3137.38	4017.04	3660.32	4040.97	3728.62
200	3322.43	**4552.81**	4006.49	4579.39	4124.34

(CMS, 2016)

The major damages observed after the flood was:

- Outflanking through the left bank.
- Dislocation of the tail portion of the right-wing wall from its original alignment.
- Filling up of head regulator with gravel and boulders.
- Silting up of gravel trap.
- Washout of downstream earthen embankment thereby subsiding the gabion protection works.


(CMS, 2016)

Fig. 1: Completed Part of Badkapath Intake **Fig. 2:** Damaged Intake after the flood

The proposed remedial measures for damaged structures are:

- Increase of freeboard on the intake walls.
- Close of the outflanked part.
- Concrete barrel after the head regulator canal.
- Protection works upstream of intake.
- Close the detached part of the right-wing wall.
- Bypass of the incoming local drain.
- Shifting of the sand and gravel trap.
- Scour protection at the upstream wall.
- Realignment of the canal at highway crossing (CMS, 2016) [7].

The size of the orifice is an important factor in the design of side intake. A very small orifice does not allow sufficient discharge while a large orifice can allow flood water to enter and cause damage to the canal (ILO, n.d.).The study of conjunctive use of groundwater with surface irrigation can be an alternative design for year-round irrigation in Dang Valley (DoI, 2016) [2, 8].

4.3 Value Engineering:

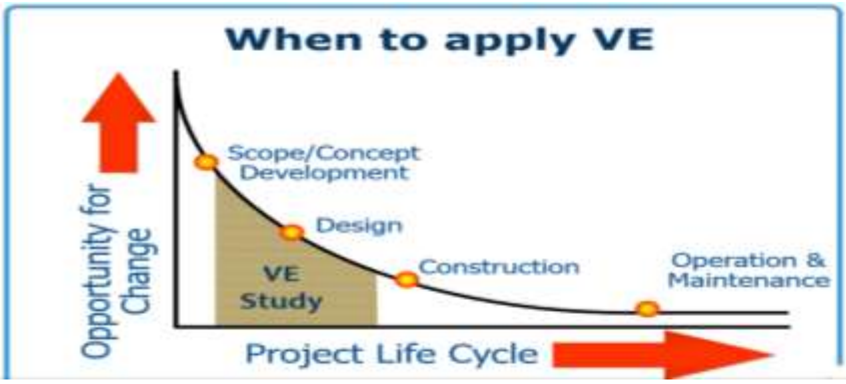


Fig. 1: Application of Value Engineering [9]

According to the value engineering system, the effective and key factors in the success of the project from the team member's point of view should first be identified and defined. These criteria will be the evidence in valuing and grading the ideas in the process of optimizing value engineering. The standards emphasized by the value engineering team members in Jofair IDN areas are outlined in the following list (Rezania et al., 2011) [10].

1. Protection of the environment
2. Ease of operation
3. Ease of construction
4. Reduce the investment costs
5. Possibility of producing the materials or supplying them locally
6. Access to construction technology
7. The possibility of construction and operation of the project in different phases.
8. Reduce the operation costs.

4.4 Value Engineering Application in Jofair Irrigation and Drainage Network, South West of Iran

Table 4 shows that optimization of design can be done using the value engineering concept. It supports addressing specific problems and assists in the sustainability of the system.

Table 4: Optimization of design using value engineering

Using a Low Pressure Irrigation System			
Preliminery Design	Suggested Design	Merits	Demerits
Trapezium concrete canals	Use of Pipes	Improvement in transfer efficiency,reduction in wasted agricultural lands,ease and speed of implementation.	Need of excessive head,need of pressure regulating structures
Reflection on the conveyance canal taking note of earth quality			
Canal depth upto 4 m and soil used as source material	Depth upto 2.5m only and increment of width	Ease in construction,no need to carry away sand from excavation,reduction in cost,sustainability and stability of structures	Reduction in efficiency of water transfer,increase in ownership of lands

(Rezania et al., 2011)[10]

4.5 Factors affecting design change:

Factors affecting design change:

There are various causes of variations in any construction project. The causes due to the design consultant of the project include: change in design by consultant, errors, and omissions to design, the inadequate scope of work, lack of coordination, inadequate working details, lack of experience (Sunday, 2010) [11].

- **Survey**

Surveying and levelling play a vital role in the construction of irrigation canals. If proper surveying is not done then the whole design works seem to be useless. This is the major task as preparation for design (Agor, 2011) [12].

The objective of surveying and mapping is to obtain information to the standards required to support decision-making while evaluating irrigation projects and to enable accurate designs to be prepared for schemes that are selected for implementation (PDSP, 1990) [13].

- **Design**

The design of any engineering structure has to be undertaken with proper regard for the context in which that structure will be placed, how it will be used and maintained, and so forth (Yoder, 1994) [14]. A cost-effective design takes into four types of costs:1) Initial construction cost2) recurrent maintenance costs,3) rehabilitation costs,4) costs to live. To produce a cost-effective design, a design that serves the intended purposes and is not overbuilt, requires some system of incentives to seek a low-cost design. These incentives come from some contribution from WUA, a budget ceiling for the structure, and an effective accounting system to build confidence in farmers. When farmers invest in

a structure, they need to decide on investment rules. This forces farmers to decide on how to mobilize resources. The topography has a predominant influence on both the design approach and the design product [2,14].
The potential benefits of irrigation rehabilitation could be of many folds when the rehabilitation design fits the physical and socio-technical settings of the irrigation system. The rehabilitated infrastructures should also be operated and maintained by the water users (Adhikari & Basnet, 2007) [15].

- **Sustainability**

The concept of sustainability assumes particular importance where transportation and communication may be rudimentary, where heavy reliance may be placed upon the mobilization of local resources for maintenance and operations, and where cost and value must be expressed in local, not national terms (Yoder, 1994) [14]. Sustainability in the context of hill irrigation refers to the ability to mobilize resources to meet expected needs continuingly to keep the system operating within tolerable limits.
Sustainable development and management of water resources would require a holistic approach and simultaneous attention to all aspects of water use and management and threaten sustainability relate to water quality management. Rapid silting up of reservoirs and canals increased flood damages due to uncontrolled development of catchment areas and lack of adequate attention to preventive and regular maintenance of water infrastructure are the major issues to be addressed (Michael, 2011) [16].

- **Local Knowledge**

Local knowledge plays a vital role in cost-effective and sustainable design. A valuable resource for developing irrigation is the knowledge and experience of the presence and would-be irrigators in the community. However, engineers are not trained to examine and improve traditional technology. Often, the facilities that farmers have built are not recognized as irrigation systems. The first step in the design process should be a careful assessment of all irrigation facilities that exist, determination of the experience irrigators have with the system management, and evaluation of all other locally available resources. A participatory appraisal may be supportive to collect valuable information. It is important to know who will manage operation and maintenance is an important factor in selecting among alternative designs because it will determine the complexity that can be managed and the type of material and supplies needed for maintenance (Yoder, 1994) [14].

- **Materials**

Materials play a very vital role in irrigation canal construction. A process that seeks to produce an efficient design should also consider the use of local material. It is also important to understand the nature of the present and future availability of these local resources. Calculation of nonlocal materials such as cement and reinforcement are a routine activity but the real cost of sand and stones are sometimes underestimated which forces the design modification (Yoder, 1994) [14].

- **Environmental and social factors**

Magnitude, Space, and Time scale, which signifies if the impact is likely to be short, medium, or long term (Khadka et al., 2012) [17].

5. METHODOLOGY :

This is a continuity of earlier research conducted by Dahal et ai, 2022[2] so the area of study is same.

5.1 Study Area:

Jeetpur Irrigation Sub Project

Jeetpur ISP lies in Ghorahi sub metropolitan city -11, Province no. 5 with household 122 nos. and population 634 nos. The sub- project which is 5 km far from the market centre of Ghorahi Bajar. The salient features of the ISP are as follows (DoLIDAR, 2014) [18]:

1.	Subproject Classification	:	New project
2.	Location (VDC &Ward No.)	:	Ghorahi Sub-Metropolitan city-11
3.	Ilaka	:	2
4.	District	:	Dang
5.	District Headquarter	:	Ghorahi
6.	Province	:	5

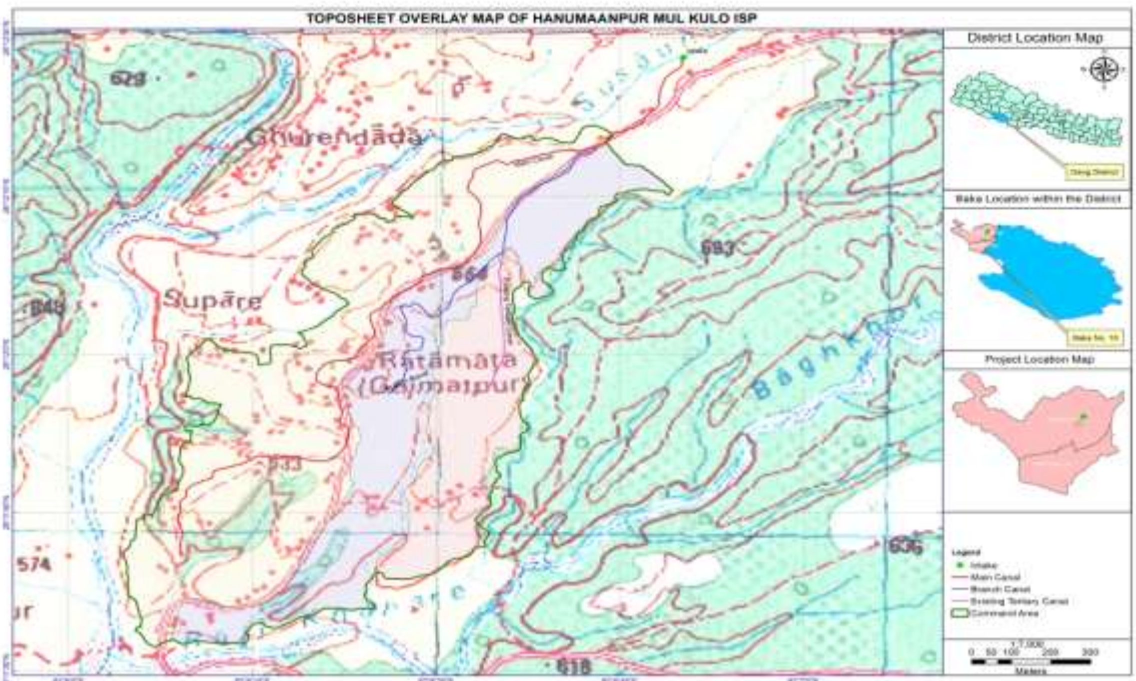
7.	No. of Households	:	122	
8.	No. of DAG Households	:	23	
9.	Population	:	634	
10.	Land holding			
	Landless	:	0	
	Small /Marginal	:	107	
	Middle	:	15	
	Large	:	0	
11.	Accessibility			
	Nearest Road head	:	Ghorahi	
	Nearest Airport	:	Tulsipur	
	Nearest Market	:	Ghorahi	
Command Area Characteristics				
12.	Total Canal Length			
	Main Canal	:	1900 & 1500m (two canals)	
13.	Gross Command Area	:	56.30 ha	
14.	Net Command Area	:	47.8 ha	
	Existing Area	:	47.8 ha	
	New/Extension Area (if any)	:	None	
15.	Name of Water Source	:	Bagale Khola	
16.	Type of Water Source	:	Perennial	
17.	Catchment Area (ha)	:	3.14 sq. km	
18.	Discharge at Intake	:	90 l/s (April flow)	
19.	Physical Facilities Proposed			
	Head works/Diversion Structure	:	Orifice type intake with gabion protection	
	Main and Branch Canal Works		Reshaping	Realignment
	Main Canal	:	-	1900 m
			-	1500m
			Main Canal-1(s)	Main Canal-2(s)
	Canal Lining Both sides	:	150 m	150 m
20.	Present/Future cropping intensity		**173% / 220 %**	

(DoLIDAR, 2014)**[18]**

Hanumanpur Mulkulo Irrigation Sub Project:
The salient features of Hanumanpur Mulkulo Irrigation Sub Project is as follows (DoLIDAR, 2013)[19]:

1.	Subproject Classification	:	Rehabilitation, Improvement		
2.	Location (VDC &Ward No.)	:	Babai Rural Municipality-2,3		
3.	District	:	Dang		
4.	District Headquarter	:	Ghorahi		
5.	Province	:	5		
6.	No. of Households	:	200		
7.	No. of DAG Households	:	8		
8.	Population	:	1213		
9.	Land holding	·			
	Landless	:	None		
	Small /Marginal	:	180		
	Middle	:	20		
	Large	:	0		
10.	Accessibility (Nearest Road Head)				
	Nearest Road head	:	Mahindra Highway ,28 km from project area		
	Nearest Airport	:	Nepalgunj/Tulsipur-Dang		
	Nearest Market	:	Tulsipur Bazar, Dang District		
11.	Command Area Characteristics	:	Terai cultivated area		
12.	Total Canal Length				
	Main Canal	:	2350m		
	Branch Canal	:	1100m		
13.	Gross Command Area	:	86.02ha		
14.	Net Command Area	:	74.0 ha		
	Existing Area	:	86.02ha		
	Extension Area (if any)	:	None		
15.	Name of Source	:	Susaune River		
16.	Type of Source	:	Perennial		
17.	Catchment Area	:	7.1 sq.km		
18.	Canal Type	:	Lined, Earthen		
19.	Canal Discharge	:	0.12 m^3/s		
20.	Side Slope	:	1:1		
21.	Bed Slope	:	1:14 to 1:1400 (shown in L-Section)		
22.	Existing Diversion Structure	:	None		
23.	Physical facilities proposed	:			
	Main and Branch canal works (m)		Reshaping	Realignment	Extension

	Main Canal	:	2200	-	-
	Branch Canals	:	1100	-	-
	- Headwork/Diversion Structure	:	Gated H/R, - Gabion Weir		
			Main Canal	Branch Canals	
	- Canal Lining Both sides (m)	:	150	-	
	- Outlet (Nos)	:	1	1	
	- Road crossing (Nos)	:	3	-	
	- Aqueduct	:	-	-	
	- Retaining Wall	:	-	-	
24.	Present cropping intensity	:	152%		
25.	Future cropping intensity	:	205%		



(DoLIDAR, 2013)**[19]**

Fig. 2: Layout Map of Hanumanpur Mulkulo ISP

Parseni Taal Irrigation Sub Project:

The salient features of Parseni Taal ISP is as follows (DoLIDAR, 2014) [20].

1.	Subproject Classification	:	Rehab Project
2.	Location (VDC &Ward No.)	:	Ghorahi Sub Metropolitan city-5
3.	Ilaka	:	13
4.	District	:	Dang
5.	District Headquarter	:	Ghorahi
6.	Province	:	5
7.	No. of Households	:	53

8.	No. of DAG Households	:	21		
9.	Population	:	269		
10.	Land holding				
	Landless	:	0		
	Small /Marginal	:	45		
	Middle	:	8		
	Large	:	0		
11.	Accessibility				
	Nearest Road head	:	Ghorahi		
	Nearest Airport	:	Tulsipur		
	Nearest Market	:	Ghorahi		
Command Area Characteristics					
12.	Total Canal Length				
	Main Canal	:	1100 m		
	Branch Canal		500 m		
13.	Gross Command Area	:	47.45ha		
14.	Net Command Area	:	42.00 ha		
	Existing Area	:	42.00 ha		
	New/Extension Area (if any)	:	None		
15.	Name of Water Source	:	Parseni Taal		
16.	Type of Water Source	:	Perennial		
17.	Catchment Area (ha)	:	0.83 sq. km		
18.	Discharge at Intake	:	100 l/s		
	Area of Taal (Pond)		0.95 ha		
19.	Physical Facilities Proposed				
	Head works/Diversion Structure	:	Side Intake		
	Main and Branch Canal Works		Reshaping	Realignment	Extension
	Main Canal & Branch Canal	:	1100	-	0 m
			Main Cana(s)l		Branch Canal(s)
	- Canal Lining Both sides	:	450 m		100
	- Road Crossing (Nos)	:	1		-
	- Division Box (Nos)	:	3		-
	- Escape (Nos)	:	1		
20.	Present/Future cropping intensity	:	**186 % / 228 %**		

5.2 Collection of Data:
The opinion of the experts was taken as key informant interviews with the Chief District Engineer, District Coordinator, Project Engineer, and WUA Chairpersons of the district to find the practical

issues related to design review of small surface irrigation schemes. Secondary data was collected from respective district offices and was cross-checked in discussion with farmers.

5.2.1 Primary Data:

Primary data are those data that were collected directly in the field using various tools such as Key Informant Interview, Field Observation, and Questionnaire Survey in the field. The basic tools used as:

Key Informant Interview (KII):

For the validity and reliability of the questionnaire, key informant interviews were taken with the expert of the irrigation sector who was directly or indirectly involved in CIP schemes. The KII was based on purposive sampling as it was essential to understand the nature of schemes and their development in Dang Valley to extract the right information. Six concerned experts were chosen for the KII and all of them had experience in small irrigation schemes design and implementation.

Field visit/observation:

The field visit was done to each case study structure to find out the changes in design during the construction phase. The observation supported knowing the causes of design change and its necessity.

Questionnaire Survey:

After the validity of the questionnaire, the questionnaires were distributed to the respondents of client, consultant, contractor, and WUA representative. Ninety percent of the questionnaire were distributed by visiting them on-site while ten percent of the questionnaires were sent by email. Most of the respondents have a positive response regarding the questionnaire. On average 92% response rate was achieved which was very high and was possible due to continuous field visits to the site.

5.2.2 Secondary Data:

Secondary data were collected from District Technical Office/CIP unit Dang. A formal letter was requested for research work and it was approved by DTO Dang and secondary data were made available in coordination with the CIP unit.

5.3 Analysis of Data:

Questionnaire survey, KII, Collection of various reports from concerned offices have been made main sources of data to express through Chart, RII, Ishikawa diagram. To find the rank of the factors Likert scale has been used to find the result. The five-point scale ranged from one to five was adopted and transformed to relative importance indices (RII) for each factor as follows (Somiah, 2015) [21]:

$$RII = \frac{\sum W}{A*N}$$

Where,

W is the mentioned scale for rating a factor by the respondents which range from 1 to 5

A is the highest weight on the scale

N is the total number of respondents

6. RESULTS AND DISCUSSION :

6.1 Causes of design change:

Design is changed due to various factors such as inadequate design or improper one to address the actual site conditions. Sometimes local demand also changes because of the interval of time between the design and construction phase. In some cases, design is also changed due to the interest of stakeholders. Change in river morphology, landslides are some of the technical causes that enforce the design to change.

Figure 3 shows that overall, 56% of respondents believe that the major cause of design change is due to technical reasons while 36% believe that another cause of change in design is due to change in local demand. Only a few percent of respondents believe that it is due to the interest of the client and consultant.

The technical issues for design change are like as poor survey, inadequate design, and inappropriate location of structures. As per DoI (2006) one type of intake may be suitable for one specific site and may not be for other sites because all rivers and every possible intake locations are unique in behavior. Similarly, change in local demand occurs due to changes in river morphology, change in local parameters in the society.

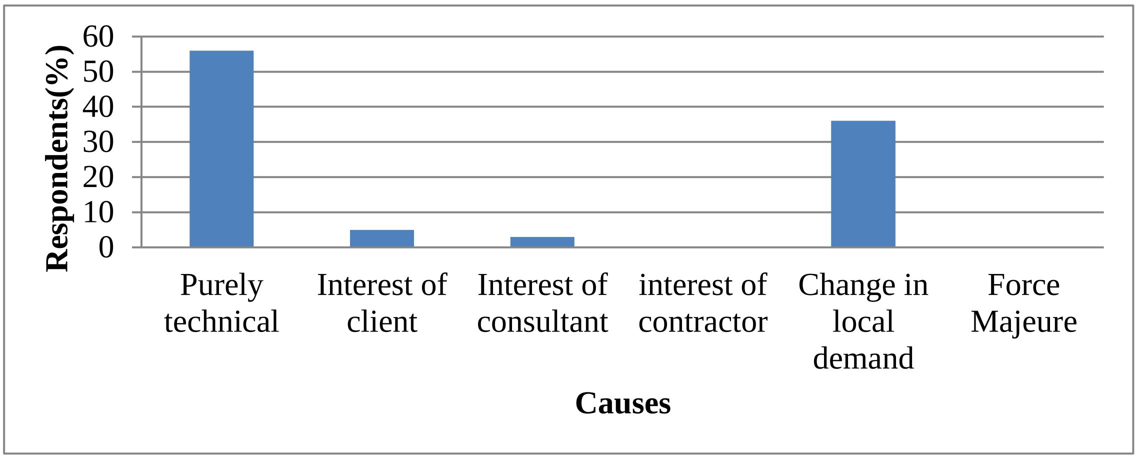


Fig. 3: Causes of design change

6.2 Frequently changed components in the system:

In a small irrigation system change in design occurs in various parts. These parts are headworks, canal lining works, gabion protection works, branch canal, or distribution works. If head work does not perform well required discharge can't be delivered to the main canal so an efficient structure in the system is always needed to fulfill the demand from farmers.

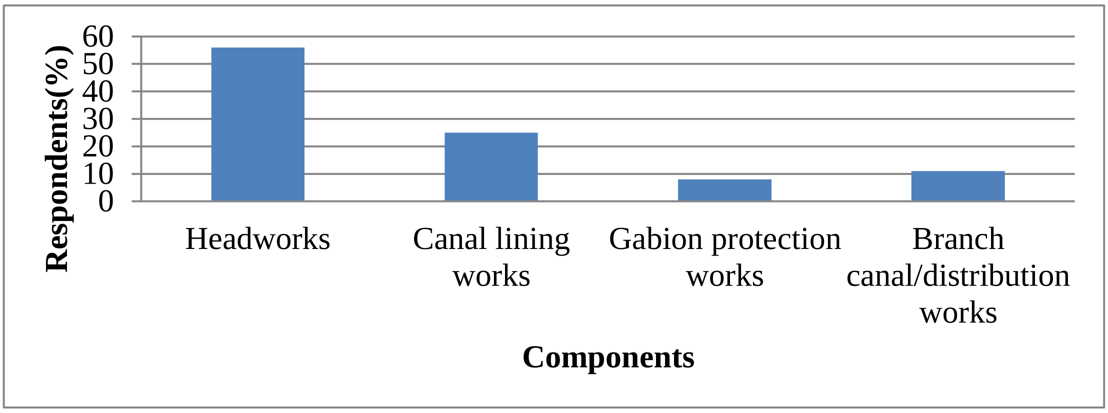


Fig. 4: frequently changed components in irrigation system

Figure 4 shows that head works in irrigation canal is mostly changing component in design review. Overall, 56% of respondents believe that headworks design changes while 25% believe that canal lining works to change and few respondents think that other works change. From field observation, KII, and secondary data analysis it was verified that 67% of intakes were revised likewise 53% of canal lining works were revised by observing fifteen irrigation schemes.

In the inner Terai region like Dang valley river seems very turbulent with a high slope which changes the landscape. As per DoI (2014) headworks and canal lining works are the frequently changed parts during the design review process that was also seen in Badkapath Irrigation Project.

6.3 Significant factors to cause design change in small irrigation schemes:

As per the design, change is concerned various parameters in a project cycle play a pivotal role. If the survey is not done well then better design and planning can't perform well. Likewise, other parameters such as survey, construction methodology, material, manpower availability, and environmental issues also play a role to change the design. Relative Importance Index (RII) as per respondents shows the rank of factors to change the design. The causes were found from literature [22, 23, 24, and 25].

Table 5: Top significant factors affecting causes of design review in small irrigation projects.

Factors	Overall		Client		Consultant		Contractor		WUA	
	RII	Rank	**RII**	Rank	**RII**	Rank	**RII**	Rank	**RII**	Rank
Survey	0.96	1	1	1	0.94	1	1	1	0.94	1
Design	0.92	2	1	2	0.9	2	1	2	0.89	2
Social issues	0.82	3	0.9	3	0.74	3	0.8	3	0.86	3
Unforeseen site condition	0.67	4	0.9	3	0.72	4	0.6	11	0.57	9
Construction methodology	0.66	5	0.7	6	0.66	6	0.7	5	0.6	5
Manpower availability	0.64	6	0.7	7	0.6	8	0.8	3	0.57	7
Material use	0.63	7	0.7	8	0.66	6	0.7	5	0.57	7
Environmental issues	0.62	8	0.8	5	0.72	4	0.7	5	0.43	11
Political causes	0.61	9	0.6	10	0.48	11	0.7	5	0.64	4
Management issues	0.59	10	0.6	10	0.58	9	0.7	5	0.54	10
Force Majeure	0.59	10	0.7	8	0.52	10	0.6	10	0.6	5

According to the Client, consultant, contractors, and WUA; it was obtained that the survey was the most important factor that affects design. It was ranked first by all the parties. The relative important index (RII) by the client was 0.97, by the consultant was 0.90 by the contractor was o.96, by WUA was o.94 and overall, it was 0.96. As per PDSP (1990) survey is the main factor to enable accurate design for schemes.

Similarly, Design is also preferred by all the parties as the most important factor securing the second position and the value of the relative important index was 0.92 in the overall ranking. Social issues are also preferred by all the stakeholders as the most important factor to cause a change in design which is ranked in 3rdposition by all the parties. As per Yoder (1994) design is predominantly influenced by the topography of the area. Management issues, manpower availability, environmental issues, and force majeure are not supposed to be so important factors to cause design change.

Unforeseen site condition is supposed as an important factor by client and consultant whereas implementer contractor and WUA suppose it as less important. This might be seen because the client and consultant may resolve the issue before the project enters the construction phase. WUA suppose political cause as the most important factor ranking in 4th position whereas other parties think this as a less important factor to change the design. Long et al. [26] stated that differing site condition occurs when a contract finds subsurface site condition materially different than it was normally expected. These conditions prevail to change the design.

7. CONCLUSION :

The main aim of the design review is to irrigate every plot of the farmers' field considering socio-cultural and environmental requirements. The major four significant factors to cause design change in small surface irrigation schemes have been found as survey, design, social issues, and unforeseen site condition respectively. However other secondary factors are construction methodology, material use, environmental, social, and management issues too. The demand collection and screening should be done properly without the influence of unnecessary political factors with due consideration of technical, social, environmental as well as the financial viability of schemes. Cost ceiling should be flexible to a certain degree to incorporate the necessary structures. The communication gap between surveyor, beneficiaries, and other stakeholders should be well tracked during survey and design time. It is needed by WUA to take full responsibility to complete the allocated task to be done as a contribution to increasing the speed of construction work. Recommendation is made for awarding the work to WUA and contractor by considering a complete set of a task rather than the portion of work for better performance. Proper design review system with technically capable personnel and realistic schedule needs to be established to control design flaws.

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