


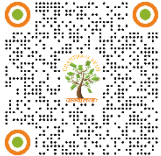


TIME OVERRUN AND ITS IMPACT ON COST OF CONSTRUCTION OF SMALL HYDROPOWER PROJECTS IN NEPAL

Suman Thapa ¹, Anjay Kumar Mishra ² 

¹ Chairperson, Epicenter Engineering Solution, Kathmandu, Nepal

² Associate Professor, Madan Bhandari Memorial College, Kathmandu, Nepal



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Corresponding Author

Anjay Kumar Mishra,
anjaymishra2000@gmail.com

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ABSTRACT

Hydropower is one of the main sources of energy that can be produced as green energy highlights the timely complementation of construction projects. The study is focused to assess the causes of time overrun and its impact on the cost of construction of small hydropower projects in Nepal. The study is based on pragmatic philosophy using case study and survey along with document analysis using correlation and financial decision tools. The result of the study found that all sample projects were facing time overrun. Only 30 % of the cost was due to time increment. Along with time overrun direct cost was negatively related and the indirect cost was positively related, the direct cost was more significant than the indirect cost of the hydropower project resulting in the total cost being negatively related to time increment. Profitability was decreased due to time factors though it was positive till other factors were not impacting. The research concluded that social issues and land problems were the main cause of time overrun which was not properly addressed at the time of planning. Time overrun had become the norm rather than the exception on projects. Time was a partial factor of cost overrun causing it to reduce in its profitability. Besides time, another factor which was causing the cost overrun is to be identified and control for cost overrun. The developer should focus on reducing the direct cost using advance purchase agreement as of schedule and specific care should be taken for social demand. Methods of time allocation of contract should be estimated based on activities using theory of constraints for assuring timely completion and profitability of hydropower projects.

Keywords: Cost Overrun, Direct Cost, Indirect Cost, Relative Importance Index, Time Overrun

1. INTRODUCTION

Nepal has been endowed with enormous hydropower potential due to numerous rivers and favourable topographical features. In more than 110 years since the first hydropower plant Pharping (50kW) in 1911AD constructed, Nepal only generated two thousand megawatts from hydro projects for commercial operation [DoED \(2013\)](#). The abundant hydropower potential of the country can be utilized to boost economic growth of the country. Nowadays, the construction of

hydropower projects in Nepal is a major priority of the Government of Nepal. To expedite the overall development of the country, the Government of Nepal (GoN) has also urged to harness the hydropower potential. Understanding the way that endeavours from the public authority just won't be adequate, an open and free strategy has been taken on for speeding up hydropower advancement with private area venture. Essential demonstrations and guidelines including Hydropower Improvement Strategy (2001) have been announced to energize Independent Power Producers (IPPs) to fabricate, own, work and move hydropower projects. Hydropower is a sector which can rapidly change the economic as well as social development of the country. The hydropower development is slowed down by a lack of suitable policies, finance, and lack of expertise, lack of technology, complex geology, and terrain. More than 90% budget of the project covers in the construction phase. Most of the Hydropower projects in Nepal have not been completed on time and within the estimated cost [NEA \(2020\)](#).

Project finishing on time and the absence of cost overrun is considered the most important factors of successful projects for small hydropower in Nepal [Chilwal and Mishra \(2018\)](#). Most hydropower projects that are under-construction are facing the problem of time and cost overrun so the cost of the project is being increased, and consequently, they are losing their profit due to the increase in project cost, and technical and managerial problems [Chilwal and Mishra \(2017\)](#). Due to the time overrun the cost increase by increasing the interest amount of the bank loans and capital of the owner also. Due to the time overrun, they have to pay not only more amount of interest, but also, they will be charged penalties. The delay in the completion of the project is also the cause of a huge amount of loss in terms of revenue generation [Chilwal and Mishra \(2018\)](#), [Kaini et al. \(2021\)](#).

Small projects can promote independently by Nepali investors. They are easy and fast to study, design and construct as compared to a medium or large project. The small project covers less area, small and simple structure, a fixed rate of PPA, and requires a small and lesser number of machines and equipment for construction [Chilwal and Mishra \(2018\)](#), [Kaini et al. \(2021\)](#). Several study related to time and cost have been done though none of the study has clearly stated the portion in cost due to time overrun only yet. Small hydropower projects have not been focused yet by researchers in Nepal. So, it has high fundamental value as it has applied accounting and economic principles together to conceptualize the only time impact on the cost of the project. So, it reveals the necessity of this study on the time and cost overrun of hydropower projects and their causes and effect on the real projects. The overall objective of the study is to assess the causes of time overrun and its impact on the cost of construction of small hydropower projects in Nepal. The specific objectives are:

- 1) To find the meantime overrun of projects.
- 2) To identify the rank of the factor and find the cost of the top factor.
- 3) To assess the cost, increase due to the time overrun of the project.

2. MATERIALS AND METHODS

The research is action research. In this research qualitative approach has been used to find factors influencing time overrun in the construction of the hydro project and the quantitative approach have used to understand the cost increase due to time overrun in the hydropower project and for finding the economic value of major factors and the economic evaluation of the project.

Four projects were selected based on the area-sampling technique. Hewa Khola Hydropower Project (4.45 MW), Sankhuwasabha (Project A), Middle Chaku Khola Small Hydropower Project (1.8 MW), Sindhupalchok (Project B), Bhairab Kunda Hydroelectric Project (3 MW), Sindhupalchok (Project C) and Bijayapur Khola-1 Hydropower Project (4.5 MW), Kaski (Project D). All four projects have a similar practice of project development in terms of financial management, PPA with NEA, local contractor and consultant, investors are Nepali, no practice of FIDIC contract, not required the Environmental Impact Assessment (EIA), no complex structure, all projects use foreign electromechanical equipment, have a time of 35 years for construction and operation etc.

Figure 1

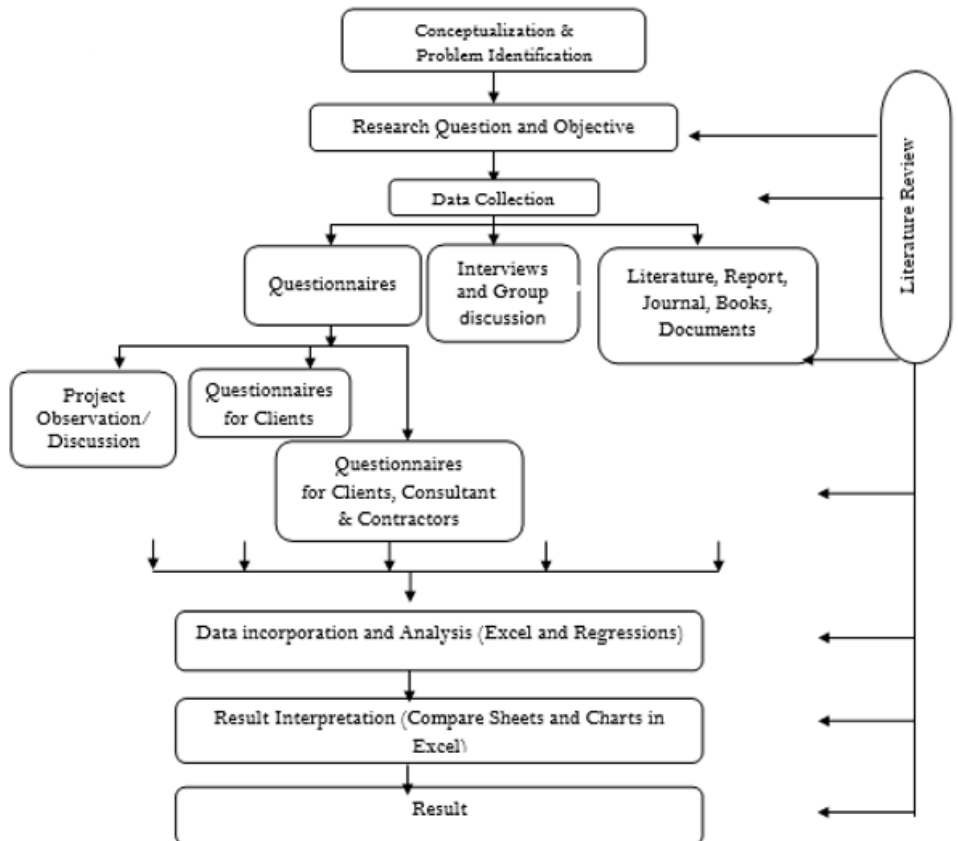


Figure 1

Data collection have done in two stages. In the first stage, all related causes of time overrun, and general schedule, costing and salient features are collected. After analysis and findings of top factors for time overrun, details of top factor data were collected in the second stage. During the field visit group discussion have done with some local people to find their perceptions towards the project and their issues.

- 1) All project parties (Client, Consultant and Contractor) were interviewed on the subject.
- 2) Two sets of questionnaire surveys had been conducted. The first set was designed for the client and the second set was designed for the client, consultant and contractor followed by an informal interview and two focus groups discussion.

- 3) The causes were divided into 8 groups. They were project-related, client-related, consultant-related, contractor-related, market-related, government-related, other factors and social group.
- 4) The qualitative data of questionnaires had been converted to quantitative data with five ranking Likert scale to calculate Relative Importance Index (RII) for causes of delay to find major factors and their cost [Chiluwal and Mishra \(2018\)](#).
- 5) After the collection of the raw data, questionnaire, and interviews they were entered into the computer spreadsheet.
- 6) To find the meantime overrun was calculated by an arithmetical mean formula.
- 7) To find factors and rank factors Likert scale is used to get the result of this part and to compare the opinions of the contractor, owner, and consultant, for the factors influencing time, the importance index is used to rank the factors for time overruns. The five-point scale ranged from 1 (not significant) to 5 (extremely significant) was adopted and transformed into relative importance indices (RII) as it has been used in several studies [Mishra & Moktan \(2019\)](#), [Mishra and Aithal \(2020\)](#), [Mishra and Aithal \(2021\)](#), [Mishra et al. \(2021\)](#) for each factor as follows.

Table 1

Table 1 Likert Scale					
Item	Extremely Significant (ES)	Very Significant (VS)	Moderately Significant (MS)	Slightly Significant (SS)	Not Significant (NS)
Scale	5	4	3	2	1

- 8) For finding the cost of the top factor detailed estimated and actual costs have compared and founded the variance. With the actual cost of the top factor, it has been compared with the total project cost in different cases.
- 9) The increment of the cost by time alone had been calculated by detailed costing and analysis along with its economic evaluation and without time overrun. For finding the cost increase due to time overrun all the project costing is divided into two parts direct cost and indirect cost. Direct cost includes all the structural items (all infrastructure, civil cost, hydro-mechanical, electro-mechanical and transmission) and property items (office, logistic, office equipment, vehicle, and cost before the project start). Indirect cost includes project supervision and management, miscellaneous and contingency, Interest during Construction (IDC), social contribution and environmental mitigation. In this research, the cost increases due to time overrun is analyzed in indirect cost. The cost of inflation or escalation is not calculated due to no provision of additional pay to the contractor in escalation. For finding the cost increase in project supervision and management, miscellaneous and contingency only due to time overrun a baseline has been taken from its estimated percentage to the direct cost. The increase in the cost of IDC only due to time overrun has been calculated by analyzing different cases. To find the cost increase in social contribution and environmental mitigation percentage increase in other indirect factors has been taken as a baseline.
- 10) For economic evaluation of the project estimated and the impact of time increases IRR, NPV, BC ratio and Roe have been calculated by excel [Chilwal and Mishra \(2018\)](#).

3. RESULTS AND DISCUSSION

All the projects failed to sell the electricity in RCOD. They are time overrun from 15 months to 27 months than scheduled. Time overrun is found from 57% to 132% of that estimated time. Except for project C, other projects actual completion time is 39 to 43 months. In project C, the factors affecting the time overrun are quantity overrun of the project and topography difficulties of the project are major factors whereas these problems are less significant in other projects. Also, project C has a unique component of the tunnel and long transmission line than others and the access road is only up to the powerhouse, but other projects have access road facilities in all sites. In project no B (the percentage of time overrun is 132% while other projects have the range from 57 to 70% only. They have taken less estimated time as compared to other project and client who has scheduled the time realized the inadequacy of time estimation.

In project A the major cause for delay is the natural Flood that occurs in the month of Baishak (May) which is very early before monsoon. Working speed is at its peak situation many machines, equipment and material flow with the flood, damage occurs in the constructing structure. The second major causes for project delay are unforeseen site conditions and changes in drawing in project B the major cause for delay is land acquisition. A second major cause for project delay is the demand and strikes of locals. During the site visit for focus group discussion and informal questionnaire asked local people about the project regarding the social issues and demand. The local people say their demands like infrastructure development, local employment, and funds for school and water supply which are given by the project with taking more time than agreed, the problem between locals and the project occurred in taking time by the project to fulfil their demand. But the demands like share, supply of materials and vehicles, contracts, transportation contracts and employment without working, and very high demand for land are not the demand of the local public these are the demands by a few no elite and unethical persons in the name of the local public. Highly increase in the price of land is due to the activeness of local land brokers in the project area. Another major cause for project delay is poor planning and management by the client. In project C quantity overrun of the project is the major cause of a project delay. Other major causes for project delay are the topography of the project, poor and inappropriate design and drawing, delay and slow mobilization of the contractor, and poor communication and coordination with other contractors and parties by contractors. The tunnel on this project has suffered from the unpredicted water leakage problem that takes extra time for water sealing of the tunnel In Project D land acquisition is one of the major causes of a project delay. The second major cause of project delay is a natural disaster. Other major causes for project delay are delays in design works and demand and strikes of locals.

3.1. COMPARATIVE ANALYSIS OF MAJOR FACTORS ON FOUR DIFFERENT PROJECTS

All the projects have different major factors for the time overrun of the project. But in some factors, some projects have a similar rank of factors. In the issue of social factor demand & strikes of local and land acquisition are major factor in project B and project D. Project B rank first and second, and project D rank second and third however project A rank 27th on both factor and project rank are 10th& 44th. In the issue problem with neighbour project C rank is 2nd and project B is 7th and project

D is 8th and project A is 27th. It shows that project B and Project D have more social problems than others this is due to project B and D lying near the market, residential area and very close to the national highway. Project C is also near to highway, but the land acquisition problem is very less significant problem than others this is due to most of the land being the property of the government. Project A and Project C have a less social problems this is due to the developer of both projects are local people.

In the issue related to consultant delay in design works, poor & inappropriate design & drawing and changes in the drawing are major problems in different projects. Change in drawing rank is 2nd in project A but in project C is 54 and in project D is 8. Changes in drawing in project A are due to changes in site condition which is also the major cause for a project delay. In project C changes in the drawing have significant causes but have a major cause of poor and inappropriate design. This may be due to project C having some features that are unique to others like it has the in consultant and project A rank is 9th due to not being confident about the site condition of the consultant.

Poor planning and management of client rank in project A are 27th, project B is 3rd, project C is 17th and project D is 8th. Project B has a most significant problem while project D has a more significant problem than others project due to poor planning and management of the client. The reason behind the poor planning and management is due to lack of experience and weakness in decision quality. All the developer has almost the same experiences in the hydropower business. According to project rank on social problems project B is 1st, project D is 2nd, project C is 3rd and project A is 4th. Conflict in the project impacts the decision making i.e., lack of proper planning and management this may justify also by [Dana \(2011\)](#).

In the issue of contractor-related problems delay & slow mobilization and poor communication and coordination with other parties are found a major problem in project C more significantly than in other projects. The rank of these factors in project C is 2nd. The rank of these factors in project D is 8th and 5th, the rank of these factors in project A is 17th and the rank of these factors in project B is 29th and 17th. The reason for the delay and slow mobilization in project C is due to the topography of the project and the problem with the neighbour but in the case of project D this is due to the problem with the neighbour and delay in design works.

Natural disaster creates problems in project A and project D for the completion of the project on time. But in project B and D is has a less significant effect. The reasons for the impact of natural disasters in projects are due to early heavy rainfall than planned and the excavation of roads without protection. In the case of another project road constructed by the project is very less.

Quantity overrun is a major factor in project C and also a significant factor in project D but very less significant in project A and B. Reason for the major factor in project C is due to poor and inappropriate design and drawing, topography and work increases in the tunnel. In the case of project D reason for quantity overrun is due to the impact of natural disasters.

In the issue of unforeseen site conditions and topography of the project. Project A rank is 2nd for unforeseen site conditions in project C rank is 2nd on the topography of the project. In the project, changes in site condition change design and drawing that impact increases work, also changes working methodology. In the case of the project, A unexpected amount of very hard rock in the powerhouse & tailrace, alignment and gravel trap has founded. The working methodology changes from chiselling to blasting which requires more than half a year for permission and processing. Project C has steep topography. Due to steep topography, an access road has not been constructed except for powerhouse areas. Winch has been installed for

the transportation of construction material in headwork, tunnel, and alignment in project C. In that scenario, the work has increased which also adds to the problem of transportation of construction materials. But in other projects, all sites are accessible by road, so the problem is due to the topography of the project in almost the last rankings.

3.1.1. FACTORS INFLUENCING TIME OVERRUNS FROM POINT VIEW OF CONTRACTORS, CONSULTANTS AND OWNERS SEPARATELY

All the parties have different points for the cause of the project delay. The contractor views weaknesses of client responsibility like communication and coordination with different parties, poor planning and management of the project and delays in the handover of the site to the contractor are major problems for time overrun of the project. Consultants give high marks to an insufficient number of workers, poor site management of contractors, changing of subcontractors and inaccurate cost estimates and low bids are major causes for the delay due to contractor and consultants also say that the limited budget of the project is also the major factor for time overrun. While social problems like land acquisition, demand and strikes of locals are major problems from the client perspective. The insufficient no of staff contractors and delay in design by consultants are also major causes from the client view.

The best interpretation for such differences is that the nature of work for each party is different. Each party feel that he exerted his almost efforts to avoid project delay. Each party deals with the delay process to avoid delay responsibility. The client considers social issues, contractor issues like insufficient no of staff and workers, delay and slow mobilization of the contractor and poor communication and coordination among different parties by contractor, consultant issues like delay in design, late issue of drawing and changes in drawing, issue related to the government like lack of protection and security, slow permits and land acquisition while contractor considers client issues like poor communication and coordination, poor planning and management, handover of the site and non-capable client representative, natural disaster, social issue and consultant issues like delay in design and change in drawing, absence of consultant staff and poor and inappropriate design and drawing. Consultants consider contractor issues like insufficient no of workers, poor site management, changing of the subcontractor, inaccurate cost estimate and low bid, improper planning and scheduling, inappropriate construction methods, misuse of mobilization money, reworks or maintenance due to error during construction financial problem of the client, social issue and project related causes like unforeseen site condition and the late issue of drawing.

As different perspectives have found to avoid responsibility on their part to show their efficient management means they have no coordination though they have the same mission, so the mission is not enough to guide their values due to a lack of professionalism.

3.1.2. FACTORS INFLUENCING TIME OVERRUNS FROM POINT VIEW OF ALL RESPONDENTS OF CONTRACTORS, CONSULTANTS AND OWNERS

All respondents ranked "Demand and strikes of locals and land acquisition" in the first and second positions. These results reflect the effect of these factors on the time overruns of the project. Both factors are a branch of the social issue. Clients, consultants, and contractors have no reason to advocate for social problems. And the defender of social causes has not been addressed through questioner though by focus group discussion they are not in support because they are blaming a few elite people only. The third factor ranked by all respondents is "delay in design and the late issue of drawings". This is due to design engineers (human resources) problems of consultants. This result clarifies the main role of the consultant to finish the project one time. Another major problem found in this study is poor planning and management of clients, and poor communication and coordination of clients. This is due to the lack of professional management and no expertise of the client.

3.1.3. MAJOR FACTOR AS SOCIAL ISSUE

Following are public and personal issues that arise from the local community and project-affected people; demand for funds for infrastructure mainly the road of VDCs, demand for a free share of the project, demand for local employment, the blame for cracks on houses of villagers due to construction activities and movement of heavy equipment, Demanding for supply and transportation of material, demanding for contract, Demanding of the vehicle on personal use and patient, demand for school infrastructure, Demand for teachers on school.

The following are issues related to land acquisition and resettlement raised by the project affected people; demand for high value land, pressure for extra land which is not required for the project, demand for compensation of land crops, land conflict between family members create problems for project, conflict of the border between land neighbours create problems to the project, some land of alignment has brought by the broker and demand a high price, land which was brought by the broker the old land owner also demand to project for increase rate and goes to court, built a temporary house on required land of project and demand for the plot to house and cost of permanent house.

It can be concluded that there is a big problem of social and land acquisition issues. There are different demands some demands are genuine and under the budget of the project and some issues are unethical and not as expected by the project. Demand for local employment without working is an unexpected problem. And blame for the crack on houses of villagers due to construction activities and movement of heavy equipment has not been traced in IEE. In the issue of land acquisition, most of the problem are common but problems like broker involvement and construction of houses in required land are unexpected and unmanaged problems. Social problems are a major problem due to the state being in political transition, the presence of government in the project area is not sufficient to solve the problems related to social and land acquisition.

From data, it shows that the estimated percentage of social contribution and environmental mitigations is increased from 2.27 to 3.97 % of total project cost without IDC. The percentage of land and land development is a rise from 2.43 to 4.41% of total project cost without IDC.

3.2. COST INCREASE DUE TO TIME OVERRUN

The data shows the correlation coefficient between time vs. different costs in four projects.

Table 2

Table 2 Correlation Coefficient between Time and Cost		
R (Total cost vs Time)	=	-0.3718
R1 (Direct cost vs Time)	=	-0.4605
R2 (indirect cost vs time)	=	0.2097

From the above data, it shows that time is not the only factor for total cost increasing the projects. Time increases the indirect cost of the project as proved by the above table while time has no significant effect on the direct cost. As per the conventional theory of the time cost relationship, this output is different. The following figure shows the reason behind it.

Figure 2

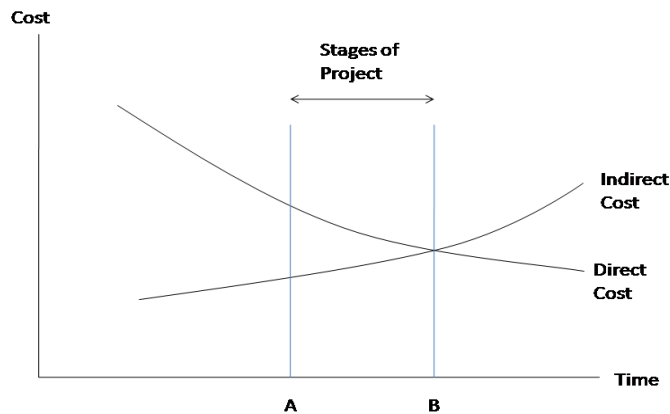


Figure 2 Time Cost Figures with Project Stage Baldwin & Bordoli (2014)

From the cost table, all the project has a higher value of direct cost than indirect cost. From the regression table, the value of the total project cost is negative which means its curve is in a downward slope same condition as the direct cost. But the value of the indirect cost is positive which means it is increasing with time. The time of the project is between point A and point B, where the direct cost value is higher than the indirect cost and in a downward slope and the indirect cost of the project is positive and in an upward slope.

The indirect costs of the project are as follows.

- 1) Project supervision Management and Engineering.
- 2) Miscellaneous & contingency.
- 3) Environmental Mitigations and Social contribution.
- 4) Interest During Construction.

Here all the above particulars have cost overrun.

In the construction of hydropower projects, due to the increase in time, the indirect cost of the contractor and the cost of the increase in material price within

the increased time is raised. So, the expenses of the contractor are increased but also in some amount the direct cost of the contractor decrease due to having a fixed item rate contract and no provision for the escalation provision contractor's profit margin decrease or may go to lose but the overall the project cost is in control.

Figure 3

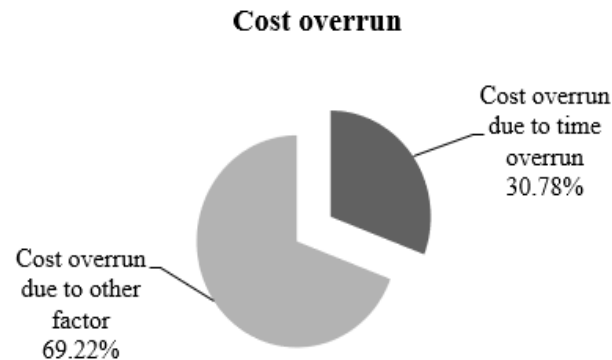


Figure 3 Cost Overrun Figures Due to Time Overrun

Cost increases due to time overrun of two years only in a project is 30.78% of the total cost increase. So, the other factors contribute more than 69% to the cost overrun of the projects.

3.3. ECONOMIC EVALUATION OF PROJECT AFTER TIME OVERRUN

The following table shows that the time overrun causes significant decreases the profit margin of the project, increase in time of 2 years IRR and RoE percentages are highly decreased. The BC ratio of the project also decreases from 1.37 to 1.21. Due to the impact of time overrun on cost, the IRR and BC decrease. IRR is still greater than bank interest so the project will be capable to pay the EMI of the bank. The BC ratio is also greater than one so the project will give a bonus or profit to its owners.

Table 3

Table 3 Financial Parameters of Projects Estimated and Actual

S. N.	Parameters	Estimated	After Time Overrun
1	IRR	12.95%	10.51%
2	BC Ratio	1.37	1.21
3	RoE	15.55%	11.27%

4. CONCLUSION

Time overruns have become a norm, rather than an exception in the construction of small hydropower projects in Nepal All sample projects have suffered from a time overrun from 57% to 132% than the estimated time.

To avoid the responsibility of time overrun all parties are blaming each other. There are differences in information and coordination among project parties and also the problem in the participation of all parties in setting the goal process. The top factors which cause time overruns are as follows: Demand and strikes of local, land acquisition and resettlement, delay in design works and the late issue of

drawing, poor planning and management of client, poor communication and coordination by client and contractor to other project parties, quantity overrun of works, natural disaster, delay in handover of the site by the client, slow mobilization of the contractor and lack of protection and security arrangement by government.

Social issues and Land Acquisition are the major factors in the time overrun construction of small hydropower projects. Most of the social problems are due to elite and unethical persons. The costs of social issues are increased by 90%, as during planning due respect is not given to social issues.

Time is not the main factor for the cost increase of the project. There should be other factors for 69.22 % responsible while time overrun only contributes 30.78 % causing on total cost overrun of the project. However, time overruns increase the indirect cost significantly which is not significant in comparison to direct cost.

Time overrun results in decreasing IRR, NPV, B/C ratio, RoE and increasing payback period resulting into reduce profitability. However, the project is profitable if other factors are not functioning.

From this research it is recommended that during project planning and scheduling, major factors should not overlook for estimating the project schedule, to overcome the major factors adequate budget, time, strategy, and policy must be adopted. For small hydropower, construction time should be more than 3 years is safe to avoid time overrun. In the projects, 4% to 5% of the total project cost should be allocated for social contribution work. The client or Developer should only start the project after a detailed study and engineering. Project developers are recommended to mobilize the work only after the completion of land acquisition works.

CONFLICT OF INTERESTS

None.

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