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THESIS

STUDY AND ANALYSIS OF THE PERFORMANCE OF MEGA
SCALED CONSTRUCTION PROJECTS IN NEPAL

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A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
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Dharma Kumar Neupane 2009: Study and Analysis of the Performance of Mega Scaled Construction Projects in Nepal. Master of Engineering (Civil Engineering), Major Field: Civil Engineering, Department of Civil Engineering. Thesis Advisor: Associate Professor Santi Chinanuwatwong, Ph.D. 252 pages.

Past experience showed that, delays and cost overrun are prevalent and there exists number of hindrances for achieving satisfactory quality performances of mega scaled construction projects (MSCP) in Nepal. This research aimed to study and analyze the performance of ongoing highly prioritized, public MSCP in Nepal and to identify the critical causes of delays and cost overrun; and factor affecting quality. This study employed exploratory research methodology and four mega projects namely; SIP, MMHEP, BSBRP and MWSP were selected as the sample projects.

The study result revealed that time, cost and quality performance of the MSCP in Nepal are not satisfactory. This research showed that, social and political conflicts; frequently occurring nationwide strike, closure, blockade and obstruction; frequent obstruction in project activities by different groups; problems of decision making; shortage of fuels, lubricants and construction materials; are the critical problems causing delays and cost overrun. Furthermore, inflation, exchange rate, material price escalation, unexpected rise in price of fuels and lubricants; construction delay are the critical causes attributed for the cost overrun. Similarly, problems of communication between the project parties; lack of QC, QA and QMS in MSCP; equipment breakdown; problems of good quality construction material; contractors not having good quality policy and performance are the critical factors affecting the quality in MSCP. Based on the study findings, recommendations are made to mitigate the problems of project delays, cost overrun and quality related issues in MSCP in Nepal.

Student's signature

Thesis Advisor's signature

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TABLE OF CONTENTS

	Page
TABLE OF CONTENT	i
LIST OF TABLES	ii
LIST OF FIGURES	vii
LIST OF ABBREVIATION	vii
INTRODUCTION	1
OBJECTIVES	12
LITERATURE REVIEW	14
RESEARCH METHODOLOGY	52
RESULTS AND DISCUSSIONS	68
CONCLUSIONS AND RECOMMENDATIONS	134
Conclusions	134
Recommendations	137
LITERATURE CITED	146
APPENDICES	151
Appendix A Questionnaire	152
Appendix B Details of the respondents	171
Appendix C Evaluation of quality performance of the sample projects	179
Appendix D Ranking of the delay causes in MSCPN	181
Appendix E Ranking of the causes of cost overrun in MSCPN	216
Appendix F Ranking of the factors affecting quality in MSCPN	229
CURRICULUM VITAE	252

LIST OF TABLES

Table	Page
1 Summary of the investments in infrastructure projects	5
2 Schedule performance of completed projects in Nepal	9
3 Cost performance of completed projects in Nepal	9
4 Project classification	15
5 Classification of delays	31
6 Major causes of delays in Nepal	33
7 Major delay causes in developing and developed countries	35
8 Major causes of cost overruns in developing countries	39
9 Quality needs of the construction project	41
10 Summary of the project participants related factor	47
11 Summary of the project management related factor	48
12 Summary of the project characteristics related factors	49
13 Summary of the materials, equipments and labor related factors	49
14 Summary of the external factors	50
15 Sample questionnaire	58
16 Summary of the sample projects	59
17 Academic and professional background of the respondents	61
18 Guidelines for correlation interpretation	67
19 Status of the sample projects	68
20 Schedule performance of the sample projects	69
21 Cost performance of the sample projects	70
22 Quality performance of the sample projects	72
23 Top ten delay causes in mega scaled construction projects in Nepal (MSCPN)	75
24 Records of incidents/disturbances in Middle Marshyangdi Hydro Electric Project between periods May 15, 2001 – Feb 1, 2007	76

LIST OF TABLES (Continued)

Table	Page	
25	Top ten delay causes in MSCPN based on their level of impact	81
26	Top ten delay causes in MSCPN based on their frequency of occurrence	83
27	Relationship between the level of impact and frequency of occurrence of the delay causes in MSCPN	85
28	Ten most important delay causes in MSCPN from the view of project parties	86
29	Ten most important delay causes in MSCPN from the view of project types	90
30	Top ten causes of cost overrun in mega scaled construction projects in Nepal (MSCPN)	95
31	Breakdown of cost overrun components in MMHEP	97
32	Top ten causes of cost overrun in MSCPN based on their level of impact	100
33	Top ten causes of cost overrun in MSCPN based on their frequency of occurrence	101
34	Relationship between the frequency of occurrence and the level of impact of the causes of cost overrun in MSCPN	103
35	Ten most important causes of cost overrun in MSCPN from the view of project parties	105
36	Ten most important causes of cost overrun in MSCPN from the view of project types	107
37	Top ten factors affecting the quality in mega scaled construction projects in Nepal (MSCPN)	112
38	Top ten factors affecting quality in MSCPN based on their level of impact	118

LIST OF TABLES (Continued)

Table		Page
39	Top ten factors affecting quality in MSCPN based on their frequency of occurrence	120
40	Relationship between the frequency of occurrence and level of impact of the factors affecting quality in MSCPN	122
41	Ten most important factor affecting quality in MSCPN from the view of project parties	125
42	Ten most important factors affecting quality in MSCPN from the view of project types	128
43	Spearman rank correlation coefficient between the project parties in pair for the causes of delay in MSCPN	131
44	Spearman rank correlation coefficient between the project parties in pair for the causes of cost overrun in MSCPN	132
45	Spearman rank correlation coefficient between the project parties in pair for the factors affecting quality in MSCPN	133

LIST OF TABLES (Continued)

Appendix Table	Page
B1 Details of the respondents	172
C1 Evaluation of quality performance of the Sample Projects	180
D1 Result of the overall ranking of the delay causes in MSCPN	182
D2 Result of the overall ranking of the delay causes in MSCPN based on their level of impact	188
D3 Result of the overall ranking of the delay causes in MSCPN based on their frequency of occurrence	194
D4 Result of the ranking of the delay causes in MSCPN from the view of project parties	199
D5 Result of the ranking of the delay causes in MSCPN from the view of project types	204
E1 Result of the overall ranking of the causes of cost overruns in MSCPN	217
E2 Result of the ranking of causes of cost overrun in MSCPN based on their level of impact	219
E3 Result of the ranking of causes of cost overrun in MSCPN based on their frequency of occurrence	221
E4 Result of the ranking of the causes of cost overrun in MSCPN from the view of project parties	223
E5 Result of the ranking of causes of cost overrun in MSCPN from the view of project types	225
F1 Result of the overall ranking of the factors affecting quality in MSCPN	230
F2 Result of the ranking of the factors affecting quality in MSCPN based on their level of impact	234
F3 Result of ranking of the factors affecting quality in MSCPN based on their frequency of occurrence	237

LIST OF TABLES (Continued)

Appendix Table	Page
F4 Result of the ranking of the factors affecting quality in MSCPN from the view of project parties	240
F5 Result of the ranking of the factors affecting quality from the view of project types	244

LIST OF FIGURES

Figure	Page
1 Map of Nepal in the world Atlas	2
2 Map of Nepal	2
3 Quality is an integral part of the scope, budget, and schedule	15
4 Phases of a project	17
5 Stakeholders involved during construction phase	18
6 Project management control and integrative functions	20
7 Project quality management overview	21
8 Objectives and constraints of project management control functions	22
9 Project management steps	24
10 Major categories of the factors affecting quality of construction project	46
11 Research methodology framework (RMF)	53
12 Framework for questionnaire design	55
13 Summary of the questionnaire	57

LIST OF ABBREVIATIONS

TYIP	=	Three Year Interim Plan
SIP	=	Sikta Irrigation Project
MMHEP	=	Middle Marshyangdi Hydro Electric Project
BSBRP	=	Bardibas-Sindhuli-Banepa Road Project
MWSP	=	Melamchi Water Supply Project
MSCP	=	Mega Scaled Construction Projects in Nepal
MSCP	=	Mega Scaled Construction Projects
QC	=	Quality Control
QA	=	Quality Assurance
QMS	=	Quality Management System
ISO	=	International Organization for Standardization
TQM	=	Total Quality Management
CONQUAS	=	Construction Quality Assessment System
RMF	=	Research Methodology Framework
TI	=	Time Index
CI	=	Cost Index
SP	=	Schedule Performance
CP	=	Cost Performance
QP	=	Quality Performance
QPI	=	Quality Performance Index
LOI	=	Relative Level of Impact Index
FOI	=	Relative Frequency of Occurrence Index
LIFI	=	Relative Level of Impact and Frequency of Occurrence Index

STUDY AND ANALYSIS OF THE PERFORMANCE OF MEGA SCALED CONSTRUCTION PROJECTS IN NEPAL

INTRODUCTION

1. General background

Situated in the lap of Himalaya, the kingdom of Nepal is a small land locked country bounded by India to the east, south and west; and China to the north. In the world map, Nepal is located between the Latitude 26° 22' North to 30° 27' North and Longitude 80° 4' to 88° 12' East. Total area of the kingdom is 1,47,181 Sq. km with average length 885 Km. east to west and average width 193 Km. north to south . Population of Nepal is estimated as 27.5 Millions in 2008. Socially and culturally, this small kingdom is the common garden of more than 60 different casts or ethnic groups.

Geographically, Nepal is divided in to three regions Terai, Hill and Mountain; with elevation ranging from 90m to 8848m south to north. The northern Himalaya (Mountain) ranges are covered with the snow all over the year; the middle (Hill) ranges are captured by gorgeous mountains, high peaks, hills, valleys and lakes; and the southern (Terai) ranges are the gangiatic plains of alluvial soil. This geographic diversification has also led to the climatic diversification. Figure 1 shows the map of Nepal in the World Atlas and Figure 2 shows the map of Nepal.

As per the national economic census 2008, size of the Nepalese economy is Nrs. 828. 80 Billion (US \$ 12.80 Billion), economic growth of the country for the Nepalese fiscal year 2064/2065 B.S (July 2007/ June 2008) was 5.56% with per capita income about US \$ 470, inflation rate 9%. Still 30% of the population is under poverty line. The share of construction industry in the national economy is about 8 %. After emerging from 10 years long social and political conflicts from 1995 to 2005 and after 2 years long peace efforts in March 2008, Nepal has conducted historical constituent assembly (CA) election. On June 2008, CA has declared Nepal as a “Federal Democratic Republic Country”. The new constitution is under drafting stage

and Nepalese people are hopeful that this will open the every door of opportunities for the national development and prosperity in future.



Figure 1 Map of Nepal in the World Atlas



Figure 2 Map of Nepal

2. A Historical perspective

Historical development of the Nepalese construction industry can be broadly divided in to four parts. The first part covered the period up to 1767 A.D. During this period rural dwellings, temples, forts and trails were built. The second part covered the period from 1767 A.D. to 1951 A.D. The history of modern construction in Nepal dates back to the 1767 A.D, when the Great King Prithivi Narayan Saha; founder of the unified Nepal organized “Banaune Adda” or “Construction Bureau” under his primeministership (Vaid, 1993). He also laid down the system of governance and administrative setup to execute it. The first recorded engineering structure built in Nepal was an iron bridge over the Bagmati river in 1850 (Yadav, 1992). The third part covered the period from 1951 A.D. to 1990 A.D. During this period country moved towards planned development. The first development plan was implemented on 1956-57 A.D., which recognized the construction as the priority sector. Planned development of infrastructures started during this period with much focus on road network development.

The fourth part started on 1990 A.D. after the restoration of multiparty democracy and continued today. After 1990 A.D., Nepal entered in to open market economy and during this period much flow of money realized in the form of loans and grants through multilateral and bilateral projects. During this period many mega scaled projects particularly in hydropower, water supply, irrigation and road sector were started. Some were finished; some are under construction and many others are in pipeline. During this period private sectors also emerged significantly in construction business in the form of investors and contractors.

After the start of first planned development in 1956 A.D., Nepal have completed tenth five year plan in June 2007. This was followed by the currently continuing three year interim plan (2007/2008 – 2009/10).

3. Construction projects and the Nepalese development context

In every country, construction industry is an important sector of the economy, which transforms various available resources in to constructed economic and social infrastructure and facilities. By the process of construction, resources available in the form of material, manpower, machine and money are put together to create tangible products. The technology and method plays vital role for transforming resources in to products. In recent decade, construction industries have also become a part of manufacturing industries with the application of same flow chart i.e. Input, Process and Output. Although construction and manufacturing industries are same in their principal feature; but in reality construction industries are different from the manufacturing industries in the aspect that, in construction industries customers of the product or “employers” are also involved in the production process or “construction stage” where as in the manufacturing industries, customers are concerned with the final product only. Beside that, construction industries involve multiple participants from the diversified sector. They are planners, designers, employers, contractors, material and equipment suppliers, workers, financier, accountants, lawyers, insurers, operators and many more. The regulatory environments such as procurement policies and procedures; budgeting systems; disbursement procedure; licensing requirements; codes and practices; credit system; tax structure; import policies; contract laws and many other requirements further bound the construction industries.

In developing countries like Nepal, majority of the construction activities are under the public sector. The volume and composition of the construction may vary considerably from year to year. Most of the construction products are custom- made to meet the particular need of the owners. As a result, they are location specific and vary considerably in the aspects of requirements for movement of materials, equipment, staff and labor to the site of each job. The products also vary widely in terms of material, levels of technology used, mix of inputs and methods of construction. Although, all these features provide opportunities for innovation and flexibility in the use of the technology but make the construction industry very competitive and exposed to high risk. As a result, construction works mostly extend

over long periods, price changes, difficulty in maintaining consistent quality and probability of facing newer challenges is always high (CAN, 1991).

Implementing construction projects most efficiently and effectively is very important to make the development pace faster. Although construction industry is essentially a service industry whose responsibility is to convert plans and specification into finished product, it is exceedingly complex and highly individual in character (Peurifoy and Ledbetter, 1996).

After the start of planned development in 1956 A.D., Nepal has been investing a substantial amount of her development budget in construction sector in the form of infrastructure projects. Table 1 shows the summary of the investments in infrastructure projects since 1970 to date.

Table 1 Summary of the investments in infrastructure projects

Development Plan Number	Year of Implementation	Development Expenditure (Nrs. Millions)	Expenditure in Infrastructure Projects (Nrs. Millions)	Percentage
Fourth	1970/71 – 1975/76	4131.86	1867.86	45.20%
Fifth	1975/76 – 1979/80	10324.76	4619.84	44.74%
Sixth	1980/81 – 1984/85	22092.73	9861.10	44.63%
Seventh	1985/86 – 1989/90	48445.23	22578.10	30.85%
Eighth	1992/93 – 1996/97	87080.00	59087.77	67.80%
Ninth	1997/98 – 2001/02	129105.00	85849.94	66.49%
Tenth	2002/03 – 2006/07	162200.00	128615.00	79.29%
Interim	2007/2008 – 2009/10	280301.00	176396.00 ¹	62.93%

Symbol: ¹ Proposed.

Source: National Planning Commission, Nepal (Year 1970 – 2008)

Table 1 shows that, for last 16 years construction sector consumed more than 60% of the annual development expenditure to develop different infrastructure projects in Nepal. Despite all these efforts, following are the current development challenges of Nepal. (Source: Approach paper of Three Year Interim Plan)

- 23% of the total population have no access to the drinking water
- 11 remote (hills and Himalayan) districts have no motorable road access
- Among the total 3912 Village Development Committee (VDC); about 1812 VDC have no electricity facility and about 1000 VDC have no telephone facility
- There is daily load shedding in dry season due to lack of power supply. Maximum load shedding for the months of January and February, 2009 was 16 hours per day.
- About 1.50% of potential hydropower has been generated
- About 5,71,372.00 ha. of agricultural land have no irrigation facility.
- About 85% of the total population don't have acceptable housing facility
- About 37% people are still illiterate
- There is loss and damage property having value Nrs. 5 Billion and 13500 people died during social and political 995-2005
- About 31% of the total population are still below absolute poverty line.

Rapid development of physical infrastructure is the only solution to overcome these challenges. Hence, construction projects were vital in Nepal and attracted larger parts of the development expenditure in the past and same in the years to come.

4. Focus of the Study

Construction activities are the vital for and are the index to measure nation's development. Construction activities make national economy movable and it will be an inevitable component for every sectors of economic development. Hence, to move national economic development in the targeted track, it is very important to implement the construction projects as planned or in other words within the specified time, cost and quality.

For every country, its income, investment, construction activities and economic growths are closely interrelated. In other words, they are complement to each other and move parallel. For example, when a country has more income, it invests more for the development. Development is associated with number of construction projects and this ultimately lead more economic growth and more income for the country. This cycle is continuing.

In developing countries, about 50 to 70 percent of the development expenditures are invested in construction sector. As shown in Table 1, out of its total Nrs. 280.30 Billion development expenditure, Nepal has targeted to invest Nrs. 178.99 Billion (62.93%) for the infrastructure development during TYIP period from 2007/08 to 2009/10. Significant part of this investment has been allocated for the development of major and minor infrastructure projects. They include development of road, hydropower and irrigation projects; housing and urban development; water supply and sanitation projects; local development works or development of physical infrastructure to villages; reconstruction and rehabilitation of damaged infrastructure during decade long social and political conflict; and information and communication facilities. This shows that, efficiency of the national investment program and ultimately the pace of country's economic development directly depends on the efficiency of these construction projects.

There is not a single sector in the national development activity where the construction industry does not play an important role. Every country, particularly a developing one, has an important stake for the development of an efficient domestic construction industry. Hence, even a small productivity enhancement in this sector could make a substantial impact on the national economy (Rao, 1983).

Management of any construction project within schedule, budget and predetermined quality is the most important consideration for a project owner, contractor and a project manager. Hence, time, cost and quality are the most important Parameter to measure the success, failure and effectiveness of any construction project.

In developing and least developed countries, it is common to see the project failing to achieve its mission of creating facility within the specified cost, time and quality performance. Time, cost and quality are soul and also the integral part of every construction project. Delay in project implementation, cost overrun and poor quality performance of the construction projects hinders to achieve targeted benefits from the projects. As a result, the whole development process of the nation goes slow.

Nepal is among the least developed countries and in the quest of development, hence investing significant parts of her income to develop the infrastructure through different mega scaled construction projects. In this context, the focus of this research is to study the performance of ongoing public mega scaled construction projects in Nepal; to find out the causes of delays, causes of cost overrun and factors affecting the quality; and to suggest some recommendations to improve the performance of mega scaled construction projects in the future.

Statement of the problem

Scheduled completion of mega scaled construction projects within the budgeted cost and specified quality performance is prerequisite for achieving fast economic growth of the developing country since they consume significant parts of the development resources. Project delay, cost overrun and unsatisfactory quality performance not only preclude for rational utilization of scarce national resources; getting project benefits timely and appropriately but also causes a magnitude of negative effects on the project and its participating parties i.e. owner, consultant and the contractor.

Mega scaled projects are very large investments involving high level of political interest and public attention. It consists of number of small, medium and large sized projects involving different national and international project parties. "Mega" also implies the size of the task involved in developing, planning, and managing projects with substantial risks and conflicts. Management of such project is complex, dynamic and multifaceted. As a result of all these facts, delay and cost

overrun are prevalent in mega scaled construction projects and achieving good quality performance is always challenging.

The above statement is substantiated in Table 2 and Table 3 which shows the schedule performance and cost performance of the completed projects in Nepal in last four decades.

Table 2 Schedule performance of completed projects in Nepal

Type of Project	No of Project			Time Index of the delayed projects (%)
	Executed	Completed on Time	Delayed	
Irrigation	10	3	7	138 -192
Water Supply ¹	20	1	19	123- 188
Road ²	9	0	9	118 -242

Symbol: ¹ Executed under Small Town and Sanitation Sector Project

² Executed under Road Maintenance and Development Project

Table 3 Cost performance of completed projects in Nepal

Type of Project	No of Project completed			Cost Index of the projects with cost overrun (%)
	Total	Within budgeted cost	With cost overrun	
Irrigation	16	7	9	105.68 -280.53
Water Supply ¹	9	0	9	101.94 – 141.82
Road ²	17	0	17	101.05 – 216.58

Symbol: ¹ Executed under Small Town and Sanitation Sector Project

² Executed under Road Maintenance and Development Project

Regarding the quality of construction works, the present level of quality performance in Nepal cannot be considered satisfactory. In Nepal quality of majority of the construction works are achieved mainly by adopting “quality control” and “inspection and testing” methods. Modern aspects to achieve quality such as quality assurance (QA) and quality management system (QMS) are in the very preliminary stage. Even a single Nepalese contractor and consulting firm yet not received ISO or any other international standard quality certification. Most of the employers, consultants and contractors still have strong perception that, meeting quality means satisfying different strength values or other values of materials and finished works as stated in the specification. Recipe specification is predominant in all construction projects. To achieve quality, current construction practice instructs the contractor to follow the specification under the supervision of employer and consultant; and test the finished work in the laboratory to check the specified values i.e. characteristic strength of concrete cubes; density of embankment; weight per running meter and yield strength reinforcement; and surface tolerance of the finished works etc. Hence meeting the strength and other requirements by the products and works during the laboratory tests are the criteria for evaluating quality performance of construction works. It has been experienced that, most of the contractors always try to achieve strength values of the construction works by applying all possible ways; mostly by adopting normal ways as stated in the specification; otherwise by cheating, manipulating and sometimes even by spending extra costs. All these quality related practices caused difficulty in achieving required quality consistently and sometime also caused disputes and extra cost to the project parties.

Time, cost and quality are the main factors to measure the outcome of construction projects since they are collectively associated with the project objective. For any project, these factors are always interdependent and integrated or in other words, each factor is the function of the others. For example, quality always requires cost and time; delay always contributes to the cost overrun and also hamper to the quality. Hence, for the holistic analysis of the performance and problems in any construction project, three main factors need to be analyzed simultaneously.

In Nepal, most of the past studies have been carried out to find out the causes of delays and cost overrun of the medium and big sized projects by considering these three factors separately. Besides that, very less or almost none of past studies have covered the quality aspects of construction projects. Further, no studies have been carried out in the past considering the time, cost and quality aspects of the mega scaled construction projects. Hence, for the holistic understanding of the problems in mega scaled construction projects and finding solutions for improving their performance in future, there is a need to study and analyze the performance of mega scaled projects in Nepal considering the time, cost and quality aspects collectively.

Ahmed *et al.* (2002) stated that, delays on construction projects are a universal phenomenon. They are always accompanied by cost and time overruns. Assaf *et al.* (2005) further stated that, rarely the projects are completed on time. Chan *et al.* (1997) remarked that, project delays occur mostly during the ‘construction phase’ of a project, as many unforeseen factors are always involved during construction phase.

The construction phase is also considered important because the quality of the completed project is highly dependent on the workmanship and management of construction. The construction phase is important because majority of project budget and schedule is expended during this phase (Oberlender, 2000). Hence, it is imperative that the factors causing delays and cost overrun and factors affecting the quality are studied for better execution of future mega scaled projects in Nepal.

Therefore, through this study an effort shall be made to gain better understanding of the performance of ongoing mega scaled construction projects in Nepal with specific focus on the time, cost and quality aspects; to identify the causes of delays, causes of cost overruns and factors affecting the quality; and recommend some specific measures to minimize delays and cost overruns; and improve quality for improving performance of mega scaled projects in future.

OBJECTIVES

1. To carry out brief overview on the performance of ongoing mega scaled construction projects in Nepal in the aspects of time, cost and quality.

2. To identify and prioritize the causes of delays; causes of cost overruns; and factors affecting the quality from the overall, project type and project parties perspectives. .

2. To recommend specific measures to minimize the project delays and cost overruns; and to improve quality, for improving overall performance of the mega scaled construction projects in Nepal.

Scope

This study was focused on ongoing mega scaled construction projects in Nepal covering different infrastructure sectors i.e. irrigation, water supply, hydropower and road. Sikta Irrigation Project (SIP), Banke district; Middle Marshyangdi Hydro Electric Project (MMHEP), Lamjung district; Bardibas-Sindhuli-Banepa Road Project (BSBRP), Kabrepalanchok, Ramechhap and Sindhuli districts; and Melamchi Water Supply Project (MWSP), Sindhupalchok and Kathmandu districts were selected as the sample projects for this study. They are the highly prioritized public projects undertaken by the Government of Nepal and located over the central, central western and western part of Nepal.

There are number of parties involved in mega scaled construction, but due to time limitation, this study focused on the views of main project parties i.e. owners, consultants and contractors. Further more, sample projects under the study are at different stages of construction phase. Particularly in irrigation, road and water supply project; construction works on all components have not started yet, this study covered only those components that were ongoing and completed.

Expected Contributions

This study is expected to provide some insight knowledge on performance of ongoing mega scaled construction projects in Nepal with specific focus on time, cost and quality aspects. Critical factors causing the project delay and cost overrun; and factors affecting the quality of mega scaled construction were expected to be identified and prioritized based on their severity (level of impact) and frequency of occurrence.

This study is also expected to recommend some specific measures to minimize the project delays and cost overruns; and to improve quality in mega scaled construction. The outcomes of this study shall be useful to the Nepal and other developing countries for improving the performance of mega scaled construction projects in future. Furthermore, results and recommendations are also expected to provide useful information to the different project participants undertaking the mega scaled projects in those countries.

LITERATURE REVIEW

1. Project Definition

A project is an endeavor that is undertaken to produce the results that are expected from the requesting party (Oberlender, 2000). It is also a combination of human and non-human resources pulled together in a temporary organization to achieve a specific purpose (Cleland and King, 1983).

Project is a “temporary” endeavor or activity undertaken to create a “unique” product or to provide certain service. The term “temporary” indicates that, every project consists of one-time activity having definite starting and ending time and implemented to achieve specific objectives. Further, the term “unique” refers that, each project differs with the other in terms of working environment, available resources and final product or service they targeted to deliver. A project has the following distinct features:

- (a) Specific objectives and goals
- (b) Detailed implementation plan
- (c) Time bound activities
- (d) Project life cycle
- (e) Investment plan and activities

A project consists of three basic components; scope, budget, and schedule (Oberlender, 2000). Scope states details of work that need to be done including quantity and quality of work. Budget refers to the amount of money required to accomplish the work. Schedule refers to the logical sequencing and timing of the works to be performed. The quality of a project must meet the needs of the owner and is considered as an integral part of project management. This is illustrated in Figure 3.

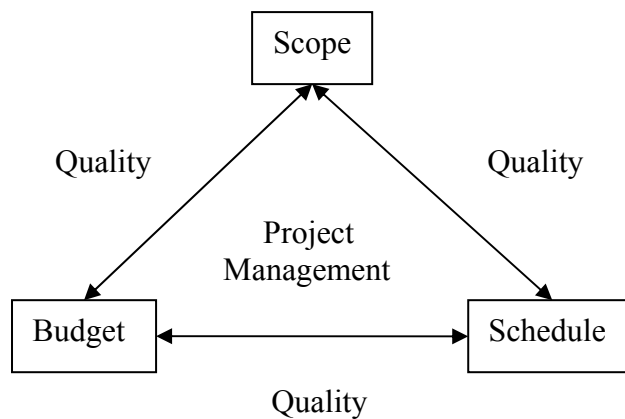


Figure 3 Quality is an integral part of the scope, budget, and schedule

Source: Oberlender (2000)

2. Project classification

Projects are classified based on the different criteria. Table 4 shows the project classification.

Table 4 Project classification

No.	Category	Classification
1	Area	National and International
2	Ownership	Public and Private
3	Financial and other scale	Mega, Large, Medium and Small
4	Time/Duration	Long term, Medium term and Short term.
5	Output	Product (Goods) and Service
6	Urgency	Urgent, Fast track/Crash program and Normal
7	Source of fund	Indigenous, Bilateral and Multilateral
8	Techniques of Implementation	Labour intensive, Capital intensive and Labour based.

2.1 Mega scaled project (MSP)

Mega scaled project is an extremely large-scale investment project. A project is considered as MSP if the project cost is more than 1 Billion. (Chitkara, 2006). Furthermore, mega scaled projects are complex in nature attracting a lot of political interest and public attention because of its' substantial impacts on communities, environment, and budgets. A MSP consists of number of small, medium and large sized project involving different national and international project parties. "Mega" also implies for the size of the task involved in developing, planning, and managing projects of this magnitude with substantial risks.

3. Project Phases

Based on the nature of the works to be performed and to provide better management control, projects can be divided in to three phases.

- (i) Project definition phase
- (ii) Project design phase
- (iii) Project construction phase

Every project passes through above three phases from its starts to completion. Figure 4 below illustrates the details of the activities that are carried out in different phases of the project. The first two phases mainly consists of planning activities and the last phase is predominant with construction activities.

In the project definition phase, firstly project is identified and decision is made to test the viability of the project by carrying out feasibility study. If the project is found viable by feasibility study, then it is forwarded for the design phase.

During the design phase, detailed design, drawing, project estimate and project plan are prepared to find the answer of some critical questions related to the project economy, finance and execution. For example, what is the project cost and benefit; how funding will be arranged; who will be the other stakeholders and what method

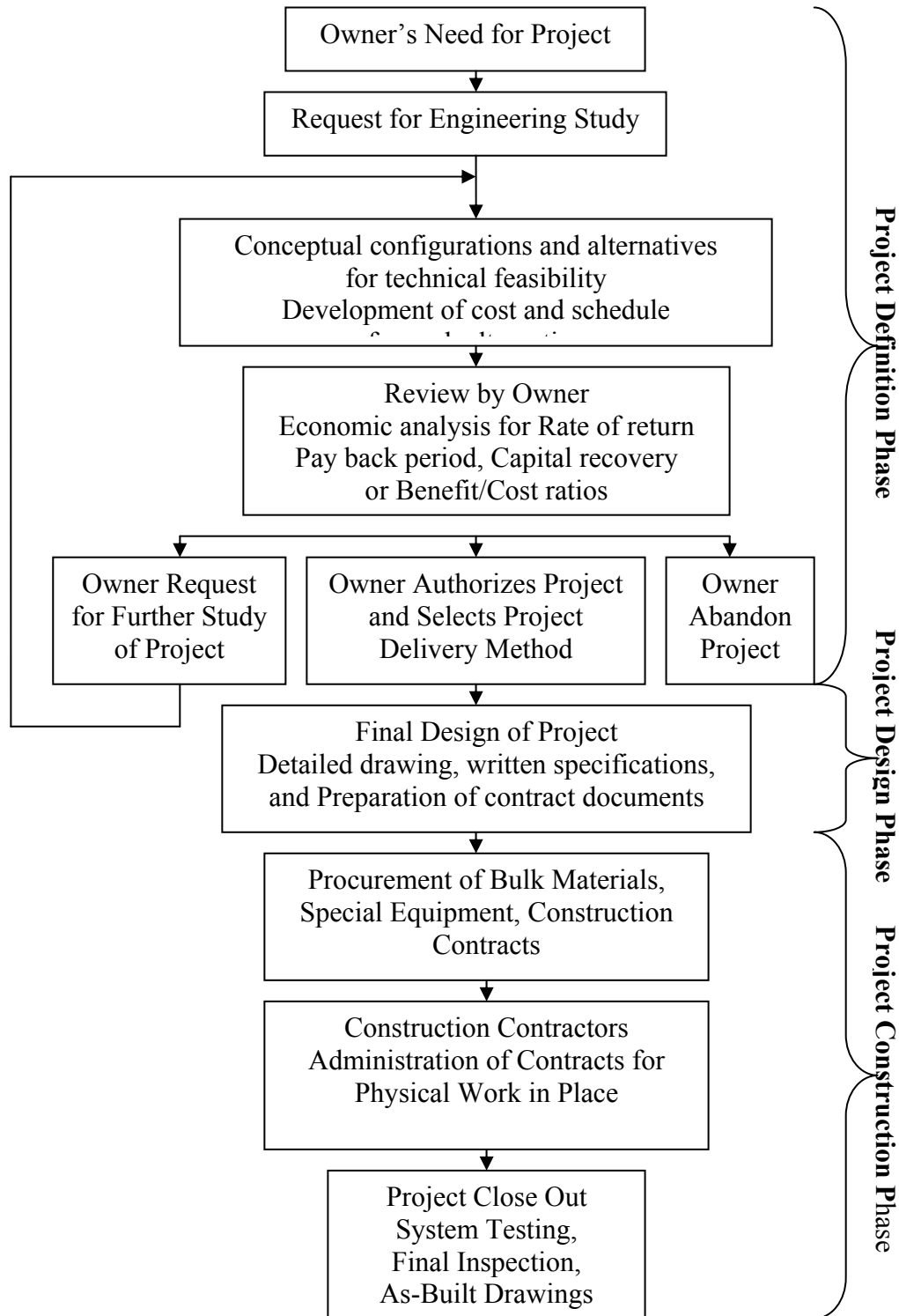


Figure 4 Phases of a project

Source: Oberlender (2000)

will be adopted to construct the project etc.

During construction phase plans, designs and drawings in papers that were prepared during earlier phases are converted in to the real object or infrastructure. The project construction or implementation phase is crucial not only because it consumes major parts of the budget and schedule; and concerned with achieving quality but also because number of different stakeholders are also involved in this phase. Different stakeholders involved during this phase are shown in Figure 5. During construction phase, each stakeholder influences or has the capacity to influence the project activities where by causing project delay, cost overrun and affecting quality performance of the project.

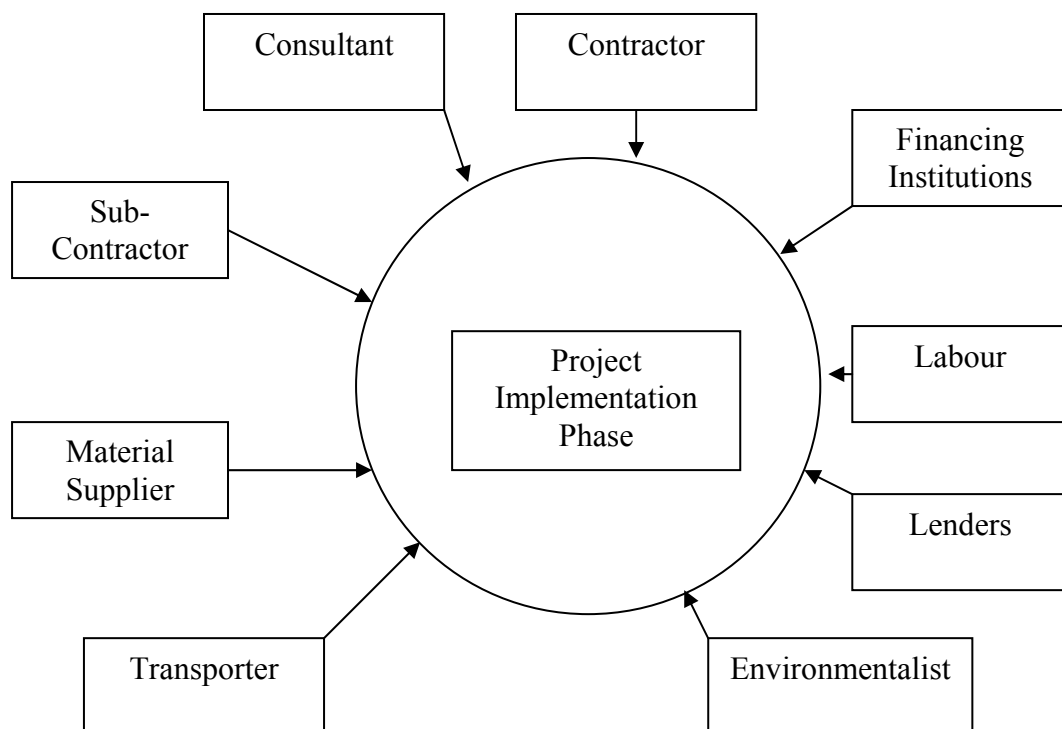


Figure 5 Stakeholders involved during construction phase

4. Project Management

4.1 General Background

Many researchers and professionals realized that, application of the fundamental concepts of project management can help to achieve objectives of project development. Project management consists of two words. As stated earlier, the word “project” is defined as an activity, which has a starting and ending time and is executed to achieve specific objective; and “management” is defined as art and science that converts disorganized human and physical resources into useful and effective results (Bhattarai, 2004). The results are in the form of tangible product (infrastructure) and services.

Project Management Institute (PMI) defined project management as, “the art of directing, and coordinating human and all other resources throughout the life of a project by finding modern techniques to achieve predetermined objectives of scope, cost, time, quality and participants or stakeholders satisfaction.

Organizations often use project as the means by which they can attempt to meet several of their objectives (Maylor, 1999). Thus, project is considered as a vehicle for carrying out the strategies of organization. Project success plays important role for the organizational continual development; and furthermore it also plays decisive role for survival, development and failure of the organization.

4.2 Project Management Functions

For the success of the project, project management has to perform two main functions, which are,

1. Project management control functions
2. Project management integrative functions

Figure 6 shows the two main functions of the project management and

they are described as follows.

4.2.1 Project Management Control Functions

As illustrated in Figure 6, scope, time, quality and cost of a project are the four main areas of “Project management control functions”.

(i) Scope (What?)

Scope is the project’s objectives together with all activities in terms of their results and resources requirement. In other words, scope could be definite as sub-

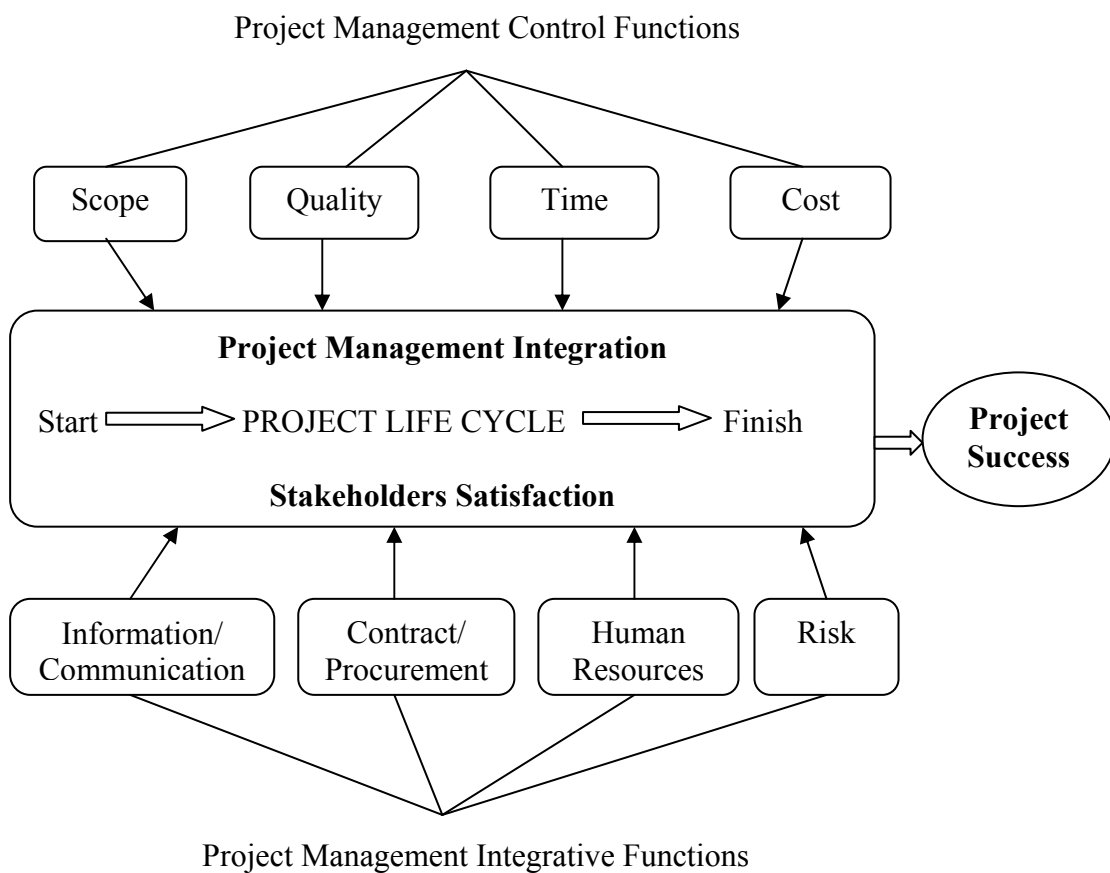


Figure 6 Project management control and integrative functions

Source: Wideman (2001)

dividing the major project deliverables into smaller and more manageable components. Scope management includes the processes required to ensure that the project includes all the required works in order to achieve expected completion.

(ii) Quality (How good?)

Quality of a project must meet the needs of the owner or end user. It is considered an integral part of project scope, budget and schedule. Quality management for project includes the process and product management of various works under the project to ensure that the project will satisfy the needs of its end users. It covers all activities of the overall management function that determine the quality policy, objectives and responsibilities; and implement them by means of quality planning, quality assurance, quality control and improvement inside quality system. This is illustrated in Figure 7.

In practice quality management of any construction project means that the quality of any product or work and service shall conform to the project specifications with acceptable deviation. Furthermore, quality management is continuous process throughout the project life cycle.

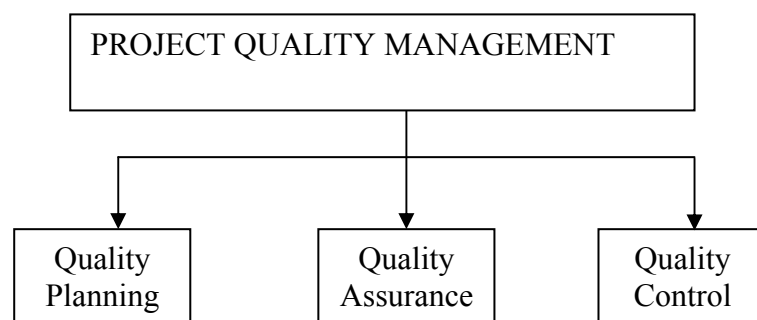


Figure 7 Project quality management overview

Source: Project Management Body of Knowledge (2000)

(iii) Time (When) and Cost (How much?)

Management in terms of time and cost include all processes that ensures

the project shall be completed timely and within approved budget (PMBOK, 2000). In practice, time management includes all the techniques and method adopted to use the available time efficiently to facilitate the execution of a project in an effective manner. Time management is the most critical aspect of a project because it affects all other aspects of the project directly and indirectly.

Cost management is also the important function of project management. It involves controlling project costs effectively with the use of modern techniques of estimation, forecasting, budgeting and reporting. Total cost of the project is the sum of all costs required for different phases of a project and it must be within the specified budget. Four objectives of the project management control functions and illustrated in Figure 8.

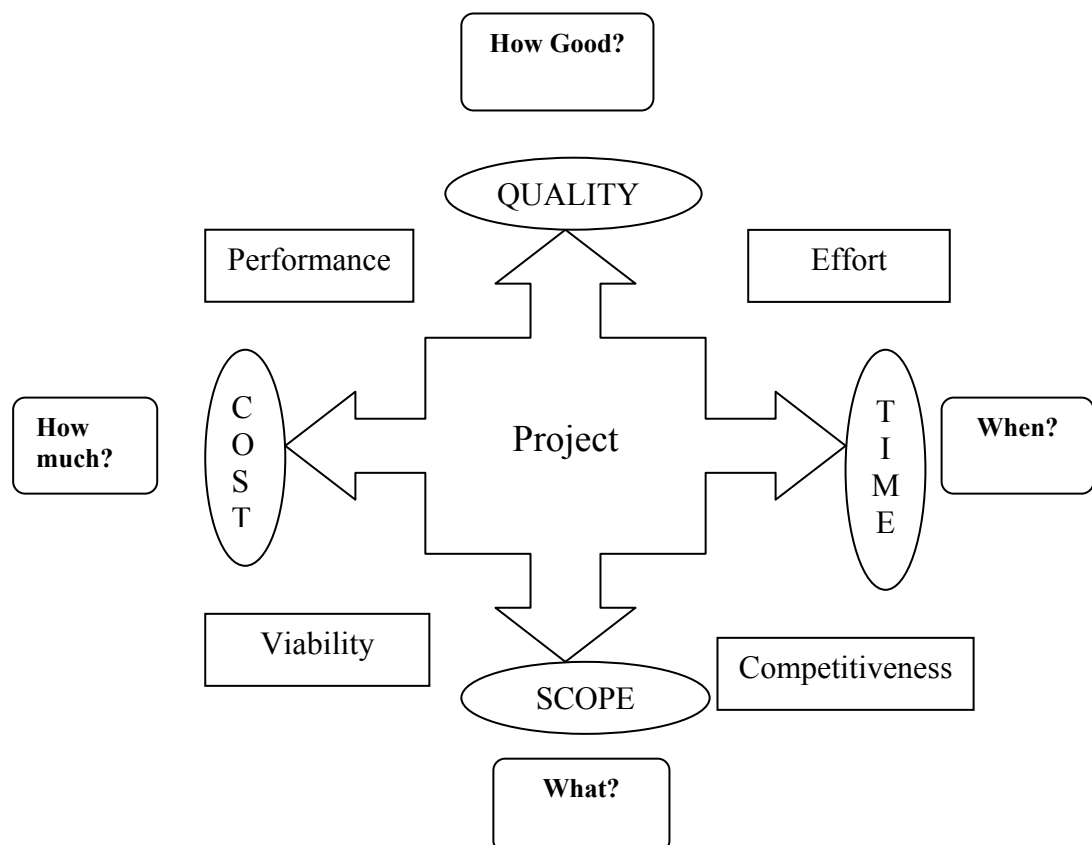


Figure 8 Objectives and constraints of project management control functions

Source: Wideman (2001)

4.2.2 Project management integrative functions

Four major areas of project management integrative functions as illustrated in figure 6 are described as follows.

(i) Information/Communication management

Information and communication management refers to the functional interface among individuals and groups within the project environment. This involves proper organization, flow and control of information needed for the project. Good communication creates common understanding between the communicator and the target groups on a specific issue.

(ii) Contract/Procurement management

Contract/procurement management is the process of acquiring the necessary equipments, tools, goods, services, and resources for successful accomplishment of project goals. Major amount of the project cash flow occur for procurement management process.

(iii) Human resource management:

Human resources management signifies the importance of people in executing a project. It involves directing people throughout the project life cycle. The active participation of all key participants is of utmost importance for achieving project objectives.

(iv) Risk management:

Risk management involves identifying and analyzing the various risks and uncertainties that might affect the project. Risk analysis outlines possible future events and their likelihood of occurrence.

4.3 Project Management Steps

Managing project from its identification to completion is a challenging task. It needs series of systematic steps to be followed by project management to reach from problem identification or initial stage to the completion or final stage of a project. Badiru and Pulat, (1995) suggested ten systematic steps of project management. As illustrated in Figure 9, this starts with problem definition and ends with project termination.

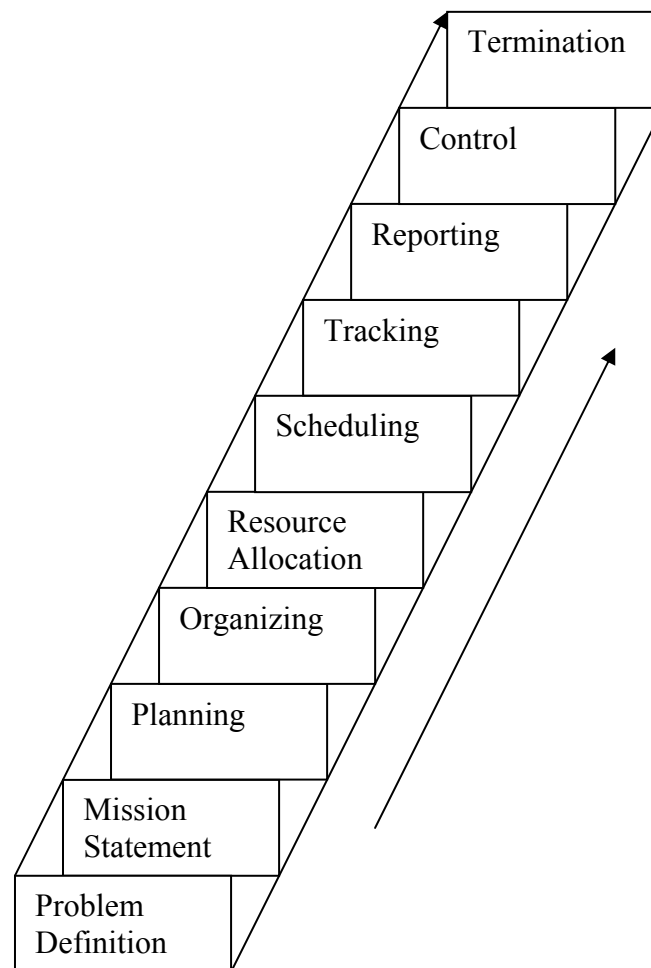


Figure 9 Project management steps

Source: Badiru and Pulat (1995)

The problem definition is the beginning stage in which the proposed project is identified and defined. The project could be construction of an entirely new infrastructure; implementation of new processes or improving the existing facilities. This is followed by successive steps i.e. the mission statement, planning, organizing, resource allocation, scheduling, tracking, reporting, controlling and finally the termination.

Among these ten steps, planning is of the utmost important for a project to be successful because the ways and means to achieve project objective is identified during planning and is included in the project plan.

Organizing represents assigning and integration of each individual's responsibilities involved in the project. Allocating resources i.e. man, material, machine, and money to a project is critical because many times these resources are in short supply and needs to be used in an optimum manner.

Scheduling is also considered as the most important step in project management. The project resources shall be allocated in such a way that, overall project objectives are achieved within the specified time. Inaccurate scheduling may cause project delay and most of the time cost overruns.

Besides these, tracking, reporting, controlling and termination are also the significant steps involving distinct activities of the project management and have important role for successful completion of a project.

5. Project Performance

Project performance is the measure of projects achievement against different project parameters i.e. scope, time, cost, quality and others. In general project performance also indicates the relative success or failure of the any project. The mega scaled construction projects are multidisciplinary in nature involving many stakeholders i.e. owners, designers, contractors, sub-contractors, specialists and

construction managers and many more depending upon the nature of the project. Each stakeholder has some responsibility for the success of a project hence has some contribution for the project performance.

Konchar and Sanvido, (1998) measured project success in terms of unit cost, construction speed, delivery speed, cost growth, schedule growth and several quality measures. Chan and Chan, (2000) included the additional dimension of users expectation, participants satisfaction, environmental performance, health and safety factors; and commercial value for measuring project success. Further, Ling *et. al.*, (2004) added owner's satisfaction and owner's administrative burden.

Iyer, K. C. and Jha, K. N., (2006) pointed out that, project performance is normally measured in terms of cost and time. Projects are often rated as successful because they have come in nearly within the budget and schedule, achieved an acceptable level of performance (Pinto and Slevin, 1989). Frimpong *et al.*, (2003) stated that, a successful project means that, the project has accomplished its technical performance, maintained its schedule, and remained within budgetary cost.

From above opinions of the researchers, this study choosed three most important project parameters i.e. time, cost and quality to study and analyze the performance of mega scaled construction projects in Nepal.

Performance of any projects in terms of time and cost can be simply measured by computing the Time Index (TI) and Cost Index (CI) as follows,

$$\text{Time Index (TI)} = \frac{AD}{SD} \times 100\% \quad (1)$$

$$\text{Cost Index (CI)} = \frac{AC}{EC} \times 100\% \quad (2)$$

Where,

AD = Actual duration; SD = Scheduled duration

AC = Actual cost; EC = Estimated cost

Time index exceeding 100% indicates time overrun or delay while below 100% indicates project completed before time. Similarly, cost index exceeding 100% indicates cost overrun and below 100% indicates project completed within the budgeted cost. The time and cost index of exactly 100% represents the project completed on schedule and budget respectively. A project can be considered as success in terms of time and cost performance, if the TI and CI values are less than or equal to one.

Measurement of project performance in terms of quality by adopting formulae based computation as above is difficult or impossible because quality primarily meant to satisfy the needs of the owner and hence subjective in nature.

Florence *et. al.*, (2008) stated that, quality performance of any construction project gives an indication of workmanship, technical and functional quality performance. Singapore Construction Industry Development Board (CIDB), developed a measurement system namely Construction Quality Assessment System (CONQUAS); containing objectively measurable quality parameters for assessing the quality of constructed works for structural, finishing and services works. Further, ISO 9000 states all aspects to be included to assure the quality in construction process. They are quality control (QC), quality assurance (QA), quality management (QM) and quality system (QS)

Hence it can be concluded that, quality management in construction projects includes both product management and process management to ensure that the project will satisfy the owners need. This also implies that, construction project performance in terms of quality can be measured by evaluating quality in construction process as well as quality of constructed product. Quality in construction process can be accessed by evaluating all aspects of projects as certified by ISO 9000 i.e. QC, QA, QM and QS; and quality of constructed product can be accessed by judging project works in the aspects of its' workmanship for finishing works, technical quality for structural works and functional quality for system works

6. Past Studies on project delay, cost overrun and quality

6.1 Delay

6.1.1 General Background

Time is the most important resource for all construction projects. As stated earlier, all construction projects, construction activities and construction contract are time bound. In other words, they have defined starting date, duration and completion date and are stated in the project document, project schedule and contract document respectively. Delay simply mean, failure to comply with these predetermined time. In this context, Semple *et al.*, (1994) stated that all extensions to the original schedule were considered as delay.

In construction, delay is defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project (Assaf *et al.*, 1995).

Over the past decade mega scaled construction projects (MSCP) have become more and more complex as new technologies have demanded concentration of large number of resources into single facilities. The bigger the project, there is increase in involvement of number of stakeholders. Furthermore, EIA, land acquisition, public and political issues became more critical. All these factors make the execution of mega scaled projects more complex than previous. A striking feature of any such project has been the noticeable occurrence of delay and cost overruns. Hence, delay in MSCP have been became a universal phenomenon.

Joy, (1991) reported that, out of 315 central public sector mega scaled projects in India, 189 suffered substantial delay. Time overrun in one of the project was as much as 194 months (325%) with corresponding cost overrun of 788%. Similarly, Kharbanda and Stallworthy, (1984) concluded that, time and cost overrun has become the rule in India not the exception. These phenomenons are common in all countries over the world and also in Nepal. During the last three decades, delays

were among the most common phenomena in the construction industries. Delays have occurred in most types of projects ranging from simple building projects to the most complex projects i.e. nuclear power plant, hydropower and tunneling projects (Majid and McCaffer, 1988). Past records showed that, there were 50-80% delay on the 1627 number of World Bank sponsored projects from 1974 to 1988. There noticed 23.20% average time overruns on UK Government construction projects from 1993 to 1994 (Bordoli and Bladwin, 1998).

Project delay could result in loss of revenue to the owner due to not having production facilities timely or having to depend upon the present facilities with some lack. For a contractor, delay normally means more overhead costs, and sometimes has to bear more labor and material costs due to inflation. In summary, project delays have debilitating effects on all parties involved in construction, resulting in growth of adversarial relationships, distrusts, litigation, arbitration, cash-flow problems, and sometimes a general feeling of apprehension towards each other.

In developing countries like Nepal, delay is taken as the most critical problem encountered in majority of MSCP. Since time have the overriding importance for both owner (in terms of performance) and the contractor (in terms of money), delay is the frequent source of disputes and claims leading to lawsuits (Ahmed *et al.*, 2002).

6.1.2 Delays in different project phases

Project can be delayed in different phases of its lifecycle (Joy, 1995). Obviously, causes of delay are different for the different phases of project.

During the pre-feasibility phase, possible causes of the project delays are problems of land acquisition, clearance from the regulation body, lack of infrastructure facility and management problems. During the evaluation phase, the possible causes are inadequate study, political influence, and wrong assessment during pre-feasibility phase. During the detailed engineering and technology selection

phase, delay of the project might be due to the selection of inappropriate technology and method; complications in design, long and tedious bureaucratic chain for approval.

During the contracting and procurement phase, the projects are delayed because of slipshod preparation of the project document, complications in selections of the contractors, difference between the government procurement regulation and donors' procurement guidelines; and local, national and international political influence.

During the startup phase of the construction, the potential causes of the project delay are, delay in supply of inputs like special tools, first fills, manuals and services; absence of commissioning specialists, defects in erection and installation, troubles resulting from bad quality control during erection and improper testing equipments.

During the construction phase, the main causes of project delay are, very early starting of the construction activities before ensuring the availability of working drawings; lack of storage and preassembly space; lack of sequential supply of equipment and materials; inadequate infrastructure; inadequacy in contractor's mobilization; poor planning by contractors; lack of close co-ordination and owner's serious involvement; poor law and order situation in the project area; strike and closedown by different trade unions; and internal war and social conflict. Furthermore, contractor's low productivity and financial problem; indecision and delay in decision; lack of control of micro level schedule with reference to the macro plan of the project; delay in payments; delay in provision of infrastructural facilities; delay in settlement of extra changes and claims can also be the possible causes of project delay. This shows that there always have possibility of occurring project delays at different phases of the project. But, Chan *et al.*, (1997) stated that, project delays occur mostly during the construction phase of a project, as many unforeseen factors are always involved during this phase. Hence, it is imperative that, for the

better execution of projects in future, there is a need to study on the factors causing delays during the construction phase and find the measures for minimizing delays

6.1.3 Classification of delays

Delays are classified based on the different criteria. As shown in Table 5, delay classification based on its effect is of the utmost important and discussed further.

Table 5 Classification of delays

S. No	Criteria based on	Delay Classification
1	Forecastability	- Forecastable delays - Non forecastable delay
2	Responsibility	- Delay attributable to the employer - Delay attributable to the engineer - Delay attributable to the contractor
3	Source	- Contractual delay - Extra-contractual delay - Combined delay
4	Effect	- Excusable delay i.e. Compensatory and non compensatory - Non-excusable delay - Concurrent delay

Excusable delays are the delays that arised from the causes beyond the control of the contractor. Excusable compensatory delays occur due to acts or omissions of the owner or owners' representatives. This type of delay entitles the contractor to get time extension for completion with additional compensation for the cost of delay. For example, failure to provide site or access; late notice to proceed; failure to provide proper financing; interfering with or obstructing work on the project; defective plan and specification; failure to provide drawing on schedule;

delay in review or approval of shop drawings; delay in change orders; and stop work order are some examples of excusable compensatory delays. Excusable non-compensatory delays are the delays caused by the events which are beyond the control of the any party. In this situation contractor entitles to get the time extension without compensation. Delay due to act of god and public enemies; unusual delay in transportation; unusual weather condition; political interference; and strikes by the workers are few examples of such delays.

Non-excusable delays occur due to the act of the contractor. The contractor is fully responsible for this type of delays and hence he is entitled neither compensation nor any time extension. In this situation, the owners have the right to claim for the loss due to delayed completion of his project in the form of liquidated damages as per provision in the contract document. These delays could be the results of underestimation of productivity; inaccurate scheduling; management mistakes during construction; equipment breakdown; staffing problems, etc. were some examples of delays of this category.

Concurrent delays occur due to occurrence of at least two or more delay at the same time of which if any one have occurred alone would also cause delay in project completion. The owners and the contractors are individually or combinely responsible for such delays. For this type of delays, the contractors are entitled to get only time extension or sometimes time extension with compensation.

6.1.4 Causes of delays in the literature

In the past, many researchers have conducted research to find out the causes of delays in construction projects. Bhattarai, (2004) conducted research on the factors contributing to delays in development projects in Nepal, which highlighted the causes of delays in developing countries like Nepal. Findings of his research are summarized into nine major delay categories as illustrated in the Table 6.

Table 6 Major causes of delays in Nepal

S. No	Delay Category	Delay Causes
1.	Material related	<ul style="list-style-type: none"> - Non-availability of materials - Delay in supply - Reject by the engineer. - Problems in Procurement and transportation - Shortage of fuel and lubricants
2.	Manpower related	<ul style="list-style-type: none"> - Shortage of foreman and supervisory staff - Shortage of skilled labors - Shortage of unskilled labors - Low skill of construction workers
3.	Machinery related	<ul style="list-style-type: none"> - long time taking and complicated procurement - Difficulty in transportation - Repeated failure and breakdown - Spare parts not available
4.	Management related	<ul style="list-style-type: none"> - Lack of control and communication - Problem in scheduling - Lack of co-ordination due to involvement of many agencies - Low management efficiency
5.	Money related	<ul style="list-style-type: none"> - Arranging money for the project - Contractors financially not sound - Late payment by the employer - Unhealthy competition among the contractors - Corruption
6.	Weather related	<ul style="list-style-type: none"> - Abnormal or unusual bad weather - Unprecedented harsh weather

Table 6 (Continued)

S. No	Delay Category	Delay Causes
7.	Design and document related	<ul style="list-style-type: none"> - Late delivery of drawings - Frequent change in design - Contractor take long time in preparing and submitting shop drawings - Variations and extra items - Ambiguity in contract documents
8.	Technology related	<ul style="list-style-type: none"> - Selection of improper contractors - Use of traditional technology - Unnecessary use of Hi-Tech - No use of innovative approach
9.	Employer caused	<ul style="list-style-type: none"> - Getting permit and approval takes long time - Long time to approve material samples - Site access problem after site hand over to the contractor - Long time taken for decision making - Change in requirement of employer or increased scope of works - Late approval of extra item rate - Politically motivated decision of the employer - Delay in contract award - Frequent change of project personnel - Custom clearance of imported material taking long time - Problem in procuring locally available material like gravel and sand

Lo *et al.*, (2006) carried out a similar study in Hong Kong construction industry and found that inclement weather, unforeseen ground

conditions, inaccurate bills of quantities and delays in providing design information are the major factors causing delays in construction projects.

Alwi and Hampson, (2003) conducted a survey to determine the causes of delays in building projects in Indonesia. Their study revealed that, design changes; lack of trades' skill; and slow decision-making process; are the major causes of delays.

Abdul Rahman *et al.*, (2006) conducted research to the causes of delay in the construction industry in Malaysia and found that shortage of manpower; poor site management; and client influence were the major factors. Similarly, Ahmed *et al.*, (2002) conducted an empirical study on construction delays in Florida. The major causes of the delays were employer and document related.

Assaf and Al-Hejji, (2006) carried out similar studies and reported financial, managerial and labor shortage are the main cause of delays in Saudi Arabia. Odeh and Battaineh, (2002) conducted a separate study to identify the causes of delay in large public and private buildings; roads and water; and sewer projects in Jordan. They concluded that, the owner's interference; inadequate contractor experience; financing and payments; labor productivity; slow decision making; and improper planning are the most important delay factors. Research findings on the causes of delay that were carried out between the period 2000 to 2006 in various developing and developed countries are summarized in Table 7.

Table 7 Major delay causes in developing and developed countries

Country	Delay Causes	Researchers
Hong Kong	<ul style="list-style-type: none"> - Inclement weather - Unforeseen ground conditions - Inaccurate bills of quantities - Delays in providing design information 	Lo <i>et al.</i> , (2006)

Table 7 (Continued)

Country	Delay Causes	Researchers
Indonesia	<ul style="list-style-type: none"> - Design changes - Lack of trades' skill - Slow in making decisions 	Alwi and Hampson, (2003)
Malaysia	<ul style="list-style-type: none"> - Shortage of manpower - Poor site management - Client influence 	Abdul - Rahman <i>et al.</i> , (2006)
U.S.	<ul style="list-style-type: none"> - Building permits approval - Change order - Changes in drawings - Incomplete documents 	Ahmed <i>et al.</i> , (2002)
Saudi Arabia	<ul style="list-style-type: none"> - Change orders - Delay in progress payments - Improper planning and scheduling by contractor - Poor site management and supervision - Shortage of labors 	Assaf and Al-Hejji, (2006)
Jordan	<ul style="list-style-type: none"> - Owner interference - Inadequate contractor experience - Financing and payments - Labor productivity - Slow decision making - Improper planning - Subcontractors 	Odeh and Battaineh, (2002)

6.2 Cost Overrun

6.2.1 General Background

Cost management is also a main area of project management. Fulfilling and satisfying the owners need as targeted by the project within the budgeted cost is also considered as the most important objective of any project. In 21st century, economic benefits have been considered as the main criteria for measuring the success or failure of most of the human efforts for infrastructure development or construction projects. All projects consist of physical and economic environment. All the issues related to the investments on the project and benefits from the project in future come under the economic environment and these always have preference over the physical environment. A project is considered as success one, if the targeted benefit is achieved at the specified project cost.

6.2.2 Project Cost

Project cost is the sum of costs of all work units associated with the project. The work unit may be an activity, a work item or a work package. Each work unit is composed of one or more cost elements, which include labor costs, material costs, plants and machinery costs, administration costs and other expenses.

Project cost can be classified into two categories,

1. Direct cost
2. Indirect cost

Direct costs are the costs of the materials, labor, and other expenses, which can be identified with the execution of an item of work or activity. These include, direct material cost, direct labor cost and other direct expenses related with the production of any activity (Chitkara, 2006). Indirect costs include all costs, which are attributable to a given project but cannot be identified with the performance of a specific activity or work package. In other words, all costs other than direct costs are

covered under indirect costs. (Chitkara, 2006)

6.2.3 Past studies on Cost Overrun and its Effects

Cost overrun is defined as an excess of actual cost over budgeted or contract cost. Cost overrun is also called "cost escalation", "cost increase," or "budget overrun". However, cost escalation and increases do not necessarily result in cost overruns if these are included in the contract.

Cost overrun is common phenomenon in most of the construction projects. But as compared to the small projects, this phenomenon was found more severe in big and mega scaled projects because they involved more risks and uncertainty.

Spectacular examples of cost overrun in internationally remarkable MSP are the Sydney Opera House project, Australia with 1,400 percent; Boston's Big Dig project, USA with 275 percent, or US \$11 billion. The cost overrun for the Channel tunnel between the UK and France was 80 percent for construction costs and 140 percent for financing costs (A Wikimedia Project, 2009).

Cost overrun is typically calculated in one of two ways. They are either as a percentage, namely actual cost minus budgeted cost in percent of budgeted cost, or as a ratio i.e. actual cost divided by budgeted cost.

Project costs have direct and indirect relationship with other resources namely material, machine, manpower and time. Further they also have relationship with the other factors like social factors, political and economical factors; internal and external factors. Among these, the most critical one is the relationship between time and money. Hence, in most of the construction projects, if the planned schedule is exceeded, it is likely to exceed the planned cost.

Habison, (1985) stated that, extra charges claimed by the contractor against the owner for project delay is justified because the project delay caused to,

- (a) increase in wage costs
- (b) increase in material costs
- (c) increase in costs of site equipment and site overhead costs
- (d) increase in general overhead costs

Construction activity requires major investment outlays in most developing countries, yet most construction projects in these countries were characterized by cost and time overruns (Dlakwa and Culpin, 1990). They further stressed that, delay and cost overrun have a “knock-on” effect on the construction industry, and indeed on the overall economy. Arditi *et al.*, (1985) stated that, the effect of cost overruns are not confined to the construction industry alone but are reflected to the overall economy of the country.

James Odeck, (2004) expressed his view as, cost overruns are predominant in the construction sector as opposed to under runs. Cost overrun normally means wastage of resources which otherwise could have been used for other productive purposes. Hence, it is imperative to minimize the cost overrun or unproductive spending. Numerous studies have found that, the main cause of cost growth was poorly defined scope at the time that the budget was established (A Wikimedia Project, 2009). Study of the research findings on cost overrun carried out by the different researchers in different countries revealed that, there are various factors causing cost overruns. They are summarized in Table 8.

Table 8 Major causes of cost overruns in developing countries

Country	Major causes of Cost Overrun	Researchers
Turkey	- Inflation - Increase in material prices and workmen’s wages - Construction delays - Errors in first estimates	Arditi <i>et al.</i> , (1985)

Table 8 (Continued)

Country	Major causes of Cost Overrun	Researchers
Nigeria	- Delayed payment by owner's to the contractors - Fluctuation in material, labor, and plant costs	Dlakwa and Culpin, (1990)
Nigeria	- Errors in first estimates - Fluctuation claims - Variation orders	Okuwoga, (1998)
India	- Conflict among project participants - Ignorance and lack of knowledge - Hostile climatic conditions - Reluctance in timely decisions - Aggressive competition at tender stage - Short bid preparation time	Iyer and Jha, (2005)

6.3 Quality

6.3.1 General Background

Quality is the degree of excellence of a product or services. ISO 9000 defined quality as, “the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs”. This definition is customer oriented and concerns for satisfying the customer's stated or implied needs. For example, for a building project, the ultimate customer can be the owner, tenant or occupier; each having set of needs to be met. For public projects, customers are the concerned government departments and authorities who pay for the design and construction of the project. The stated or implied needs as shown in Table 9 would therefore have to be met by the designer (consultant) or the builder (contractor).

Definitions of quality also included terms like freedom from deficiencies, zero defects, doing things right the first time and every time. These

definitions are related to the quality targets within the organization.

Table 9 Quality needs of the construction project

Quality Requirements	Stated or Implied needs	Criteria
Design	1. Aesthetics	- Good design taste
	2. Functionality	- Design does what it is intended to - Meet all building codes and requirement
	3. Durability	- Materials and equipment last to its intended life
	4. Safety	- Safe for occupiers - Meet all building code requirements
	5. Cost	- Within the clients budget
Construction	1. Workmanship	- Quality of constructed work according to drawings and specifications
	2. Integrity	
	3. Completion time	- According to clients requirement

In summary, the owners' requirements or in other words needs and satisfactions are the prime factors for defining the quality characteristics of any construction project and can be monitored by quality targets. Quality requirements of the overall project and individual works and activities; are defined in the contract specification.

6.3.2 Elements of Quality

There are three elements of quality as follows,

1. Quality characteristics
2. Quality of design
3. Quality conformance

Quality characteristics are those characteristics of the product or an activity, that is actually measured to determine the quality conformance of the product or activity with a given requirement as stated in the specification. They include dimensions, color, strength, temperature and density etc.

Quality of design, defines the desired standard of the products or project activities that are required for the given purpose with acceptable tolerances or ranges of variation from the standard. Quality of design must be economical. Too high quality standard involves high cost of the project and too low standard leads to produce low quality.

Quality conformance is the degree to which the physical works produced confirms to the standard.

6.3.3 Achieving quality in construction projects

Quality management of construction projects starts with defining the quality of each activities, goods and services included in the project. Quality requirements are specified in the specification which is a part of contract document. Owner, consultant and contractor have equal responsibility for achieving the quality. There are two approaches for achieving quality in construction works as follows,

1. Detecting works or products that do not meet the specification
2. Preventing the production of works or products that do not meet the specification

The first approach is the corrective approach for achieving quality in any construction project and hence concerned with the detection of faulty products, works and activities that do not meet the specification. Method of inspection and testing; and method of quality control comes under the first approach. Second approach is the preventive approach and method of quality assurance (QA) and total

quality management (TQM) come under this approach.

Regarding the quality aspects in construction works, some commonly used terminologies are as follows

(i) Inspection and testing

Inspection and testing are the conventional method of achieving quality in which physical products, works and activities of the project are inspected and tested after their production or work completion so as to detect the defects for correction or rejection.

(ii) Quality control (QC)

QC includes all operational techniques and activities which are used to fulfil requirements for quality. In other words, these are the techniques and activities to ensure that products or services meet specifications. These include design checks, tests carried out during construction, sample tests on materials, calibration of machinery and testing equipment and production of test certificate. QC is necessary in construction to prove that requirements and specifications of the works, materials and products are being met. QC serves as useful feed back and enables early detection of defective areas which require attention or correction.

(iii) Quality assurance (QA)

QA includes all those planned and systematic actions necessary to provide adequate confidence that a products or services will satisfy given requirements for quality. QA is the preventive functions to ensure that, all controls are intact and are in place; and all operation will satisfy the quality requirements. Examples of QA in construction projects are proper monitoring system to track changes in drawings; instructions for formwork setting and reinforcement works; procedures for concrete pouring and instructions for pumps installations.

(iv) Quality management (QM)

QM includes those aspects of the overall management function that determines and implements the quality policy. QM requires top management commitment and involvement. QM includes having quality as part of the organization's values and goals; setting the organization's quality strategies and standards; allocating suitable resources; and setting up a quality system.

(v) Quality system (QS)

QS is the organizational structure, responsibilities, procedures, processes and resources for implementing quality management. The QS should be pervasive throughout the organization from management to supervisory level. The objective of QS is to enable individual employee to know their contribution and responsibility and can be achieved through properly documented manuals and training for the employees.

(vi) Total quality management (TQM)

TQM is the management approach of an organization which is centered on quality. TQM is based on the participation of all its members and aimed at long term success through customer's satisfaction and benefits to the members of the organization and also to the society. TQM is the totality of the concepts of quality which includes QC, QA, QM and QS applied to an organization.

6.3.4 Past studies on factors affecting quality in construction

David and Murad, (1999) studied the factors affecting the quality in construction projects and emphasized on improving the process quality and product quality for achieving the overall quality of works, activities and any physical products in construction. Product quality indicates the quality of construction work components that are directly related to the physics of final products. Process quality is related with

the quality of all working processes that affect the quality of final products. For example, in any construction project the product quality meant using high quality material, machine and technology having high productivity for achieving the best quality of physical products, works and activities. Similarly, process quality naturally meant quality of working system, supervision and monitoring mechanism.

Since last two decades, Quality Management System (ISO 9000), has been accepted as an international standard for managing the process quality to achieve product quality. The guidelines on process quality set by ISO 9000 are based on the assumption that, when the processes are good, the final results or product outcome are also good. Nowadays, internationally reputed companies in the construction sectors are also using ISO 9000 for improving their process quality to achieve quality of work items and ultimately the quality of construction projects.

Santi, (2001) studied about relationship and responsibility of the main project parties or owner, designer and contractor to achieve the quality of a project, since each of them have common responsibility for achieving the project quality. The study revealed that, sometime difference in their perception regarding the objective of project quality have become the causes of conflict. For example, the project owner expects project with best quality at lowest possible construction cost. The project designers try to give the best level of project quality to satisfy the owners' requirement at the specified project cost. Contrary, the contractors target to achieve quality as specified in the construction plans and specifications by investing minimum expenditure. Therefore, for any construction projects, if there is no proper quality definition and its' controlling system, problems and conflicts might occur between each party.

Chan and Tam, (2000) studied the factors affecting the quality of construction projects. Their study suggested 77 factors which can be grouped into 6 main categories i.e. project owner, project characteristic, project environment, project operation and project management.

Based on the past researches and findings it can be concluded that there are various factors affecting the quality of a construction projects. For the sake of simplicity of understanding and further study, they are classified into 5 major groups as shown in Figure 10 and are further discussed in the following paragraphs.

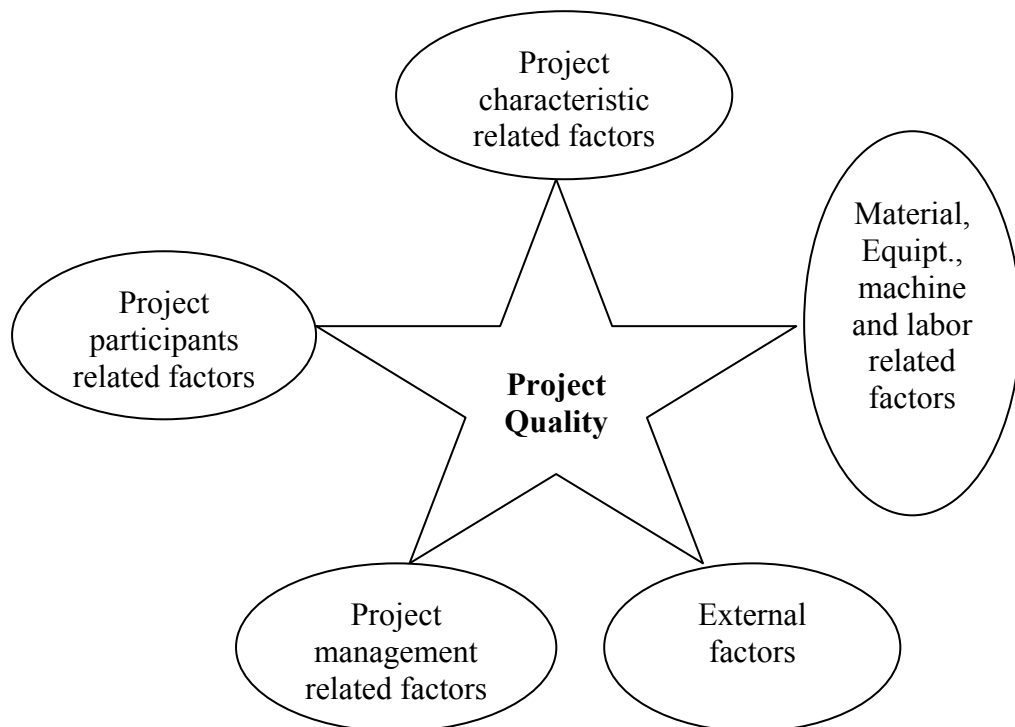


Figure 10 Major categories of the factors affecting quality of construction project

(i) Project participants related factors

They are the most significant factors that include the experience, knowledge, skill, roles, responsibilities and relationships between the main project participants that affect the project quality. They are summarized in Table 10.

Table 10 Summary of the project participants related factors

S. No.	Project participants	Related factors
1	Owner	- Knowledge and experience of the owner
2	Designer	- Skills and experience of the designer - Constructability and clarity of drawings - Responsibilities of the designer on construction phase
3	Project Manager	- Managerial skills of the project manager - Experience in managing and solving the problem - Leadership of the project manager - Collaborative and characteristic to contractor
4	Contractor and Sub-contractor	- Experience - Number of works (projects) in hand - The coordination and relation between contractor, sub-contractors and the supplier

(ii) Project management related factors

These include all management functions that affect the project quality as well as overall project performance and are summarized in Table 11.

(iii) Project characteristic related factors

These cover all factors that are directly related to the project or uniqueness of project i.e. project documents and project site etc. They are summarized in Table 12.

Table 11 Summary of the project management related factors

S. No.	Management function	Related factors
1	Planning	<ul style="list-style-type: none"> - Appropriate and reasonable planning - Use of appropriate construction techniques - On site planning integrated to other plan - Reasonable project duration - Availability of resources
2	Organizing	<ul style="list-style-type: none"> - Effective organization - Good documentation system
3	Monitoring and controlling	<ul style="list-style-type: none"> - Effectiveness of monitoring and feedback systems - Regular updating of plans - Good quality control system - Use of efficient construction management techniques - Effective conflicts resolving method
4	Communication	<ul style="list-style-type: none"> - Use of informal communication among project teams - Use of formal communication such as daily and weekly meeting
5	Safety and health	<ul style="list-style-type: none"> - Safety system and safety training program to project members

(iv) Material, equipment, machine and labor related factors

They are the physical and human resources put together to get the work item or product in any project. Hence these are the factors which directly affect the quality of each work items and ultimately the quality of a whole projects. They are presented in Table 13.

Table 12 Summary of the project characteristics related factors

S. No.	Project Characteristics	Related factors
1	Contract document	<ul style="list-style-type: none"> - Use of appropriate contract type - Well defined scope of works in the contract - Clarity of contract documents - Clarity of conflict resolution method specified in the contract documents - Clarity of terms of payment in contract documents
2	Project site	<ul style="list-style-type: none"> - Density of traffic that interrupts construction activities - The limitation of project site access - Availability of utilities

Table 13 Summary of the material, equipment, machine and labor related factors

S. No.	Resources	Related factors
1	Equipment and Machine	<ul style="list-style-type: none"> - Breakdown - Shortage - Level of user's skill - Productivity and efficiency - Late delivery - Controlling
2	Labor	<ul style="list-style-type: none"> - Lack of workers - Unqualified workforce - Low productivity of workers
3	Material	<ul style="list-style-type: none"> - Quality and availability in the market

Table 13 (Continued)

S. No.	Resources	Related factors
3	Material	- Shortage - Change in specifications - Late delivery - Late procurement

(v) External factors

Mega scaled construction projects are the long- term mission. They involve many organizations of government, state enterprise and private sectors having influence over the project. Hence, project performance and quality are also affected by external factors such as social environment and culture; government policy and regulation; economic and natural environment as summarized in Table 14.

Table 14 Summary of the external factors

S. No.	External factor	Related factors
1	Social environment	- Conflicts caused by the local people - Social and cultural difference
2	Economy, law and political environment	- Effects of inflation and exchange rates - Fluctuation of material, machine, and labor price - Government policies affecting construction industries - Prevailing law and politics about contract
3	Natural environment	- Risk from natural disasters i.e. flooding, and storm - Geological conditions of the project site

7. Spearman rank correlation coefficient

A correlation coefficient measures the extent to which two random variables are related. The correlation between two variables is defined only when they are both random. If the data come in the form of ranks and there will often not be a linear relationship between the two random variables. Further data are discrete rather than continuous and range for each variable is limited. In this case Pearson correlation coefficient is inappropriate and Spearman's rank correlation coefficient is used to calculate the degree to which two random variables are related.

Spearman's rank correlation coefficient is computed by first ranking the data on each variable from smallest to largest, then applying the formulae as follows,

$$\text{Spearman rank correlation coefficient } \gamma = 1 - \frac{6 \sum d^2}{(n^3 - n)}$$

Where,

d = difference between the ranks of each causes of delay; causes of cost overrun and factor affecting quality as opinioned by the two parties in pair

n = total number of records

Thus from the above equation if the ranks are same thus indicating perfect correlation, the correlation coefficient is 1. Similarly, if the ranks are just the opposite thus indicating perfect negative correlation, the correlation coefficient is -1. This indicates that the values of Spearman rank correlation coefficient ranges from maximum '+1' indicating perfect correlation; '0' indicating no correlation, to minimum '-1' indicating perfect negative correlation.

RESEARCH METHODOLOGY

1. Overview

Research methodology is the roadmap for the researchers to carry out the researches by following defined steps. It concerns on approaches and techniques to accomplish the research objective and logically explains how study was conducted. The research methodology for this study was designed accordingly for accomplishing the study objectives as explained in earlier chapter. This study employed an exploratory research methodology through literature review, field visit, discussions with the project personnel, project document study; and questionnaire survey. The stated research methods and techniques were developed in accordance with the study objectives. The type and number of samples were identified accordingly considering its suitability for the objectives and limitations of the study i.e. available time, resource and availability of the required data. Finally the data were analyzed by using appropriate statistical analysis techniques and Microsoft Excel programs.

Figure 11 shows the research methodology framework (RMF) adopted for this study. RMF shows the logical sequence of activities that the author carried out for conducting this study. As shown in Figure 11, the major steps followed for this study were objective identification, study design, data collection, data analysis, research findings and recommendations.

2. Identify problems, objectives and limitations of the study

This was the first phase of this study. The performance status of the completed projects as well as problems for achieving targeted project performance in the aspects of time, cost and quality; were identified by thoroughly reviewing literature and by studying the progress reports of the completed projects in Nepal. The objectives of this study was set as study and analyze the performance of ongoing mega scaled construction projects in Nepal and to find the actual difficulty to achieve it. The limitations and scope of the study were also defined based on the available resources,

time frame and purpose of this study; and possibility for accessing and collecting data.

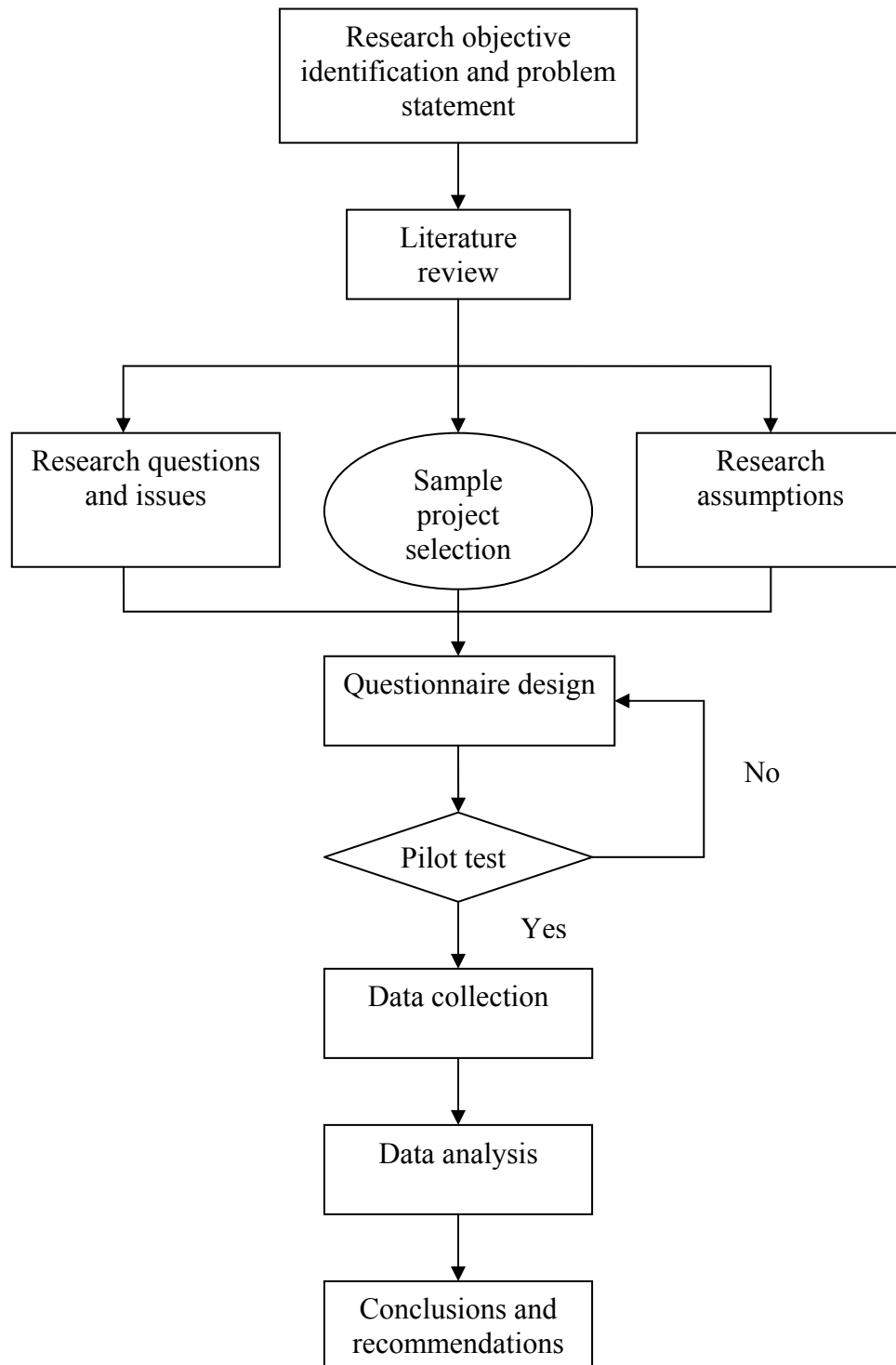


Figure 11 Research methodology framework (RMF)

3. Literature Review

Journals, books, magazines, research papers and proceedings on project performance especially focusing on delays, cost overruns and quality aspects were reviewed to familiarize with the theoretical part. Furthermore, performances of the completed big and mega scaled projects in Nepal and in different countries particularly in the aspects of time; cost and quality were also studied. These helped to identify the theoretical overview on the different aspects of delays and cost overruns and factors affecting the quality of construction projects. Similarly, these also helped to gain knowledge on performance of the completed projects as well as causes of delays and cost overruns and factors affecting the quality in construction projects in Nepal and other countries. Literature review formed the basis for preliminary questionnaire design and also gave an idea about the methods of data collection, analysis, presentation and interpretation for this type of studies.

4. Questionnaire development

Main objective of this study was to be accomplished with the help of questionnaire survey. Hence, questionnaire development phase was the most important, time taking and critical phase for this study. Steps followed for the questionnaire design are shown in Figure 12. This process started with thoroughly reviewing the past literatures on causes of delays, cost overrun and factors affecting the quality of construction works. Since, past study data were not available regarding the study on the performance of mega scaled projects in Nepal covering the aspect of time, cost and quality; hence, it was assumed that, the causes of delays and cost overruns and the factors affecting the quality performance in other developing and developed countries could also be applicable in the Nepalese context. However, those causes and factors needed to be verified in Nepalese condition because different countries have different level of development, technological advancement, external and internal conditions; hence, all causes and factors from literature review may or may not represent the present context of the Nepalese construction industry. Finally, all factors were collected, sorted, rephrased and organized to prepare the preliminary

questionnaire. Besides that, senior engineers, practitioners and project managers were also consulted informally to get an idea for questionnaire development.

To make the questionnaire suitable into the Nepalese conditions; they were pilot tested. Six experienced professionals in the Nepalese construction were involved for pilot testing. Among them, four were in executive positions of the sample projects; one was in senior management and policy making position and one was the academic personnel or professor in construction management. Their comments were very useful to prepare the final questionnaire.

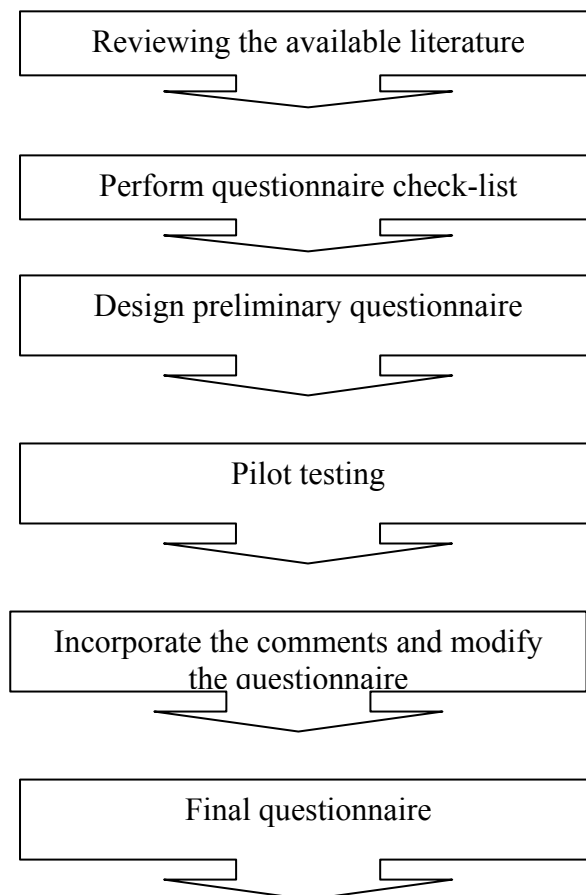


Figure 12 Framework for questionnaire design

Final questionnaire was divided in to two parts. The first part was prepared for collecting general information of the respondents i.e. name, name and address of the organization, designation, years of experience, address etc.

The second part was prepared for collecting the actual information required for this study. This was further divided in to three sub-parts for collecting respondent's view separately on the study issues as follows,

- (a) Causes of delay in mega scaled construction projects in Nepal (MSCPN).
- (b) Causes of cost overrun in MSCPN.
- (c) Factors affecting the quality of construction work in MSCPN

The first sub-part of the questionnaire was related to the causes of delays with 65 questions separated in 11 major delay categories. The Second sub-part was related to the causes of cost overrun and included 19 common questions. Similarly, the third sub-part was related to the factors affecting the quality of construction in MSCPN and included 35 questions separated in 5 major quality categories. Summary of the questionnaire is given in Figure 13.

At the end of each sub-part of the questionnaire, spaces were provided for adding more about the causes of delays, cost overrun and factors affecting quality in MSCPN which in the respondents own opinion were vital and not included in the questionnaire. Sample questionnaire is shown in Table 15. The details of questionnaire are given in Appendix A.

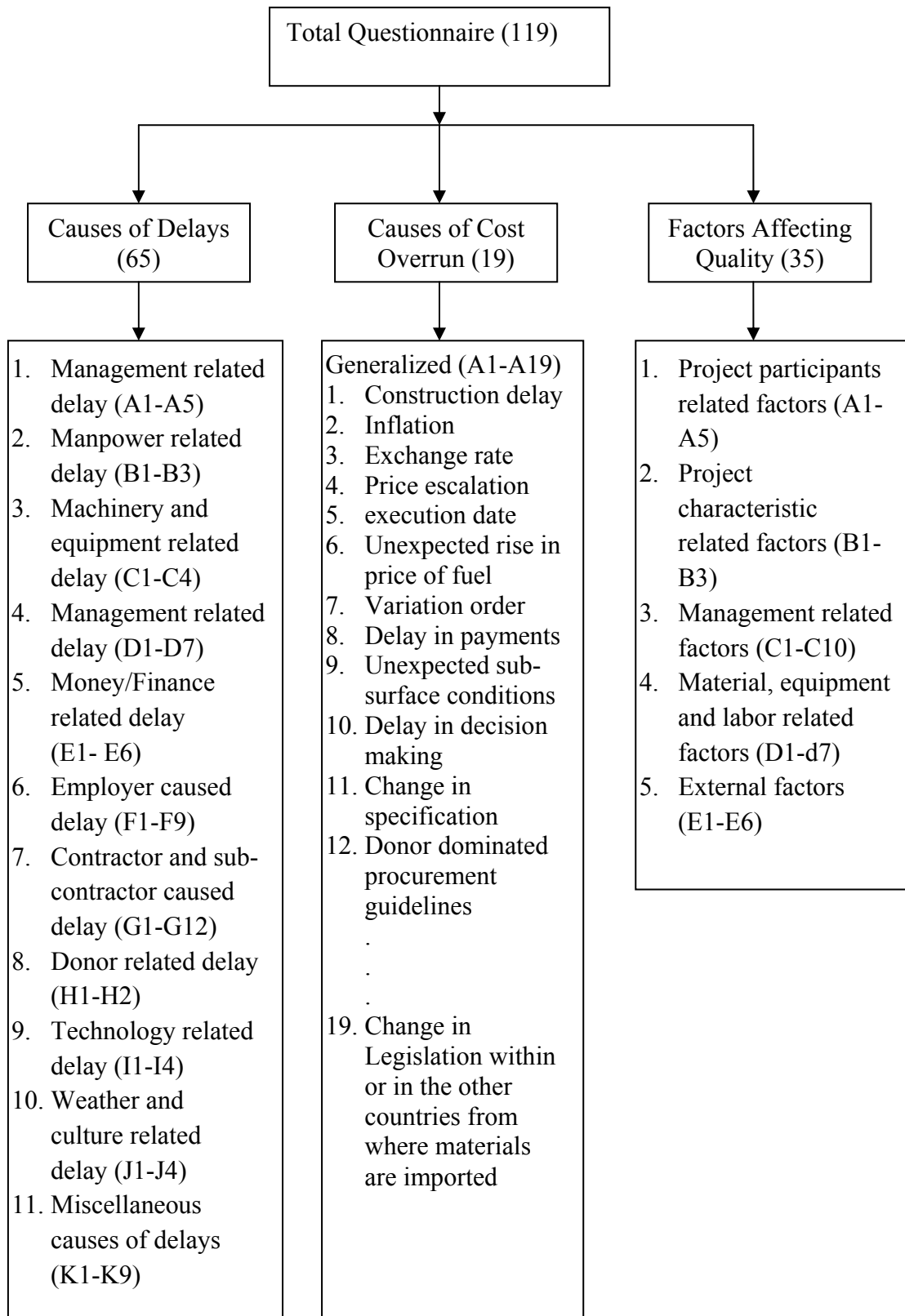


Figure 13 Summary of the questionnaire

Table 15 Sample questionnaire

S. No	Causes of delay	Level of impact ¹					Frequency of occurrence ²				
		1	2	3	4	5	1	2	3	4	5
K	MICELLANEOUS CAUSES OF DELAY										
1	Unexpected underground conditions										
2	Social and political conflicts										
3	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.										
4	Various demand raised by the local communities, different NGOs and INGOS.										

Symbol: ¹1 = Very less, 2 = Little, 3 = Moderate; 4 = Great; 5 = Extreme

²1= Very low; 2 = Low; 3 = Medium; 4 = Often; 5 = Very often

5. Sample project selection

This was also a critical task for this study. Following were the criteria for selection of sample project to meet the study objective.

- (a) Project representing the major infrastructure sector in Nepal
- (b) Projects with diversification in different aspects i.e. nature of construction, location, stage of construction, executing agency, project parties involved, donor involved and construction related issues etc.
- (c) Accessible in location. This is due to time limitation and resources available for data collection
- (d) Availability of required data

Summary of the sample projects selected for this study are presented in Table 16 .

Table 16 Summary of the sample projects

S. No.	Name of the project	Location (District)	Project cost Billion (Nrs.)	Status
1.	Middle Marshyangdi Hydropower Project Capacity : 69 MW	Lamjung	Original: 14.00 Revised: 28.00 (Base cost: 2006)	Recently complete
2.	Sikta Irrigation Project Command area: 36000 ha.	Banke	7.45 (Base cost: 2003)	Ongoing
3.	Melamchi Water Supply Project. Capacity: 5000 liter/sec	Kathmandu	Original: 40.83 Revised: 26.72 (Base cost 2006)	Ongoing
4.	Banepa-Sindhuli-Bardibas Road Project Length: 158 Km	Kabrepalanchowk, Ramechap and Sindhuli	Japanese Yen 26 Billion	Ongoing

Note: 1 US \$ = Nrs. 80.00

Source: Project reports (Year 2008)

6. Data collection

Data collection was done in order to collect the information needed for this study. Depending on the nature of information required, there are several methods of data collection. For this study, two methods were adopted. They were as follows,

(a) Questionnaire survey

(b) Miscellaneous method i.e. construction site visit, project document and project progress report study; discussion with the project parties etc.

6.1 Questionnaire survey

Questionnaire survey was conducted to quantitatively confirm the list of delay causes, causes of cost overrun and factors affecting quality as prepared during questionnaire development. Past experiences have shown that, questionnaire surveys conducted by post have problems of timely gathering and done through e-mail always have very low response rate. To avoid these problems in this study, questionnaires were distributed and collected by direct or person to person approach. This method of direct approach was costly and time taking but more reliable qualitatively and quantitatively. For this purpose firstly, shortlists of the potential respondents and their general (academic and professional) background were gathered from the project head office. Final selection of the respondents was done based on the minimum criteria as stated earlier and their availability at the project site during data collection period. A snow balling technique or “finding the potential respondents from the existing respondents” was also used to select some respondents. Different respondents selected for this study were project managers, project engineers, site engineers representing the owners, consultants or designers and contractors of the sample projects.

Before distributing the questionnaires, each respondent was given a brief introduction about the objective, scope, methodology and importance of final outcome of this study. They were further clarified in shortly, about the structure of the questionnaire and what are the basis for ranking each cause and factor in the aspect of its’ “Level of impact” and “Frequency of occurrence”. Furthermore, a brief introductory request made by the author on the front page of the questionnaire also helped to clarify about these aspects. The purpose of these activities was to introduce the respondents about this study, questionnaire structure, and importance of their correct ranking; and help them to respond correctly in minimum time. This was necessary because all respondents were the professional personnel working in the key posts of the mega scaled project hence they always have shortage of time.

Altogether, 48 numbers (12 in each sample project) of questionnaire were distributed and 42 numbers (87.5%) of them were duly collected. The overall as well

as project wise response rate was found satisfactory. Details of the respondents are given in Appendix Table B1. Table 17 shows the summary of the respondents.

Table 17 Academic and professional background of the respondents

S. No.	Description	Respondent		
		Number	Percentage	
1.	Experience (in years)	< 10	3	7%
		10 - 20	19	45%
		20 -30	13	31%
		> 30	7	17%
2.	Education	- BSC. Eng.	11	26%
		- MSC Eng.	31	74%
3.	Project parties	- Owner	18	43%
		- Consultant	13	31%
		- Contractor	11	26%
4.	Project type	- Irrigation	12	28%
		- Water supply	9	22%
		- Hydro power	11	26%
		- Road	10	24%

6.2 Project site visit and project document study

In order to get an idea on schedule, cost and quality performance of the MSCPN and it's ongoing components; and to collect other relevant information, the author visited the head office, project site office and construction site. He observed the ongoing construction activities, interacted with the different project parties and also collected photographs and progress reports of the sample projects. Information collected during this period was found very useful to analyze the project performance in different aspects and to get knowledge about the projects from different perspectives.

7. Data analysis

7.1 Analysis of the project performance.

As stated in the objectives of this study, performances of the ongoing mega scaled construction projects in Nepal were evaluated briefly in the aspect of time, cost and quality as explained in the following paragraphs.

7.1.1 Analysis of schedule performance (SP) and cost performance (CP)

Time index (TI) and cost index (CI) were used to measure the SP and CP of the sample projects respectively and are expressed as,

$$\text{Time Index (TI)} = \frac{AD}{SD} \times 100\% \quad (1)$$

$$\text{Cost Index (CI)} = \frac{AC}{EC} \times 100\% \quad (2)$$

Where,

AD = Actual duration; SD = Scheduled duration

AC = Actual cost; EC = Estimated cost

7.1.2 Analysis of the quality performance

Quality performances of the sample project were measured by objectively judging and measuring the “quality in construction process” and “quality in constructed product”. Different aspects considered for objectively measuring the quality in construction process were as follows,

- (i) Quality control (QC)
- (ii) Quality assurance (QA)
- (iii) Quality management (QM)
- (iv) Quality system (QS)

These quality aspects were considered by ISO 9000 for certifying the quality in construction process. Similarly, different quality aspects considered for measuring the quality of constructed product were as follows,

- (i) Workmanship for finishing works
- (ii) Technical quality for structural works
- (iii) Functional quality for system works

These quality aspects were considered in detail by CONQUAS for measuring the quality of constructed product.

Since this study was only focused on brief and rapid assessment of the overall quality performance of MSP based on the available data and within the limited study time; detail process as used by ISO 9000 and CONQUES were not adopted for this study.

The existence of above mentioned quality aspects in “construction process” as well as “constructed product or completed work” in the sample projects were evaluated by ranking in the scale from 1-5 as follows,

1 = poor; 2 = fair; 3 = good; 4= great and 5 = excellent

This ranking was based on the authors’ fair judgment which was further based on the study of available project documents i.e. contract document, specification, drawings, quality reports, monthly and yearly progress reports; discussions with the project personnel; site observations of the construction process and constructed works during project site visit etc.

Details of the calculation of “quality performance of construction process” and “quality performance of constructed product” for the each sample projects is given in Appendix Table C1

Since, “construction process” and “constructed product” are equally important for the overall quality performance in mega scaled construction projects, equal weightage was given to the “quality of construction process” and “quality of constructed product” to evaluate the overall quality performance index (QPI) of each sample project. Quality performance of the each sample projects were evaluated and discussed individually based on their QPI value.

7.2 Analysis of the causes of delay, causes of cost overrun and factors affecting quality.

7.2.1 Analysis of the overall results

The relative importance index (RII) was used to calculate the degree of importance for each cause of delay, cause of cost overrun and factor affecting quality. As shown in equation (3), RII is simply a weighted average of scores given by the respondents on each cause or factor under the same category i.e. delay, cost overrun and quality; based on their level of impact for causing those category to happen.

Chan and Kumaraswamy, (1997) stated that, RII method is best suited to determine the relative importance of the each cause or factor from the overall list of causes or factors. RII is expressed by following equation,

$$RII = \frac{\sum w}{A \times N} \quad (3)$$

Equation (3) was also used to calculate the Level of impact index (LOI) and Frequency of occurrence index (FOI) of the each causes of delay; causes of cost overrun; and factor affecting quality.

Thus,

$$LOI = \frac{\sum w}{A \times N} \quad (4)$$

$$FOI = \frac{\sum w}{AxN} \quad (5)$$

Similarly, mean value, standard deviation of each causes of delay; causes of cost overrun; and factors affecting quality were calculated using usual statistical formulae as follows,

$$\bar{x} = \frac{\sum f.w}{N} \quad (6)$$

$$S.D = \sqrt{\frac{\sum (w - \bar{x})^2}{N - 1}} \quad (7)$$

Where,

w = weighing given for level of impact and frequency of occurrence to each causes of delay; causes of cost overrun and factor affecting quality by the respondents and ranges from 1 to 5.

A = highest weight of level of impact and frequency of occurrence for each cause and factor i.e. '5';

\bar{x} = mean value

SD = standard deviation

f = frequency

N = total number of respondents

Level of impact and Frequency of occurrence index (LIFI) was calculated by considering the combined effects of the "level of impact" and "frequency of occurrence" of each causes of delay; causes of cost overrun and factors affecting quality, to determine their overall relative importance in the mega scaled projects. LIFI is expressed by following equation,

$$LIFI = \frac{\sum \sqrt{(l_i \times f_i)}}{A \times N} \quad (7)$$

Where,

l_i = ' w ' value for level of impact

f_i = ' w ' value for frequency of occurrence

7.2.2 Analysis of the results by project parties

In order to analysis the causes of delays and cost overrun; and the factors affecting quality from the point of view of the project parties i.e. owner, consultant and contractor independently, the data or questionnaire responses of the project parties were analyzed separately. The LOI, FOI and LIFI for this purpose were also calculated; they were analyzed separately and each causes of delay; causes of cost overrun and factor affecting the quality were ranked separately for the each project parties adopting the same procedure and criteria as described in 7.2.1. This analysis also facilitated for the correlation tests to determine the degree of agreement of their opinion between the each project party.

7.2.2.1 Correlation tests

Correlation analysis was performed to describe the strength and direction of the linear relationship between the different groups of respondents or project parties. Alwi and Hampson (2003); Assaf *et al.* (1995) and Razek *et al.* (2008) suggested that, Spearman rank correlation coefficient can be used to quantitatively measure the degree of agreement or degree of correlation of the opinions between the parties and is calculated by using the following equation.

$$\text{Spearman rank correlation coefficient } 'r_s' = 1 - \frac{6 \sum d^2}{(n^3 - n)} \quad (8)$$

Where,

d = difference between the ranks of each causes of delay; causes of cost overrun and factor affecting quality as opinioned by the two parties in pair

n = total number of records

The values of Spearman rank correlation coefficient ranges from maximum (+1) indicating perfect correlation, (0) indicating no correlation, to minimum (-1) indicating perfect negative correlation. Table 18 shows

the guidelines for interpreting the strength of correlations.

Table 18 Guidelines for correlation interpretation

Value of ‘γ’	Strength of correlation
0.10 to 0.29 or -0.10 to -0.29	Small
0.30 to 0.49 or – 0.30 to -0.49	Medium
0.50 to 1.0 or -0.50 to -1	Large

Since three types of respondents i.e. owners, consultants and contractors, participated in the study; hence, three pairs of respondents i.e. owners and consultants; owners and contractors; and consultants and contractors; were made to compare the strength of correlation in their opinions.

7.2.3 Analysis of the results by project types

Four sample projects selected for this study were significantly different in their nature of work, project location, financing characteristic and many other project characteristics. Hence, to analyze the causes of delay, causes of cost overrun and factor affecting quality; from the point view of the different project types, all data or questionnaire response were separated in to four different project type as, irrigation project, hydro power project, water supply project and road project. The LOI, FOI and LIFI for this purpose were also calculated; they were analyzed separately and each causes of delay; causes of cost overrun and factor affecting quality were ranked separately for the each project types adopting the same procedure and criteria as described in 7.2.1.

RESULTS AND DISCUSSIONS

1. Project performance

Performance of the sample projects were studied and evaluated in the aspects of three major parameters namely time or schedule performance; cost or cost performance; and quality or quality performance. In this context, Table 19 shows the existing status of the sample projects considered for this study.

Table 19 Status of the sample projects

S. No.	Name of the sample project	Name of component	Status
1.	Sikta Irrigation Project (SIP)	Head works	Under construction
2.	Melamchi Water Supply Project (MWSP)	ADIT access road for tunnel	Completed
3.	Bardibas – Sindhuli – Banepa Road Project (BSBRP)	Section I Section II Section IV	Completed Under construction Completed
4.	Middle Marshyangdi Hydro Electric Project (MMHEP)	All works or Project	Completed

Table 19 shows that, three sample projects (SIP, MWSP and BSBRP) are ongoing and MMHEP is completed. Hence, only completed and under construction components of the SIP, MWSP and BSBRP; and all works of the MMHEP were considered for the performance study and evaluation.

1.1 Schedule performance (SP)

Schedule performance (SP) of the ongoing and completed components of SIP, MWSP and BSBRP; and all works of the MMHEP are given in Table 20. From Table 20, time index (TI) values of the sample projects are ranging from 114.30% to

162.13% indicate that SP of these projects are not satisfactory and delay is predominant in all sample projects. Particularly, recently completed Middle Marshyangdi Hydro Power Project (MMHEP) with planned project duration 45 months showed very poor SP with TI value 162.13%, indicating project delay for 36 months. Furthermore, all ongoing sample projects SIP, MWSP and BSBRP have multiple components. It must be noted that, all mega scaled sample projects have multiple components; and further that, successor components are linked with their predecessor components in every aspect. Hence, delayed completion of the successor components of ongoing sample projects obviously will cause delay in implementation of the predecessor components and ultimately the project delay.

Table 20 Schedule performance of the sample projects

Name of project	Name of component	Scheduled duration (days)	Actual duration (days)	Time index (TI) (%)
SIP	Diversion head works	630	810	114.30
MWSP	Sindhu and Gyalthum ADIT access road for tunnel	650	850	138.21
BSBRP	Section-I	840	840	100.00
	Section -II	840	1200	142.86
	Section -IV	1770	2460	138.95
MMHEP	All works	1730	2805	162.13

Source: Progress reports of SIP, MWSP, BSBRP and MMHEP (Year 2008)

1.2 Cost performance (CP)

Cost performance (CP) of the ongoing and completed components of SIP, MWSP and BSBRP; and all works of the MMHEP are given in Table 21. Cost index (CI) values in Table 21 shows that, Section I and II of BSBRP have good CP with CI values 100%. CI values of the ongoing and completed components of SIP, MWSP

Table 21 Cost performance of the sample projects

Name of project	Name of component	Budgeted cost (Million)	Actual cost (Million)	Cost index (CI) (%)
SIP	Diversion head works	Nrs. 1000.00	Nrs. 1022.35	102.24
MWSP	Sindhu - Gyalthum ADIT access road for tunnel	Nrs. 958.60	Nrs. 1040.14	108.51
BSBRP	Section-I	J.Y 1864.00	J.Y 1864.00	100.00
	Section -II	J.Y 7231.00	J.Y 7231.00	100.00
	Section -IV	J.Y 4312.00	J.Y 4703.00	109.07
MMHEP	All works	Euro 174.00	Euro 273.46	157.16

Source: Progress reports of SIP, MWSP, BSBRP and MMHEP (Year 2008)

and BSBRP (Section IV) indicated that, these projects have fair range of CP. But MMHEP with CI value 157.16% showed very poor cost performance. It must be noted that, for SIP, MWSP and BSBRP; CI of only completed and ongoing components were calculated. All these projects have multiple components and total project cost is the sum of the cost of each components. Hence, even a small cost overrun in each component may cause cost overrun for the overall project. Hence if CP of SIP, MWSP and BSBRP are not carefully monitored in future this may ultimately cause cost overrun in these projects.

1.3 Relation between schedule performance and cost performance

From Table 20 and Table 21 it can be concluded that, MMHEP have very poor schedule as well as cost performance. This project is considered as the most delayed project having highest cost in terms of per unit power production in the history of hydropower development in Nepal. For example average cost of hydropower project for Nepal is US \$ 2500 per kilowatt of installed capacity, but the

cost of MMHEP was US \$ 5000 per kilowatt of its installed capacity which is double than the average cost.

One component of MWSP have poor schedule performance with TI value 138.21% and fair cost performance CI value 108.51. This result seems to be controversial. In this regard, it must be noted that, due to contract delay in this component of MWSP, the contractor has notified Nrs. 150 million as claims and this issue is under amicable settlement. This claim amount has not been finalized yet and hence not included in the final cost; and hence CI value seems to be less. Section I of BSBRP has both TI and CI value 100%. This result seems to be obvious. But the section II and section III of the same project have poor TI values i.e. 142.86% and 138.95% respectively; but have good (100%) and fair (109.07%) CI values respectively. Actually, this project adopted lump sum price contract for all its component hence any cost overrun due to delay is the responsibility of the contractor. As reported by project office, small increment in CI value of the section IV of BSBRP was due to addition in scope of works for this section to reconstruct the flood damaged portion of road at 15 locations. One component of the SIP have fair TI value 114.30% with almost good CI value 102.24%. It was noticed from the project that, contractor has issued some letters notifying intention to claim for delay due to various causes. It can be expected that, contractor claim may slightly increase the actual cost and also push the CI value to the fair level.

All these results indicated that schedule performance as indicated by TI and cost performance as indicated by CI almost have directly proportional relationship with each other except for the lump sum price contract.

1.4 Quality performance

Quality performance (QP) of the ongoing and completed components of the SIP, MWSP and BSBRP; and all works of the MMHEP are given in Table 22. The details of the calculations are given in Appendix Table C1

Table 22 Quality performance of the sample projects

Name of Project	Quality performance of construction Process (%) (A)	Quality performance of constructed product (%) (B)	Quality performance index (QPI) (%) C = (A+B)/2
SIP	76	80	78
MWSP	66	70	68
BSBRP	86	90	88
MMHEP	90	100	95

Note: Excellent = $QPI \geq 90\%$; Very good = $80\% \leq QPI < 90\%$

Good = $70 \leq QPI < 80\%$; Fair = $60 \leq QPI < 70\%$

QPI values in Table 24 indicate that, MMHEP has excellent quality performance with QPI value 95%. This project has excellent quality performance in construction process as well as constructed product. During the field visit of the author, one slogan noticed within the MMHEP was “no compromise for quality at any cost”. Favorable condition for this project was that, all major works are located within the close range of distance; hence, easy to implement, maintain and monitor the different activities regarding the quality.

From Table 24, it is apparent that, BSBRP have very good quality performance with QPI value 88%. This value was slightly less than the QPI value for the MMHEP. Actually BSBRP also have same value of quality performance of the construction process as MMHEP, but have less value for the quality performance of the constructed product. In this context, it must be noted that, all works in the road project were scattered over the long range of distance and hence it was difficult to implement, maintain and monitor different activities regarding the quality aspects. Particularly, workmanship of works in road project cannot be achieved perfectly due to scattered nature of works and involvement of number of sub-contractors.

Table 24 further shows that, SIP has good QP with QPI value 78%. It was observed that, in SIP much focus was given to the quality of product rather than quality of process. Besides that, workmanship quality was found less in the product of SIP as compared to the MMHEP and BSBRP. Workmanship quality was attributed to the contractor. Actually MMHEP, BSBRP and SIP selected under this study involved internationally recognized German, Japanese and Chinese contractors respectively. But it must be noted that, Chinese contractor involved in the SIP have to improve their workmanship quality as compared to the other two. Furthermore, SIP was the first mega scaled project with full involvement of own human resources from Department of Irrigation (DOI) to plan, design and execute the project independently. By working within the bureaucratic environment and facility; whatever achieved in SIP in the aspects of its quality performance was a matter of proud for DOI. But there still have a lot to be improved in the quality aspects particularly in the “quality of process” to achieve better quality performance in the future.

As shown in Table 24, MWSP has fair quality performance with QPI value 68%. This evaluation is based on the completed components of ADIT access road of MWSP which was executed by the Nepalese contractor under the supervision of Nepalese consultant. Completed component represented very small or about 1/10 parts of the total scope of MWSP. In past, MWSP suffered lot due donor related, management related, political, local community related and other problems. All these problems adversely affected for achieving quality in the “construction process” as well as achieving “quality of the constructed product”. Fortunately, critical components of this project i.e. tunnel and head works; and water treatment plant have not started yet. Hence by achieving excellent quality in those critical components quality performance of the overall projects can be improved in future.

2. Causes of delays, Causes of cost overrun and Factors affecting the quality

2.1 Causes of delays

2.1.1 Overall ranking of causes of delays

The overall ranking of the delay causes were done by considering their combined effect of level of impact and frequency of occurrence in all sample projects. The result of overall ranking of all 65 delay causes is given in Appendix Table D1; among them summary of top ten delay causes are shown in Table 23.

From Table 23, “Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions” and “various demands raised by the local communities, NGOs and INGOs” have been identified as the most severe and top two causes of delay in mega scaled construction projects in Nepal (MSCPN). After the restoration of multiparty democracy in 1990, major political parties expanded their trade union organization in all economic and business sectors. During this period thousands of NGOs and hundreds of INGOs were also emerged in the name of civil society. Further more, Nepal entered in a decade long social and political conflicts from 1995-2005; this has been followed by political transition period and continued to date. During this period, above mentioned events has been frequently occurring under the umbrella of trade unions, labor groups, NGOs, INGOs and local communities. Table 24 shows the records of incidents and disturbances happened in MMHEP between periods May 15, 2001 – Feb 1, 2007; which shows that, these delay causes have been prevalent in mega scaled projects (MSP) in Nepal and adversely affected the MSP activities.

As shown in Table 23, “social and political conflicts” also have significant effect for the project delays in MSCPN. As stated earlier, Nepal entered in a decade long social and political conflicts from 1995-2005 in the name of Maoist insurgency. Recorded facts in Table 24 shows that, MSP activities were seriously affected directly and indirectly during this period. Based on the project record and

Table 23 Top ten delay causes in mega scaled construction projects in Nepal (MSCPN)

Factor Code	Delay cause	Category	LIFI	LIFI Rank	LOI	FOI
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	Miscellaneous	0.737	1	0.743	0.700
K.7	Various demand raised by the local communities, different NGOs and INGOS	Miscellaneous	0.724	2	0.662	0.714
A.5	Shortage of Fuel, Lubricants and construction material	Miscellaneous	0.692	3	0.804	0.605
F.4	Long time taken to make decision Shortage	Employer	0.692	4	0.732	0.657
K.9	Social and political conflict	Miscellaneous	0.653	5	0.691	0.643
F.1	Getting permits and approval takes long time	Employer	0.627	6	0.684	0.600
K.8	Influence from the political sector and other groups	Miscellaneous	0.625	7	0.662	0.614
G.11	Adhoc management adopted by majority of the contractors and sub- contractors	Contractor / Sub-contractor	0.603	8	0.639	0.576
G.10	In-effective project planning and scheduling	Contractor / Sub-contractor	0.598	9	0.685	0.543
D.5	Lack of co-ordination due to involvement of many agencies	Management	0.586	10	0.635	0.576

discussion with the project personnel it was noticed that, security threats for the

project personnel; fear created by asking huge financial donations; restriction on the use of blasting materials and night shift working; stoppage of work due to gun firing; nation wide strikes and blockades; difficulty in transportation of the construction materials and equipment; were the frequently occurring incidents and disturbances that caused frequent stoppage of project activities and ultimately the project delay.

Table 24 Records of incidents/disturbances in Middle Marshyangdi Hydro Electric Project between periods May 15, 2001 – Feb 1, 2007

S.No	Causes of Incidents/Disturbances	No ¹
1	Nation wide closure (Nepal bandha)	32
2	Disturbances/stoppage of project works/activities by local communities	106
3	Threats to management by locals	3
4	State of emergency	331
5	Explosives not available due to no security escorts	10
6	Denial of night shift working	107
7	Curfew during night (no night shift work)	629
8	Restriction on use of explosives	559
9	Occurrence of gunfire	47
10	Arson attack by Maoist	48
11	Transport strike in India	8
12	Works suspended by contractor	38
13	Suspension of works involving explosives	53
14	Transport and economic blockage	30
15	Threats from Maoists	126
16	Labor strike	8
17	No communication due to state of emergency	8

Symbol:¹ Total number of days that particular incidents/disturbances occurred in MMHEP during the record period

Source: MMHEP (Year 2008)

Further “long time taken to make decision” and “getting permits and approval takes long time” have been identified as the critical delay causes in MSCPN attributed to the employer oneself who has to share the most parts of the negative impacts due to delays. Above delay causes disclosed the overall problems of decision making in Nepalese administration at the policy level as well as decision making problems at the project level. Nepalese administration has been predominated by adhoc beaurocratic system influenced by politics. This has been further weakened by decade long socio-political conflicts and ongoing unstable political transition period.

In fact, contract related decision making procedures have been linked by governments own financial regulations and directives; donors’ mandatory procurement guidelines; and other prevailing rules and regulations. Some of them are impractical and also controversial. Due to this, contract related decisions always require dozens of black & white formalities; piles of paper work and is time taking. In past, some contractual decisions related to the mega scaled project became controversial. As a result, decision makers have become extra attentive and reluctant to make the contractual decisions particularly involving financial expenditure i.e. approval of contract, change in scope of works, approval of variation etc.

Furthermore, Nepal has been depended on bilateral and multilateral donors for financing mega scaled projects. Donors always have their own conditions and procurement guidelines tied up with their loan and grant. For example, donors have conditions like, their approval or concurrence or no objection letters are required for the major and sometimes even for the minor contractual decisions. They also impose restriction on employing consultants and contractors from other countries except they specified and sometimes also have instructions for the use of particular brand of construction materials, equipment and machinery. These mandatory conditions and guidelines imposed by the donors also make the contractual decision tedious, and time taking.

Shortage of fuels, lubricants and construction materials has been noticed as the common problem in the Nepalese construction industries since last half

decade. Actually, Nepal has its own production of major construction materials i.e. cements and reinforcements but this is not enough to fulfill the national demand. Hence, deficit quantities have to be imported from India and other countries. Besides that, Nepal has no production of fuel and lubricants and they are solely imported from India. Since Nepal has land locked topography, all imported materials are brought in Nepal via. India, after traveling long road distances. Due to this facts, change in price of construction materials and fuels and any shortage of construction materials in the international markets; change in export legislation in other countries and any kind of disturbances in exporting countries; always interrupts for the smooth supply of construction materials in Nepal. Besides that, frequently occurring strikes, road blockades, economic blockades, transport strikes and other incidences, as explained earlier also caused problem for the smooth supply of fuels, lubricants and construction materials.

As shown in Table 23, “influence from the political sector and other groups” has been also noticed as remarkable cause of project delay in MSCPN. In every country politics and mega project always have direct relationships. Bigger the scale of project, more the political influences are. In Nepal, there have been numerous evidences of influence from the politician and different unseen mega project mafia causing project delay. They influence the mega project specifically for the selection of project consultants and contractors; selection of project location, project type, technology and materials to be used; untimely and frequent change of project manager and project personnel during project execution; recruiting their followers as project employee; and the use of project resources for their own purpose. All these influences always impart extra burden to the project and project management team; the contractor; and ultimately cause project delay.

Delay causes in MSCPN namely “ad hoc management adopted by majority of the contractors and sub-contractors” and “in-effective project planning and scheduling” were attributed to the contractors and sub-contractors who are the main project party responsible for the actual execution of project works. It was noticed that, in MMHEP, SIP and BSBRP; foreign contractors were working as the

principal contractor; and in MWSP, Nepalese joint venture firm was working as the principal contractor. All principal contractors nominate Nepalese construction firms as their sub-contractors. During the field visit, the authors noticed that, majority of the principle contractors and all sub-contractors of these projects were using traditional and management. None of these projects have been found using planning and scheduling software for planning, scheduling, tracking and reporting of the project activities. BSBRP, SIP and MWSP have been found using simple bar chart for planning; and time vs. cumulative cost or cumulative work curve for monitoring the works under their contract. In MMHEP, the contractor has been using primavera project planner only for the purpose of justifying their claims for delay. Principal contractor's of the MMHEP and MWSP were not found fully committed for the timely completion of the works due to the belief that they can earn more benefit by additional claims for compensable delay rather than timely completion of the project. Road project was exception due to adoption of lump sum price contract with no extra claims.

As shown in Table 23, "lack of co-ordination due to involvement of many agencies" was also noticed as a critical cause of delay in MSCPN with 10th rank. In practice, MSP require involvement of many agencies at project level, departmental level and ministerial level for making different project related decisions. At project level, decisions are related to the day to day project execution; maintaining security inside the project area; use of explosives; acquisition of land and solving resettlement and compensation issues; and solving social and political problems etc. At departmental level, decisions are related to the approval for felling trees; borrow of construction materials; use of construction equipment and labor inside the forest, wild life reserves and national parks areas. The decisions are also related to the approval of EIA report and to implement the environmental impact mitigation plan. At ministerial level, decisions are related to the project approval; making financial arrangement; allocating budget for the project; and solving major contract related issues. In reality, due to absence of modern administrative procedure as described earlier, effective co-ordination between these agencies for promptly solving contract related problems is always lacking and caused project delay.

2.1.2 Ranking of the delay causes based on their level of impact and frequency of occurrence

Ranking of the delay causes based on their level of impact on the MSCPN are given in Appendix Table D2. Similarly, ranking of delay causes based on their frequency of occurrence in MSCPN are given in Appendix Table D3. Among them, top ten delay causes based on their level of impact and frequency of occurrence are shown in Table 25 and Table 26 respectively.

Table 25 shows that, “shortage of fuel, lubricants and construction materials” have the most serious impact for the project delay in MSCPN. This was because construction activities have to be stopped, if there is shortage of these materials. This has direct impact for the project delay hence ranked 1st in terms of its’ LOI. Further more, “Problems (strike, blockade and obstructions) caused by different labor group and trade unions” and “various demands raised by the local communities, NGOs and INGOs” are noticed as the 2nd and 3rd ranked delay cause because most of the time these are the reasons for stoppage of work as shown in Table 24 earlier. Besides that, “long time taken to make decision” and “in-effective project planning and scheduling”, also have indirect impact for the project delay, hence ranked 4th and 7th by the respondents. Above stated six delay causes are also included in the overall delay cause and explained earlier in 2.1.1.

Cost overrun is also prevalent in Nepalese mega scaled projects. As stated earlier, Nepal is dependent on bilateral or multilateral donor to finance MSCPN. Due to unexpected cost overrun, sometimes agreed fund between the owner and the donor is not enough to cover the project cost. In this situation, most of the time it takes long time to negotiate with the same donor or find the new donor to manage for the deficit fund and hence caused project delay. For example, initial project cost of the MMHEP was 174 million Euro in 1999, accordingly fund was arranged jointly by Nepal Electricity Authority (27.39%) and donation from the German Government (72.61%). Project construction work started on mid of 2001. Due to various reasons including delay, project cost reached 273.40 million Euros in

2006 and it took time to arrange for the deficit fund. The project activities cannot run smoothly due to lack of fund and ultimately caused project delay.

Table 25 Top ten delay causes in MSCPN based on their level of impact

Factor Code	Causes of delays	Category	LOI	LOI Rank	Mean and SD
A.5	Shortage of Fuel, Lubricants and construction material	Miscellaneous	0.790	1	3.952 ± 0.986
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	Miscellaneous	0.776	2	3.880 ± 1.109
K.7	Various demand raised by the local communities, different NGOs and INGOS	Miscellaneous	0.743	3	3.714 ± 0.995
F.4	Long time taken to make decision	Management	0.724	4	3.619 ± 0.962
E.1	Arranging financial source for the project takes long time.	Finance	0.719	5	3.595 ± 1.340
E.4	Contractor's non workable low bidding rate	Finance	0.700	6	3.500 ± 1.274
G.10	In-effective project planning and scheduling	Contractor/ sub-contractor	0.695	7	3.476 ± 1.273
K.1	Problems of land acquisition, resettlement, clearance and EIA issues.	Miscellaneous	0.690	8	3.452 ± 1.109
F.6	Late approval of variation	Employer	0.690	9	3.453 ± 1.194
K.9	Social and political conflict	Miscellaneous	0.686	10	3.429 ± 1.107

“Contractor’s non workable low bidding rate” of about 48% below the estimated price in Sindhu–Gyalthum ADIT access road of MWSP was the major cause of delay in that particular component which ultimately caused the whole project delay of MWSP. Unexpected low bidding rate further associated with the inflation always demotivates the contractor to carry out the work in schedule.

Since past one decade, problems of land acquisition, resettlement, and EIA issues have become the burning issue for mega scaled project implementation even in developing countries. In Nepal, there has been noticed an increasing trend for demanding very high price for project acquired land and asking number of local level development works as compensation. There have been noticed frequent events of obstruction in the MSP activities for settlement and environmental issues in the name of civil society. All these sorts of activities also caused project delay.

Almost all MSP have variation order. Delay in issuing the variation order will delay for the execution of the additional works necessary for the timely completion of the project and ultimately caused the project delay.

Table 26 shows the frequently occurring top ten causes of delay. Five most frequently occurring delay causes with FOI rank 1st, 2nd, 4th, 5th and 6th in Table 26 were attributed to the unstable social and political conditions prevailing in the country since 1995, and already explained earlier.

From Table 26, “long time taken to make decision” (ranked 3rd) and “getting permits and approval takes long time” (ranked 7th) in FOI were also noticed as frequently occurring problems in MSCPN causing project delay. These were attributed to the traditional and adhoc beaurocratic system prevailing at policy level as well as at the project level and explained earlier. Contractors and sub-contractors are the main parties responsible for the day to day execution of the construction activities. The level of management knowledge they have and they use in practice directly affects the production and productivity of construction activities. There is lack of

Table 26 Top ten delay causes in MSCPN based on their frequency of occurrence

Factor Code	Causes of delays	Category	FOI	FOI Rank	Mean and SD
K.7	Various demand raised by the local communities, different NGOs and INGOS	Miscellaneous	0.714	1	3.571 ± 1.328
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	Miscellaneous	0.700	2	3.500 ± 1.502
F.4	Long time taken to make decision	Management	0.657	3	3.286 ± 1.174
K.9	Social and political conflict	Miscellaneous	0.643	4	3.214 ± 1.298
K.8	Influence from the political sector and other groups	Miscellaneous	0.643	5	3.071 ± 1.438
A.5	Shortage of Fuel, Lubricants and construction material	Miscellaneous	0.605	6	3.024 ± 0.924
F.1	Getting permits and approval takes long time.	Employer caused	0.600	7	3.000 ± 1.042
G.12	Lack of modern management knowledge	Contractor and Sub-contractor	0.586	8	2.929 ± 1.521
D.5	Lack of co-ordination due to involvement of many agencies	Management related	0.576	9	2.881 ± 1.173
G.11	Adhoc management adopted by majority of the contractors and sub-contractors	Contractor and Sub-contractor	0.576	10	2.881 ± 1.273

modern management knowledge in Nepalese contractors and sub-contractors hence they are adopting adhoc management. In contrast it was also noticed that, foreign contractors working in the Nepalese mega scaled project have modern management knowledge but they were found not applying this knowledge properly.

2.1.3 Relationship between level of impact and frequency of occurrence of delay causes

Table 27 shows the relationship between LOI and FOI of top 10 delay causes in overall rank as presented in Table 23. From Table 27, it can be observed that delay causes ranked 1st, 2nd, 3rd and 4th in overall results (Table 23) have highest level of impact with LOI rank 2nd, 3rd, 4th and 1st as well as they have been most frequently occurring with FOI rank 2nd, 1st, 3rd and 6th respectively in mega scaled projects in Nepal. In contrast to this, delay causes ranked 5th, 6th, 7th, 8th and 10th in the overall results have lesser level of impact with LOI rank 10th, 15th, 11th, 19th and 22nd; but have been frequently occurring with rank FOI rank 4th, 5th, 7th, 10th and 9th respectively. Delay cause ranked 9th in overall result showed high level of impact in the project with LOI rank 7th but less frequently occurring with FOI rank 15th. This shows that, there exists mixed nature of relationship between the level of impact and frequency of occurrence of the delay causes in MSCPN.

2.1.4 Interpretation of importance of all delay causes based on their LOI and FOI values.

From Appendix Table D2 it can be observed that, out of total 65 delay causes that were tested for their level of impact in the MSCPN, 61 (94%) delay cause got LOI value ranging from 0.500 to 0.790 and the rest 4 (6%) delay cause also got LOI value between 0.433 to 0.486. This shows that, in the respondent's opinion, all delay factors have high level of impact in MSCPN. Similarly, from Appendix Table D3, it can be observed that, out of total 65 delay causes that were tested for their frequency of occurrence in the MSCPN, 24(37%) of delay causes got FOI value

Table 27 Relationship between the level of impact and frequency of occurrence of the delay causes in MSCPN

Factor Code	Delay cause	Category	LIFI Rank	LOI Rank	FOI Rank
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions	Miscellaneous	1	2	2
K.7	Various demands raised by the local communities, NGOs and INGOs	Miscellaneous	2	3	1
A.5	Long time taken to make decision	Employer caused	3	4	3
F.4	Shortage of fuel, lubricants and construction materials	Miscellaneous	4	1	6
K.9	Social and political conflicts	Miscellaneous	5	10	4
F.1	Influence from the political sector and other groups	Miscellaneous	6	15	5
K.8	Getting permits and approval takes long time.	Employer caused	7	11	7
G.11	Adhoc management adopted by majority of the contractors and sub-contractors	Contractor and Sub-contractor caused	8	19	10
G.10	In-effective project planning and scheduling	Contractor / Sub-contractor caused	9	7	15
D.5	Lack of co-ordination due to involvement of many agencies	Management related	10	22	9

ranging from 0.500 to 0.714; 31(47%) of delay causes got FOI value between 0.400 to 0.495; 9 (14%) of delay causes got FOI value between 0.352 to 0.395 and the rest

1(2%) of delay cause got FOI value 0.281. This shows that, in the respondents' opinion; majority of the delay causes were most frequently occurring in the MSCPN causing project delay.

2.1.5 Delays causes from the view of project parties

Ranking of the delay causes from the view of the main project parties is given in Appendix Table D4. Among them, ten most important delay causes in MSCPN from the view of project parties are shown in Table 28.

Table 28 Ten most important delay causes in MSCPN from the view of project parties

Factor Code	Delay cause	LIFI Rank		
		Owner	Consultant	Contractor
K.7	Various demand raised by the local communities, NGOs and INGOS	1	5	4
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	2	1	2
G.10	In-effective project planning and scheduling	3	*	*
A.5	Shortage of Fuel, Lubricants and construction material	4	10	1
G.2	Financial/Cash flow problem of the contractor	5	*	*
K.9	Social and political conflict	6	9	6
F.4	Long time taken to make decision	7	3	3
K.8	Influence from the political sector and other groups	8	4	*
F.6	Late approval of variation	9	*	*

Table 28 (Continued)

Factor Code	Delay cause	LIFI Rank		
		Owner	Consultant	Contractor
G.12	Lack of modern management knowledge	10	*	*
D.5	Lack of co-ordination due to involvement of many agencies	*	2	10
F.1	Getting permits and approval takes long time	*	6	*
D.4	Adhoc scheduling practice	*	8	*
C.4	Machinery, equipments and Spare parts not easily available	*	7	8
E.3	Delay in payments by the employer	*	*	5
G.8	Delay in sub-contractor's work	*	*	7
J.4	Stoppage of work during frequently occurring festivals	*	*	9

Symbol: “*” Delay causes that are not within the top 10 rank for each project parties

Table 28 shows that, delay causes ranked 1st, 2nd, 3rd, 4th and 5th in overall results (Table 23) are also common for all project parties except some difference in their ranking. They are already explained earlier. Regarding the difference in their ranking by project parties, it is obvious that, “problems of various demands raised by the local communities, NGOs and INGOs” were to be faced more by the owner, hence ranked 1st by the owner. But, “shortage of Fuel, Lubricants and construction material,” caused direct effect to the contractors day to day construction activities; hence ranked 1st by the contractor. Consultants ranked 1st to the delay cause “problems (strikes, blockade and obstructions) caused by different labor groups of trade unions” is also a critical problem hence also ranked 2nd by the employer and the contractor. For this common delay cause consultants view was noticed very close to the other parties.

As explained earlier, “social and political conflicts” have been the common problems of the country and have been negatively affecting all parts of the Nepalese life as well as the activities of all project parties to large extent hence ranked 6th, 9th and 6th by the owner, the consultant and the contractor respectively.

Furthermore, making decisions comes under the responsibility of the policy level beaurocracy. Long time taken to make decisions always have more and direct effect over the all project activities hence ranked 7th, 3rd and 3rd by the owner, the consultant and the contractor respectively.

Regarding the delay causes noticed commonly by two project parties only, it can be observed from the Table 28 that, “influence from the political sector and other groups” have direct effect over the all project activities hence ranked 8th by the owner and 4th by the consultant. Surprisingly, contractor gave less priority to this delay cause and ranked 17th. As explained earlier, there always have influence from the political parties and different “mega project mafia” in MSCPN while making different project level and policy level decisions. Obviously, these influences in the form of various constructions related and other demands have to be faced more by the owner and the consultant.

The delay cause “lack of co-ordination due to involvement of many agencies” was ranked 2nd by the consultant and 10th by the contractor but ranked 21st by the owner. As explained earlier, this cause was attributed to the owner. Hence owners were found reluctant to unhide the delay cause related to them.

Furthermore, delay cause “machinery, equipments and spare parts not easily available” was ranked 7th and 8th by the consultant and contractor is also a critical problem while working in Nepalese condition and is explained earlier.

Individual to the project parties, owner ranked 3rd to the delay cause “in-effective project planning and scheduling”; ranked 5th to the delay cause “financial /cash flow problem of the contractor”; ranked 9th to the delay cause “late

approval of variation” and ranked 10th to the delay cause “lack of modern management knowledge”. It is obvious that, these issues are in more priority to the owner as compared to the other parties.

Similarly, consultants give more priority to the delay cause “getting permits and approval takes long time” ranked 6th and “ad hoc scheduling practice” ranked 8th. These delay causes were directly related to the owner and the contractor respectively. In reality, these are also critical cause of delay in Nepalese construction sector as explained earlier.

Further, individual to the project parties, contractors ranked 5th to the delay cause “timely payments by the employer”; whereas, owners ranked 3rd to the delay cause “ineffective project planning and scheduling by the contractor”. Besides that, contractors ranked 7th to the delay cause “delay in sub-contractor’s work”. Actually these opinions reflect the ground reality, but giving high rank to those causes which are the sole responsibility of other parties can also be viewed as pinpointing and throwing of responsibility on other parties. But, delay cause ranked 2nd by the consultants “lack of co-ordination due to involvement of many agencies” seems to be balanced, because co-ordination between many agencies is always difficult and time taking in Nepal due to traditional and ad hoc bureaucratic system.

Furthermore, delay causes “delay in sub-contractor’s work” ranked 7th and “stoppage of work during frequently occurring festivals” ranked 9th by the contractor are obvious. These delay causes look minor but they are the critical problems to be faced frequently by the contractors during day to day work execution in Nepal due to its inherent situation as explained earlier.

2.1.6 Causes of delays from the view of project types

Ranking of the delay causes from the view of project types is given in Appendix Table D5. Among them, ten most important project specific delay causes in MSCPN are shown in Table 29.

Table 29 Ten most important delay causes in MSCPN from the view of project types

Factor Code	Delay cause	LIFI Rank			
		Irrigation	Water supply	Road	Hydro power
K.6	Problems (strikes, blockade) caused by different labor groups.	1	2	5	3
A.5	Shortage of Fuel, Lubricants and construction material	2	*	6	4
F.4	Long time taken to make decision	3	4	10	5
F.1	Getting permits and approval takes long time	4	9	*	*
C.4	Machinery, and Spare parts not easily available.	5	*	*	*
E.5	Long reimbursement procedure	6	*	*	*
G.2	Financial/Cash flow problem of the contractor	7	*	3	*
K.7	Various demand raised by the local communities, different NGOs and INGOS	8	1	1	1
J.4	Stoppage of work during frequently occurring festivals	9	*	*	*
C.3	Equipment breakdown e during construction period	10	*	*	*
G.12	Lack of modern management knowledge	*	3	9	*
K.1	Problems of land acquisition, resettlement, clearance and EIA	*	5	*	*
K.9	Social and political conflict	*	6	*	2
G.11	Adhoc management adopted by the contractors and sub- contractors	*	7	4	

Table 29 (Continued)

Factor Code	Delay cause	Project type			
		Irrigation	Water supply	Road	Hydro power
K.8	Influence from the political sector and other groups	*	8	8	6
E.1	Arranging financial source for the project takes long time.	*	10	*	8
G.10	In-effective project planning and scheduling	*	*	2	*
D.1	Deficiency in planning	*	*	7	*
E.4	Contractor's non workable low bidding rate.	*	*	*	7
K.4	Restrictions from security and other agencies	*	*	*	9
F.6	Corruption	*	*	*	10

Symbol: ‘*’ Delay causes that are not within the top 10 rank of the project types

Table 29 shows that, “problems (strikes, blockade) caused by different labor groups of trade unions”; “various demands raised by the local communities, different NGOs and INGOS” and “long time taken to make decision” are the most critical delay causes commonly affecting the all sample projects. They are ranked 1st, 2nd and 4th in the overall results (Table 23) and explained earlier. But from Table 29, it is apparent that, first delay cause has almost same effects in all project types. Second delay cause has severe effects for project delay in the water supply, road and hydro power project hence ranked 1st; but has less effect for project delay in irrigation project (ranked 8th). The main reason behind this is, as compared to the other three projects; irrigation project give direct and maximum benefit to the local people vicinity to the project area hence is more favoured by the locals. Beside that, irrigation department has been adopting participatory approach for project

implementation since last two decades. This approach has been found to help lessen the social problems during all stages of the project.

Long time taken to make decision, or problems related to the decision making were found prominent in irrigation project (ranked 3rd), water supply (ranked 4th) and hydro power project (ranked 5th); and less prominent to the road project (ranked 10th). In the case of earlier three projects, concerned departments are the executing agency and hence decision making processes are influenced by beaurocracy as explained in the overall results. But, road project is directly executed by Government of Japan through JICA using their own administrative system and resources, hence the road project is found free from beaurocratic hindrances for the project related decision making.

Regarding the delay causes common to at least three MSCPN, it can be observed that, “shortage of fuel, lubricants and construction materials” have more effect to the irrigation, hydropower and road projects; and has less effect to the water supply project. Comparatively, earlier three projects require more construction materials than water supply projects. Similarly, irrigation and hydropower projects have big and sensitive reinforced concrete (RC) hydraulic structures requiring huge quantity of construction materials and non stop operation of equipment and plant during their construction. Hence, frequent shortage of fuels, lubricants and construction materials have maximum negative effects to their critical activities and caused project delay. Besides that, major components of the MWSP requiring more construction materials have not been started yet and hence this project have not been facing the problems related to the construction materials.

As explained earlier, Nepal entered to the decade long social and political conflict since 1995. Obviously, this conflict negatively affected all economic sectors including MSP activities. Delay due to this particular cause is also reflected in the pinions of the two project type namely hydro power project (ranked 2nd), water supply project (ranked 6th) and irrigation project (ranked 11th). For this particular delay cause, opinion of the road project (ranked 26th) showing less effect due to this

conflict is unexpected and surprising.

Similar trend of some unexpected opinion was also noticed from the opinion of irrigation project for the delay cause “influence from the political sector and other groups” in MSP. Despite the fact that, there always have been felt noticeable influences from political and “mega project mafia group” in all MSP launched in Nepal. Irrigation project ranked 26th to this delay cause showing less effects due to this influence and but other three project namely waters supply (ranked 8th), road (ranked 8th) and hydropower (ranked 6th) showing more effects for project delay due to these influences.

Regarding the delay causes predominant in at least two MSCPN, Table 29 shows that, “getting permits and approval takes long time” is more prominent in irrigation and water supply projects and less prominent in other two projects. As explained earlier in overall results, this particular delay cause was attributed to the employer at field level. It was noticed that, for SIP and MWSP, the concerned department and ministry have been involved actively for day to day project execution using their own technical manpower and the decision making process hence is affected by beaurocratic formalities but for MMHEP and BSBRP, foreign consultants have been employed for day to day project execution and they are free from beaurocratic formalities.

As shown in Table 29 “lack of modern management knowledge” and “adhoc management adopted by the contractors and sub- contractors” are noticed as an important delay cause common in MWSP and BSBRP. This cause is attributed to the contractor and sub-contractor. In fact, these two projects components involved comparatively small sized and scattered works and need to employ sub-contractors by the principal contractor. Besides that, in most of these types of projects in Nepal, Nepalese contractors are working as a lead contractor. In other two project types namely irrigation and hydropower project; mostly foreign contractors are working as a lead contractor. Due to their limited exposure on modern construction technology and management, most of the Nepalese contractors do not have good knowledge on

effective construction management and still follow adhoc management style.

From Table 1, “arranging financial source for the project takes long time” is noticed as the common and most chronic delay cause for hydropower and water supply projects. Actually, MMHEP faced this problem due to unexpected variation during construction and MWSP faced this problem due to involvement of multiple donors (9 donors) each having their own conditions.

Furthermore, regarding the project specific delay cause, “long reimbursement procedure and machinery and equipment related delay causes are found more prominent to the irrigation project; where as, problems related to the local people namely “problems of land acquisition, resettlement, clearance and EIA issues” are found specific to the water supply project only. The road project has more specific problems related to the contractor and sub-contractor. On the other hand, delay causes namely “restrictions from security and other agencies” and “contractor’s non workable low bidding rate” are noticed as specific to the hydropower project. It can be noted that, the hydropower project is located in the security sensitive area and executed during mid to end of Maoists insurgency period; hence, typically faced security related problems causing project delay. There have been established trend in the hydropower project that, during tendering stage foreign contractors have tendency to submit low bidding rate to get the work; later on, during construction period, contractors were noticed to be focused more on searching for loop holes in the contract document and creating flaws to justify more and more claims to compensate for their low bid amount and profit.

2.2 Causes of cost overrun

2.2.1 Overall ranking of the causes of cost overrun

The overall ranking of the causes of cost overrun are done by considering their combined effects of level of impact and frequency of occurrence for causing cost overrun in the MSCPN. The result of the overall ranking of the 19 causes are given in Appendix Table E1. Summary of the top ten causes are given in Table 30.

Table 30 Top ten causes of cost overrun in mega scaled construction projects in Nepal (MSCPN)

Factor Code	Causes of cost overrun	LIFI	LIFI Rank	LOI	FOI
A.18	Conflict situation inside the country	0.705	1	0.794	0.651
A.16	Frequent strikes and closure of work by the workers trade unions.	0.669	2	0.742	0.621
A.8	Unexpected rise in price of fuel	0.659	3	0.779	0.578
A.2	Inflation (National and International).	0.640	4	0.740	0.584
A.6	Price escalation of construction materials in the international markets	0.626	5	0.739	0.560
A.1	Construction delay or time extension	0.608	6	0.792	0.503
A.3	Exchange rate	0.584	7	0.661	0.536
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area.	0.582	8	0.658	0.549
A.11	Delay in decision making by the employer and the consultants	0.580	9	0.661	0.530
A.14	Over dependency on foreign assistance, contractor, construction material and technology.	0.580	10	0.671	0.527

As shown in Table 32, “conflict situation inside the country” and “frequent strikes and closure of work by the workers trade unions” are identified as the most severe top two causes of cost overrun in MSCPN. These causes are attributed to the prevailing social and political condition in Nepal after the restoration of democracy in 1990 and start of insurgency in 1995. These causes are also the top causes of delay and already explained earlier. Conflict situation inside the country particularly caused frequent stoppage of construction activities due to transportation problem within the country, poor security condition within the project area, restriction on nightshift working and use of blasting materials. As a result of frequent stoppage of work, there is increase in overhead cost to the project parties; all heavy equipment and machinery including their operators are idle; there is no work output from the huge number of technical and non technical staffs and also losses of construction materials. Due to transportation problem inside the country cost of transportations are almost doubled than normal fair. Restriction on smooth use of blasting material and night shift working caused to slow the work progress and also caused extra expenses for the same work. Due to poor security condition within the project area, foreign contractors and consultants are reluctant to work in the project and the project has to provide special security to them at extra cost. As an example, the extra cost of special security arrangements in MMHEP was Nrs. 4 million per month.

Furthermore, all these sorts of work disturbances also caused project delay in MSP; which is associated with series of contractors’ claims, extra cost of hiring consultants for delayed period; and all kind of extra overhead cost within the owners’ organization for the delayed period. The additional claim for the delay in main civil contractors work in MMHEP was noticed 25000 Euro per day. Similarly, the additional claim by the ADIT access road contractor in MWSP was noticed Nrs. 0.753 million per day. Hence contract “delay and time extension” due to various reasons is also noticed as the major cause of cost overrun and ranked 5th. Table 31 shows the breakdown of cost overrun component in MMHEP as per the revised estimate.

Table 31 Breakdown of cost overrun components in MMHEP

Contract amount	Variation amount	Claim amount	Physical contingency	Price contingency	Total cost
149.78	51.30	43.46	9.08	19.79	273.41
54.78%	18.76%	15.90	3.32%	7.24%	100%

Note: All amounts are in Million Euros.

materials in the international markets” ranked 5th are noticed as the critical causes of cost overrun related directly and indirectly to the price rise in materials and fuels nationally and internationally. For example, rise in price of the construction materials within the country and outside the country was reflected in the national and international inflation, change in price of the specific construction materials in international markets was represented by price escalation. Besides that, national inflation also included price rise in labors and other human resources.

Past records showed that, for last ten years Nepal has been facing average annual inflation of about 10%. During this period price of fuel raised by almost three times. Furthermore, within this half decade price of cements was doubled; price of reinforcements was increased by almost three times; and labor price was increased by two times. Almost same trends of price rise can be noticed in other construction materials.

Depending upon the nature of works cost of construction materials, fuel and labor covered 60% to 70% of the project cost. Thus, it is obvious that, significant price rise in material and fuel components contributed to the overall cost overrun of the project.

Over dependency on foreign assistance, foreign contractors, construction materials and technology for project execution were also noticed as the major cause of cost overrun and ranked 10th. As explained earlier in delay cause, due

to its poor economy, Nepal is dependent on different donors to finance mega scaled projects. Donors always have their own conditions on using specific materials and employing foreign consultants and contractors. For example, MMHEP was implemented under 71% German grant hence have condition to use plants, machinery, contractors and consultants from Germany only. Similarly, BSBRP used Japanese grants for construction hence; it has restriction on using contractors, consultants, machine and materials except from Japan. All resources like man, materials and machine used in these two projects are very costly compared to other projects. As a result, compared to the other projects of similar nature, MMHEP and BSBRP were very costly from the very beginning. MWSP has multiple donors hence it has conditions of using international contractors and consultants. Only SIP is being implemented using the Nepalese fund, Nepalese consultants and departmental resources using J/V forms between Nepalese and foreign contractors.

Besides that, Nepal do not have enough production of basic and major construction materials like cement and reinforcement. Capacity of Nepalese contractors is still far behind to handle complex mega scaled projects. Obviously, price of materials, machines and manpower from developed countries are very high than the developing countries. For example, for the same job responsibility, cost of international experts is generally five to ten times more than the cost of Nepalese experts. As a result, major cost overrun components such as change in work scope and project delay were comparatively very costly in those projects which were more dependent on foreign materials, machine, manpower, contractors and consultants.

“Unexpected expenses on land acquisition, resettlement and fulfilling the demand of local people near project area that is not included in the estimate” is also noticed as the major causes of cost overrun in MSCPN. In fact, there have been no specific guidelines for addressing above issues by MSP. Hence there has been tradition of allocating lump sum amount in the project estimate based on the past experience. Since past one decade, it has been noticed that public have trend of demanding more and more compensation for land acquisition, resettlement and local development works. Sometime, local peoples were backed by NGOs, INGOs and

groups with some other interest for asking and compelling project authority to fulfill their irrelevant demand. Obviously all these expenses cannot be foreseen and include in the initial project estimate and later on caused cost overrun.

Delay in decision making by the employer and the consultants is ranked 9th in the overall results for cost overrun. As explained earlier in causes of delay, delay in decision making ultimately caused overall project delay. Project delay is mostly associated with cost overrun. This shows the importance of timely decision making in MSCPN and proved that delay in decision making in Nepal due to various circumstances ultimately caused cost overrun.

From Table 32, exchange rate is also noticed as the critical causes of cost overrun. As stated earlier, Nepal mostly employs foreign consultants and contractors and use foreign resources. Hence, most part of the contract expenses in MSCPN are paid in foreign currency. It can be noticed that Nepalese currency has been gradually becoming weak during last decade due to socio political instability inside the country. Due to this continuous devaluation of the Nepalese currency extra national currency is needed to pay for the imported construction materials and equipments; and foreign experts. Devaluation in Nepalese currency also increases the price escalation amount for contract. Though exchange rate can be visualized as the basic rule of transaction between national currency and foreign currencies, gradually devaluating exchange rates have high impact for the cost overrun in Nepal as proved by LOI value 0.661 and further this cause of cost overrun also appeared to be happening more frequently as indicated by the FOI value 0.536.

2.2.2 Ranking of causes of cost overrun based on their level of impact and frequency of occurrence

Ranking of the causes of cost overrun based on their level of impact on the project for causing cost overrun are given in Appendix Table E2. Similarly, ranking of the causes of cost overrun based on their frequency of occurrence are given in Appendix Table E3. Table 32 and Table 33 summarize the top ten causes of cost

overrun based on the level of impact and frequency of occurrence. respectively.

Table 32 Top ten causes of cost overrun in MSCPN based on their level of impact

Factor Code	Causes of cost overrun	LOI	LOI Rank	Mean and SD	FOI Rank
A.18	Conflict situation inside the country	0.790	1	3.952 ± 1.147	1
A.1	Construction delay or time extension	0.790	2	3.952 ± 1.229	10
A.8	Unexpected rise in price of fuel	0.767	3	3.833 ± 0.824	4
A.6	Price escalation of construction materials in the international markets	0.738	4	3.690 ± 0.811	5
A.16	Frequent strikes and closure of work by the workers trade unions.	0.738	5	3.690 ± 1.023	2
A.2	Inflation (National and International).	0.733	6	3.667 ± 0.928	3
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology for project execution.	0.667	7	3.333 ± 1.262	9
A.3	Exchange rate	0.662	8	3.310 ± 0.897	7
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area that is not included in the estimate.	0.662	9	3.310 ± 1.137	6
A.5	Long time gap between estimation date and work execution date	0.648	10	3.238 ± 1.122	15

Table 32 shows that, top nine causes of cost overrun ranked 1st to 9th having high level of impact on the project are also among the top ten causes of cost overrun in the overall results (Table 30). These causes are already explained in 2.2.1. From Table 32, it can be observed that, cost overrun causes arised due to prevailing social and political conflict; rise in material and fuel price; causes related to the donors conditions; causes related to the economy and finance of the country; and local

level issues have high level of impacts for the cost overrun

Table 33 Top ten causes of cost overrun in MSCPN based on their frequency of occurrence

Factor Code	Causes of cost overrun	FOI	FOI Rank	Mean and SD	LOI Rank
A.18	Conflict situation inside the country	0.652	1	3.262 ± 1.415	1
A.16	Frequent strikes and closure of work by the workers trade unions.	0.619	2	3.095 ± 1.322	5
A.2	Inflation (National and International).	0.590	3	2.952 ± 1.430	6
A.8	Unexpected rise in price of fuel	0.576	4	2.881 ± 1.041	3
A.6	Price escalation of construction materials in the international markets	0.567	5	2.833 ± 1.080	4
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area.	0.557	6	2.786 ± 1.335	9
A.3	Exchange rate	0.543	7	2.714 ± 1.293	8
A.11	Delay in decision making by the employer and the consultants	0.529	8	2.643 ± 1.144	11
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology for project execution.	0.519	9	2.595 ± 1.449	7
A.1	Construction delay or time extension	0.500	10	2.500 ± 1.366	2

Similarly Table 33 shows that, all top ten causes of cost overrun based on their frequency of occurrence were same as the top ten causes of cost overrun as shown in overall results (Table 30). They are already explained earlier.

From Table 32 and Table 33, it is apparent that, all ten causes of cost overrun in overall results (Table 30) are important from view of their level of impact and frequency of occurrence. Hence they can be considered as the ten most important causes of cost overrun in MSCPN.

2.2.3 Relationship between level of impact and frequency of occurrence of causes of cost overrun

Table 34 shows the relationship between the frequency of occurrence and level of impact of the causes of cost overrun. From the table, it can be observed that causes of cost overrun having rank 1st, 3rd, 4th, 5th and 6th in the level of impact also occurring frequently with rank 1st, 4th, 5th, 2nd, and 3rd respectively. Construction delay or time extension (LOI rank 2nd) has severe impact for cost over run but it occurs slightly less frequently (FOI rank 10th) compared to the others. Besides that, causes of cost overrun with LOI rank 7th, 8th, 9th and 11th and FOI rank 9th, 7th, 6th and 8th respectively in Table 34 shows that these causes have slightly less level impact as well as they occur slight less frequently. This shows that there exists mixed nature of relationship between the LOI and FOI of the causes of cost overrun in MSCPN.

2.2.4 Interpretation of the importance of causes of cost overrun based on their LOI and FOI values.

From Appendix Table E2 it can be observed that, out of total 19 causes of cost overrun that were tested for their level of impact for causing cost overrun in MSCPN, 19 (100%) got LOI values ranging from 0.522 to 0.794. Hence, all causes of cost overrun having LOI values more than 0.500 shows that, in the respondents' opinion; all causes of cost overrun have high level of impact causing

Table 34 Relationship between the frequency of occurrence and the level of impact of the causes of cost overrun in MSCPN

Factor Code	Causes of cost overrun	Rank LIFI	Rank LOI	Rank FOI
A.18	Conflict situation inside the country	1	1	1
A.16	Frequent strikes and closure of work by the workers trade unions.	2	5	2
A.8	Unexpected rise in price of fuel	3	3	4
A.2	Inflation (National and International).	4	6	3
A.6	Price escalation of construction materials in the international markets	5	4	5
A.1	Construction delay or time extension	6	2	10
A.3	Exchange rate	7	8	7
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area.	8	9	6
A.11	Delay in decision making by the employer and the consultants	9	11	8
A.14	Over dependency on foreign assistance, contractor, construction material and technology.	10	7	9

cost overrun in MSCPN.

Similarly, from Appendix Table E3 it can be observed that, out of total 19 causes of cost overrun that were tested for their frequency of occurrence in MSCPN, 10(53%) causes got FOI value ranging from 0.503 to 0.651; 6(32%) causes got FOI value between 0.443 to 0.48; and rest 3 (15%) cause got FOI value between 0.370 to 0.396. This shows that, in the respondents' opinion; majority of the causes of cost overrun were frequently occurring in the MSCPN.

2.2.5 Causes of cost overrun in MSCPN from the view of project parties

Ranking of the causes of cost overrun from the view of main project parties is given in Appendix Table E4. Among them, ten most important causes as perceived by the owners, consultants and contractors are shown in Table 35.

Table 35 showed that, causes of cost overrun ranked 1st, 2nd, 3rd, 4th, 5th, 6th and 7th in the overall results (Table 30) are also common for all project parties except some difference in ranking as per their party specific perception. For example, “conflict situation inside the country” and “frequent strikes and closure of work by the workers trade unions” were ranked 1st and 2nd by the owners but the same causes were ranked 3rd and 6th by the contractors. This is obvious because the contractors have the right to claim as per the FIDIC document if any extra cost or losses occurred due to above causes. On the other hand, the contractors ranked 2nd for the cause “unexpected rise in price of fuel” because extra cost due to rise in fuel price is to be beared by the contractors. Similarly, the contractors have option to compensate any extra cost due to inflation by charging as price escalation hence, “inflation” got rank 5th in the contractors opinion. But inflation directly cause cost overrun to the owner hence, ranked 4th. Consultants view was found similar to the owners.

Surprisingly both owners with rank 8th and contractors with rank 8th were found to give almost similar importance to the cost overrun cause “construction delay or time extension”. The reason might be, some delays are compensable and some are noncompensable. Compensable delays cause cost overrun to the owners and noncompensable delays cause cost overrun to the contractors.

Regarding the causes of cost overrun common to the at least two parties only, it can be observed that, “unexpected expenses on land acquisition, resettlement and fulfilling demand of local people” was noticed as the common cause of cost overrun to the owners and the consultants. In fact, the owners and the consultants are formally involved in decision making to fulfill the various demands of the local people in the project area. All these unexpected expenses cause cost overrun

Table 35 Ten most important causes of cost overrun in MSCPN from the view of project parties

Factor Code	Causes of cost overrun	LIFI Rank		
		Owner	Consultant	Contractor
A.18	Conflict situation inside the country	1	1	3
A.16	Frequent strikes and closure of work by the workers trade unions.	2	5	6
A.6	Price escalation of construction materials in the international markets	3	6	7
A.2	Inflation (National and International).	4	2	5
A.8	Unexpected rise in price of fuel	5	7	2
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area that is not included in the estimate.	6	10	*
A.3	Exchange rate	7	11	10
A.1	Construction delay or time extension	8	3	8
A.5	Long time gap between estimation date and work execution date	9	13	16
A.11	Delay in decision making by the employer and the consultants	10	12	4
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology.	*	4	9
A.17	Corruption	*	8	11
A.13	Donor dominated procurement guidelines and specification	*	9	*
A.10	Delay in payments	*	*	1

Symbol: ‘*’ Causes of cost overrun which were not within the top 10 rank in MSCPN

to the project.

The cost overrun due to “corruption” was attributed to the owner, and may cause extra cost to the contractors and also to the consultants. Hence, “corruption” was ranked 8th by the contractor and the consultants. But this cause was given less importance by the owner. Furthermore, from the Table 35 it can be noticed that, consultants’ and the contractors’ gave more importance to the cause “over dependency on foreign assistance, foreign contractors, construction materials and technologies for project execution” and ranked 4th and 9th respectively. But owners gave less importance to this cause. Hence, particular to this cause of cost overrun, owners’ opinion can be viewed as unbelievable and surprising because this cause of cost overrun have more impact causing extra cost to the owners as compared to the other two parties.

Regarding the project party specific ranking of the causes of cost overrun, from Table 35 it can be observed that, the contractors are found to give more importance to those causes which have more effect to them and attributed to the other parties. For example, contractors’ are noticed to give the most importance to the cause “delay in payments” and ranked 1st. This cause of cost overrun was attributed to the owners’ and the consultants’.

2.2.6 Causes of cost overrun from the view of project types

Ranking of the causes of cost overrun from the view of project types is given in Appendix Table E5. Among them, ten most important project specific causes of cost overrun in MSCPN are shown in Table 36.

Table 36 shows that, “unexpected rise in price of fuel”, “conflict situation inside the country”, “inflation (National and International)”, “frequent strikes and closure of work by the workers trade unions” and “construction delay or time extension” are the common causes of cost overrun affecting to all mega scaled projects types. Theses are also the top 5 causes of cost overrun in overall results

Table 36 Ten most important causes of cost overrun in MSCPN from the view of project types

Factor Code	Causes of cost overrun	Project type			
		Irrigation	Water supply	Road	Hydro power
A.8	Unexpected rise in price of fuel	1	8	6	5
A.6	Price escalation of construction materials in the international markets	2	*	8	3
A.3	Exchange rate	3	*	10	*
A.2	Inflation (National and International).	4	5	3	7
A.18	Conflict situation inside the country	5	1	2	1
A.16	Frequent strikes and closure of work by the workers trade unions	6	3	1	2
A.10	Delay in payments	7	*	*	*
A.11	Delay in decision making by the employer and the consultants	8	6	*	9
A.1	Construction delay or time extension	9	4	7	6
A.14	Over dependency on foreign assistance, contractor and construction materials	10	9	*	4
A.15	Unexpected expenses on land acquisition and resettlement	*	2	5	*
A.17	Corruption	*	7	*	*
A.13	Donor dominated procurement guidelines and specification	*	10	*	10
A.9	Variation order due to increase in quantity and change in original scope	*	*	4	8
A.5	Long time gape between estimation date and execution	*	*	9	*

Symbol: ‘*’ Causes of cost overrun which are not within the top 10 rank

(Table 32) and explained earlier. But from Table 36, it can be noticed that, these causes have different level of effects on different project types causing cost overrun. For example, “unexpected rise in price of fuel” caused most severe effect in the irrigation project hence ranked 1st, but caused less effect for other three project types. Irrigation project consisted of huge head works and other massive structures requiring continuous operation of number of machinery and heavy equipment. This project is located in jungle area having no power supply from common grid. Hence, depend on their own power produced by using expensive diesel plants. Due to this specific project nature and location rise in fuel cause severe effect for the cost overrun in irrigation project.

On the other hand “conflict situation inside the country” was noticed as the most severe cause of cost overrun in MMHEP (hydropower) and MWSP (water supply) projects, hence ranked 1st by both project types. Conflict situation also caused almost similar effect for cost overrun in other SIP (irrigation) hence ranked 5th and BSBRP (road) project hence ranked 2nd. This opinion was noticed obvious because as explained earlier in overall results; social and political conflicts within the country have same level of effects on all parts of life and all sectors.

Similarly, road project ranked 1st for the cause “frequent strikes and closure of work by the workers trade unions”. Due to its’ work nature, road project consisted number of scattered works involving number of sub-contractors, petty contractors and labour groups. Frequent strikes and closure of works by these groups compelled to idle all other important project resources, increased the overhead cost and also caused project delay. All these factors ultimately cause severe cost overrun in the road project. This shows that, depending upon their nature; different projects have different critical causes of cost overrun.

Besides that, “national and international inflation” was noticed to cause almost similar level of effect for cost overrun in all types of projects. But, “construction delay or time extension” caused more cost overruns in hydropower and water supply projects as compared to the other two types of projects.

Regarding the causes of cost overrun common to at least three project types; it can be observed that, “price escalation of construction materials in the international markets” have more effects to the irrigation, hydropower and road project and has less effects to the water supply projects. As explained earlier in overall results, the earlier three projects used huge amount as well as highly priced imported construction materials; hence have more effect on cost overrun due to price escalation in the international markets. The author has the opinion that, this cause may also have serious effects in MWSP, when this project will start construction of major component like construction of tunnel and head works, sedimentation tank and distribution system in future.

From Table 36, “over dependency on foreign assistances, foreign contractors, construction materials and technologies for project execution” was noticed as important causes of cost overrun for irrigation, water supply and hydro power project. These MSP involved bilateral and multilateral donors associated with their procurement guidelines which also cause cost overrun as explained in overall results. Furthermore, “delay in decision making by the employer and the consultants” was also noticed as common issue causing cost overrun in the above three projects. As explained earlier in delay results, problems related to the decision making are found more critical in irrigation, water supply and hydro power projects; and less critical in the road project. This was because concerned departments were the executing agency in earlier three projects and hence decision making processes are influenced by beaurocratic formalities. On the other hand the road project was directly executed by JICA using their own system and resources, hence free from beaurocratic hindrances for the project related decision making.

Regarding the causes of cost overrun predominant in at least two project types; Table 36 shows that, “exchange rate” has more effect in irrigation and road project because major investment from the donors in these two sectors are realized in dollars and exchange rate of Nepalese currency with dollar has been noticed more unstable than the other currency. Similarly, “unexpected expenses on land acquisition, resettlement and fulfilling demand of local people” was noticed

common and more severe cause of cost overrun for the water supply and road project. Due to their work nature, irrigation, water supply and road projects are more exposed and near to the local people. In this situation, due to lack of adoption of participatory approach in project implementation in mega scaled water supply and road projects; these projects always facing more disturbances by the local people.

Donor dominated procurement guidelines and specification were noticed as the common cause of cost overrun in the hydropower project and the water supply project. In Nepal MMHEP and MWSP are publicly considered as the chronic projects in the aspects of delay and cost overrun due to high interferences from the donors in all aspects of these projects.

From Table 36, “variation order due to increase in quantity of works and change in original scope” was found common issue for cost overrun in road and hydropower projects. As explained earlier, due to scattered and underground nature of works; road and hydropower projects are always prone to more variation order compared to the irrigation and the water supply projects.

Regarding the project specific causes of cost overrun within the top ten rank, “delay in payments” was noticed more severe in the irrigation project. This may be due to scarcity of government funds, since this project used fund from the Nepal Governments own source. Furthermore “corruption” was noticed more severe in the water supply project with rank 7th. In the past, MWSP was the most disputed project in Nepal in the aspects of corruption with high level political involvement. Similarly, “long time gap between estimation date and work execution date” was considered severe in road projects causing cost overrun. Due to lack of fund, most of the road projects can not be implemented immediately after their study or in some cases even after the contract is awarded. Long time gape between the estimated and execution date generally cause increase in price of the different resources and ultimately caused cost overrun.

2.3 Factors affecting quality

2.3.1 Overall ranking of the factors affecting quality

The overall ranking of the factors affecting quality in mega scaled construction projects in Nepal are done by considering their combined effects or in other words to what extent the particular factors affected the quality aspects and to what extent the particular factors occurred in the sample projects. The results of the overall ranking of all 35 factors affecting quality are given in Appendix Table F1. Among them summary of the most important ten factors that affected the quality of construction in MSCPN are given in Table 37. As shown in Table 37, out of top ten factors, four are of management related, another four are of material, equipment and labor related and the rest two are of project participants related.

From Table 37, it can be observed that “establish and maintain regular formal and informal communication and regular meeting of the project teams” (ranked 1st); “contractors and sub-contractors knowledge and experience in QC, QA and QMS” (ranked 2nd) and “proper arrangement of resources throughout the project period” (ranked 3rd) were noticed as the most critical factors (having almost similar LIFI values) affecting the quality of construction works in MSCPN. Beside that, quality factor ranked 4th “establishment of QC, QA and QMS system along with the effective monitoring and feedback systems” can be considered as the moderately critical; since it has the highest level of impact (LOI 0.715). All remaining factors in Table 37, ranked 5th to 10th can be categorized as the critical factors.

As shown in Table 37, “establish and maintain regular formal and informal communication and regular meeting of the project teams” ranked 1st and “regular updating of quality plan” ranked 8th are noticed as the quality factors attributed to the day to day management action or activities of the project parties. These activities can be considered as the most critical to achieve quality in Nepalese condition. In this regard, it shall be noted that Nepalese construction sectors have not yet adopted the Quality Management System (ISO 9000). In this situation, contract

Table 37 Top ten factors affecting the quality in mega scaled construction projects in Nepal (MSCPN)

Factor Code	Factors affecting quality	Category	LIFI	LIFI Rank	LOI	FOI
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams	Management	0.604	1	0.648	0.605
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	Project participants	0.601	2	0.665	0.563
C.4	Proper arrangement of resources throughout the project period	Management	0.599	3	0.659	0.569
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems	Management	0.597	4	0.715	0.510
D.4	Equipment breakdown during construction period	Material, Equip. & labor.	0.583	5	0.631	0.558
D.2	Good quality construction material not easily available	Material, Equip. & labor.	0.575	6	0.641	0.536
D.5	Proper mobilization of the equipments and machine during construction	Material, Equip. & labor.	0.571	7	0.611	0.556
C.8	Regular updating of quality plan	Management	0.564	8	0.631	0.534

Table 37 (Continued)

Factor Code	Factors affecting quality	Category	LIFI	LIFI Rank	LOI	FOI
D.6	Skill and competency of the operator	Material, Equip. & labor.	0.564	9	0.625	0.533
A.5	Quality performance and quality policy of contractors	Project participants	0.563	10	0.669	0.497

including work specifications are the bases for achieving quality in all projects. To achieve good quality; all project parties must have the same understanding regarding the project specific quality requirements and all aspects required for achieving quality i.e. quality planning, quality implementation, quality control, inspection and testing; recording and interpretation etc. In this context, regular formal and informal meeting can help to create the same understanding between the project parties regarding the quality requirements and different aspects to achieve the quality. This further can help resolve the conflicts between the project parties regarding the quality issues and regular updating of quality plans. Progress reports of the sample projects showed that, quality was among the main agenda of tri-party meeting in irrigation, road and hydropower project but this was found lacking in water supply projects.

Regarding the quality factor ranked 3rd “proper arrangement of resources throughout the project period” in Table 37; it was observed that, to achieve quality standard, every MSP needs continuous input of resources at required quantity, desired quality and as per the schedule of the work. Due to “prevailing social and political conflicts; frequently occurring labor strike; transportation problem and shortage of fuels and lubricants; financial problems; geographically difficult site location and land locked situations of the country”; uninterrupted supply of the required resources have been noticed as the most critical issues to achieve quality in Nepalese construction.

As revealed in Table 37, “contractors and sub-contractors knowledge on QC, QA and QMC” ranked 2nd and “quality performance and quality policy of contractors” ranked 10th were noticed as the two quality factors that are solely attributed to the contractors and sub-contractors. This opinion of the respondents showed the vital role of contractors and sub-contractors for achieving quality in MSCPN. Irrespective of the type and size of the project, contractors and sub-contractors are the only project parties having the most important and critical role to achieve quality since they are responsible for day to day execution of the project activities and creating project facilities in the form of physical objects. It is obvious that, if the contractors and sub-contractors are experienced and having good knowledge on QC, QA and QMS; further associated with effective quality policy and having high level of quality performance, they can better implement all quality aspects in their day to day work thus achieving good quality. Regarding these quality aspects, foreign contractors were found better than the Nepalese contractors. Hence, quality performance of sample hydropower, road and irrigation projects involving foreign contractors were noticed better than the water supply projects involving Nepalese contractors.

Similarly, quality factor “establishment of QC, QA and QMS system along with the effective monitoring and feedback systems” ranked 4th in the overall categories; indicated the importance of QC, QA and QMS along with the effective monitoring and feed back system to achieve the quality objective. It must be noted that QC is a corrective action to achieve quality based on the action, “fix it whenever it goes wrong”; hence, focused on achieving product quality; where as, QA is the preventive approach to achieve quality and believes on perfect actions and process from the beginning i.e. “do it right the first time”. QMS (ISO 9000) addresses for establishing the overall quality culture i.e. management responsibility, contract review, design control, document control, purchasing, process control, corrective actions, training and reviews and audit etc. in the construction project organization. Hence, establishment of QC, QA and QMC along with the effective monitoring and feedback system in MSPs; can help achieve quality in construction process as well as quality of constructed product. In this context, respondents’ opinion was noticed

giving equal importance to the process quality and product quality along with the effective feedback and monitoring system to achieve quality in MSCPN.

From Table 37 it was observed that, quality factors “equipment breakdown during construction period” ranked 5th; “proper mobilization of the equipment and machine during construction” ranked 7th and “skill and competency of the operator” ranked 9th are the three critical factors attributed to the “materials, equipment and labors” categories affecting the construction quality in MSCPN. These opinions of the respondents not only highlighted the need of good conditioned equipment but also the need for its proper mobilization. It further stressed the need of skilled and competent operator to maintain the quality of all types of construction works in prevailing working conditions and situations in Nepal.

Nepal has difficult geographical conditions; hence, most of the construction sites are located far from the main city. Due to this situation, prompt transportation might not be possible all the times. Nepalese markets do not have proper sales, spare part and service facility for all kinds of sophisticated equipments. Spare parts and service man of this equipment have to be brought from India or other countries and it takes long time. Besides that, frequent strikes; road blockades; and other problems inside the country also adding more difficulty and complicity for immediate repair and maintenance of equipment. These events happen frequently while working in Nepalese situation.

Obviously, mega scaled construction are equipment and machine intensive rather than labor intensive. Hence, there is a need for smooth and uninterrupted operations of numbers of simple to highly sophisticated equipment and machines for achieving good quality. It can be observed that, all foreign contractors working in the sample mega scaled projects i.e. Germany in MMHEP, Japanese in BSBRP and Chinese in SIP; have good machines and equipment from their own country. They also have well established mechanical section along with good arrangements for necessary spare parts. Compared to the foreign contractors, Nepalese contractors and sub-contractors are far behind in above aspects.

Proper mobilization of equipments and machines during construction with provision of skill and competent operators; was also noticed critical factors for achieving quality. Earlier paragraph discussed the need for uninterrupted operation of the equipment and machines for achieving quality. For this, respondents were found to iterate the need for their proper mobilization with provision of skilled and competent operators. Proper mobilization of equipments and machines during construction includes all aspects of the equipments and machinery management for the project from its start to end. This ensures the use of appropriate equipment for the particular job efficiently and productively. Besides that, operators are the human resource who operates the machine to get the work done. Hence, the actual work delivery of even the sophisticated and precise equipment finally depends on the skill and competency of the operators. Due to lack of training; and limited work experience and exposure; Nepalese construction markets do not have sufficient number of skilled and competent operators. Those who have good skill and competency, prefers to go other countries because of higher salary and better facility. Hence, lack of skilled and competent operators also critically affected the quality of MSCPN.

Good quality construction materials not easily available (ranked 6th) was also noticed as a critical factor attributed to the “material, equipment and labor” category. This opinion highlighted the need of good quality material as well as their uninterrupted supply for achieving quality in MSCPN. It is obvious that, qualities of works are basically derived from the quality of materials to be used for that particular works. Besides that, shortage of materials in the market also interrupts for smooth work operation as planned and ultimately hampers the quality of construction. Different mega scaled construction need different construction materials i.e. cements, reinforcements, aggregates, GI wire, wood, bitumen and its product; and others etc. Except bitumen and its product, Nepal has its own production of other construction materials, but internal production is not sufficient to meet the regular demand. Besides that, construction materials abundantly available in Nepal are of commercial or general quality targeted for general construction purpose. For example, reports of the trial mixes carried out in Sikta Irrigation Project concluded that “it is very difficult to achieve the strength for M40 concrete by using cement quantity even

using 400 kg/m³ of the best cements (JP53) available in the Nepalese market and using the good quality of aggregates”. All these facts show that, none availability of the good quality materials required for the specific purpose critically affected the quality of MSCPN.

2.3.2 Ranking of the factors affecting quality based on their level of impact and frequency of occurrence

Ranking of all factors affecting quality based on their level of impact on the projects for achieving quality are given in Appendix Table F2. Among them, top ten factors affecting quality are given in Table38.

Table 38 showed that, among the top ten factors having high level impact on the project quality; 6 are of “management” related, 2 are of “project participants” related; and remaining are of “project characteristics” and “material, equipment and labor” related. This indicates that, management related factors have the highest level of impact for affecting the quality; and further highlighted the importance of good project management for achieving good quality in MSCPN.

From Table 38, “establishment of QC, QA and QMS system along with the effective monitoring and feedback systems”, was noticed as the most important factor affecting quality in the aspects of its level of impacts. Obviously, lack of QC and QA may cause unsatisfactory quality of constructed products and construction process respectively. Similarly, QMS indicates the presence of quality culture within the project organization and project environment. In absence of QMS, it is difficult to implement and monitor different quality aspects within the construction projects. Furthermore, “good planning with the use of appropriate technologies for construction”, ranked 2nd; “proper arrangement of resources throughout the project period”, ranked 5th; “establish and maintain regular formal and informal communication and regular meeting of the project teams”, ranked 6th; and “regular updating of quality plan”, ranked 8th; indicated some specific management activities which are vital for achieving quality in MSCPN. Management related factor

Table 38 Top ten factors affecting quality in MSCPN based on their level of impact

Factor Code	Factors affecting quality	Category	LOI	Rank LOI	Mean and SD
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	Management	0.719	1	3.595 ± 1.127
C.1	Good planning with the use of appropriate technology for construction	Management	0.686	2	3.429 ± 1.144
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	Project participants	0.671	3	3.357 ± 1.038
B.7	Available time and budget	Project charact..	0.667	4	3.333 ± 0.989
C.4	Proper arrangement of resources throughout the project period	Management	0.662	5	3.310 ± 1.095
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	Management	0.652	6	3.262 ± 1.051
A.5	Quality performance and quality policy of contractors	Project participants	0.648	7	3.238 ± 1.107
C.8	Regular updating of quality plan	Management	0.638	8	3.190 ± 0.971
D.2	Good quality construction material not easily available	Material, equipment and labor	0.638	9	3.190 ± 1.053
C.2	Appropriate organizational structure for quality delivery	Management	0.638	10	.190 ± 1.111

“appropriate organizational structure for quality delivery”, ranked 10th by the respondents; gave stress for the need of appropriate organizational structure to execute quality related activities.

As shown in Table 38, “contractors’ and Sub-contractors’ knowledge and experience in QC, QA and QMS”, ranked 3rd and “quality performance and quality policy of contractors”, ranked 7th; showed that, contractors and sub-contractors with good knowledge and experience on different quality aspects; appropriate quality policy and high level of quality performance have high level of impact for achieving quality. As explained earlier in overall results, contractors and sub-contractors are the actual doer of each and every activities required for creating the physical works in projects. Hence, their knowledge, policy and performance on quality obviously have direct or firsthand impacts for achieving quality.

From Table 38, “available time and budget”, ranked 4th was noted as the “project characteristics” related factor having high level of impact affecting the quality of any construction. It is obvious that, quality of works is achieved at the expense of time and money. High quality of works always requires appropriate time and more money. This opinion also highlighted the importance of good scheduling technique which helps to allocate appropriate time and resources to achieve better quality in MSCPN. As per the respondents’ opinion, “good quality construction materials not easily available”, was also noticed as the critical factor having high level of impact affecting the quality of mega scaled construction in Nepal. As explained earlier in overall results, this factor has direct impact for the quality of construction.

Ranking of the factors affecting quality based on their frequency of occurrence in the mega scaled construction are given in Appendix Table F3. Among them top ten factors are presented in Table 39.

From Table 39, quality factors with FOI rank 1st, 3rd, 7th and 9th in are of “management” related. Similarly, five quality factors ranked 4th, 5th, 6th, 8th and 10th are of “material, equipment and labor” related and quality factor ranked 2nd is of

Table 39 Top ten factors affecting quality in MSCPN based on their frequency of occurrence

Factor Code	Factors affecting quality	Category	LOI	Rank FOI	Mean and SD
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	Management	0.600	1	3.000 ± 1.100
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	Project participants	0.567	2	2.833 ± 1.158
C.4	Proper arrangement of resources throughout the project period	Management	0.562	3	2.810 ± 1.137
D.4	Equipment breakdown during construction period	Material, equip. & labor	0.552	4	2.762 ± 1.038
D.5	Proper mobilization of the equipments and machine during construction	Material, equip. & labor	0.548	5	2.738 ± 1.072
D.6	Skill and competency of the operator using the machine and equipments	Material, equip. & labor	0.529	6	2.643 ± 1.059
C.10	Establishment of the safety system.	Management	0.529	7	2.643 ± 1.070
D.2	Good quality construction material not easily available	Material, equip. & labor	0.524	8	2.619 ± 1.005
C.8	Regular updating of quality plan	Management	0.524	9	2.619 ± 1.126
D.7	Lack of qualified workforce	Material, equip. & labor	0.514	10	2.571 ± 1.073

“project participants” related. This shows that, “material, equipment and labor” and “management related” quality factors were the most frequently occurring factors affecting quality in MSCPN.

Table 39 shows that, all of the most frequently occurring factors except “establishment of the safety system”, ranked 7th and “lack of qualified workforce”, ranked 10th; are similar to the top ten quality factors in overall results (Table37) and explained earlier.

Regarding the quality factor “establishment of the safety system” ranked 7th, it must be noted that safety and quality aspects in construction are complement to each other. If working environments in the projects are safe, workers can work safely and confidently; and can give good quality with high productivity. It was observed that, safety aspects are not given due importance in Nepalese construction sector including mega scaled construction. For example, among the four sample projects under this study, only MMHEP and BSBRP were noticed having proper arrangements for the safety in their work place. These projects have appointed separate safety officer; they have proper safety arrangements and regular safety meeting. Other two sample projects namely SIP and MWSP were found adopting adhoc safety arrangements. As a result, it can be observed that MMHEP and BSBRP have achieved high quality performance compared to the SIP and MWSP.

Lack of qualified workforce (ranked 10th) was also noticed as frequently occurring factor affecting quality in MSCPN. The shortage of qualified workforce was mainly attributed to the lack of construction oriented training. Besides that, due to insufficient salary, poor working conditions, lack of career advancement opportunities and inherent mentality of thinking construction work as the lower category job; many of the younger generation with basic educational background are reluctant to work as construction employee. Most of the qualified workforce preferred to move to the gulf and other countries for better salary. As a result, problems of scarcity of qualified workforce have been occurring frequently in Nepal.

2.3.3 Relationship between level of impact (LOI) and frequency of occurrence (FOI) of the factors affecting quality

Table 40 shows the relationship between “level of impact” and “frequency of occurrence” of top ten quality factors based on the overall results as presented in Table 37.

Table 40 Relationship between the frequency of occurrence and level of impact of the factors affecting quality in MSCPN

Factor Code	Factors affecting quality	Category	LIFI Rank	LOI Rank	FOI Rank
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams	Management	1	6	1
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	Project participants	2	3	2
C.4	Proper arrangement of resources throughout the project period	Management	3	5	3
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems	Management	4	1	13
D.4	Equipment breakdown during construction period	Material, equip. & labor	5	12	4
D.2	Good quality construction material not easily available	Material, equip. & labor	6	9	8
D.5	Proper mobilization of the equipments and machine during construction	Project participants	7	17	5

Table 40 (Continued)

Factor Code	Factors affecting quality	Category	LIFI Rank	LOI Rank	FOI Rank
C.8	Regular updating of quality plan	Management	8	18	9
D.6	Skill and competency of the operator	Material, equip. & labor	9	13	6
A.5	Quality performance and quality policy of contractors	Project participants	10	7	11

From Table 40, it can be observed that the factors affecting quality ranked 1st, in overall (LIFI) results have LOI rank 6th but have FOI ranked 1st. Opposite to this, quality factor with LIFI rank 4th have LOI rank 1st but have FOI rank 13th. But, quality factors with LIFI rank 2nd, 3rd and 6th have almost similar LOI and FOI rank.

Likewise, quality factor with LIFI rank 5th, 7th, 8th and 9th were noticed to have lower level of impact for quality in MSCPN but occurring at higher frequencies. On the other hand quality factor with LIFI rank 10th was noticed just opposite to the above. In summary, there appeared different patterns of relationship between the level of impact and frequency of occurrence of the factors affecting quality in MSCPN.

2.3.4 Interpretation of importance of factors affecting quality based on their LOI and FOI values.

From Appendix Table F2, it can be observed that, out of total 35 factors affecting quality that were tested for their level of impact in MSCPN; 33 (94%) factors got LOI value between 0.538 to 0.719 and the rest 4 (6%) factors also got LOI value between 0.490 to 0.495. This shows that, in the respondents' opinion; all factors affecting quality have high level of impact in MSCPN. Similarly from Appendix Table F3, it can be observed that, out of total 35 factors affecting quality

that were tested for their frequency of occurrence in MSCPN; 16(46%) factors got FOI value ranging from 0.500 to 0.600; 16(46%) factors got FOI value between 0.400 to 0.495 and the rest 3(8%) quality factor got FOI value between 0.371 to 0.395. This shows that, in the respondents' opinion; majority of the factors affecting quality selected for this study were also more frequently occurring in MSCPN.

2.3.5 Factors affecting quality from the view of project parties

Ranking of the factors affecting quality from the view of main project parties are given in Appendix Table F4. Among them, ten most important quality factors in MSCPN from the view of project parties are shown in Table 41.

Table 41 shows that, factors affecting quality with rank 1st, 2nd and 5th in the overall results (Table 37) are also common for all project parties except some differences in their ranking and are already explained earlier in the overall results. Regarding the difference in ranking by project parties, quality factor “contractors’ and sub-contractors’ knowledge and experience in QC, QA and QMS” was ranked 1st by the owner but ranked 10th by the contractors. This is because this quality factor is attributed to the contractors and sub-contractors. In the opinion of the contractors “establishment of the safety system” is the most critical factor affecting the quality, hence ranked 1st. But consultants have opinion that “proper arrangement of resources throughout the project period” is the most critical factor to achieve quality hence ranked 1st. As explained earlier, all these factors are vital for achieving quality

As shown in above Table 41, all project parties were found to give almost similar rank (owners 4th, contractors 5th and consultants 5th) to the factor “establish and maintain regular formal and informal communication and regular meeting of the project teams”. As explained earlier in the overall results, regular meeting and communication helps to create same understanding and action among the main project parties regarding the project quality requirement, hence is vital for achieving quality in Nepalese working conditions.

Table 41 Ten most important factor affecting quality in MSCPN from the view of project parties

Factor Code	Factors affecting quality	LIFI Rank		
		Owner	Consultant	Contractor
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	1	6	10
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	2	2	*
A.5	Quality performance and quality policy of contractors	3	7	*
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	4	5	5
C.3	Proper documentation system	5	*	*
C.1	Good planning with the use of appropriate technology for construction	6	*	*
D.5	Proper mobilization of the equipments and machine during construction	7	*	6
D.4	Equipment breakdown during construction period	8	3	9
C.4	Proper arrangement of resources throughout the project period	9	1	*
C.8	Regular updating of quality plan	10	*	2
B.7	Available time and budget	*	4	*
B.6	Availability of the utilities and quality construction material in the construction area	*	8	*
D.7	Lack of qualified workforce	*	9	*

Table 41 (Continued)

Factor Code	Factors affecting quality	LIFI Rank		
		Owner	Consultant	Contractor
D.6	Skill and competency of the operator using the machine and equipments	*	10	*
C.10	Establishment of the safety system.	*	*	1
C.9	Effective conflict resolution method to solve quality related issues among the project participants	*	*	3
D.2	Good quality construction material not easily available	*	*	4
A.1	Owner's level of Knowledge and experience in Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS)	*	*	7
D.1	Construction materials not easily available in the market.	*	*	8

Symbol: '*' Factors affecting quality that are not within the top 10 rank in MSCPN

Regarding the quality factors common to the two project parties; owners and consultants strongly stressed that, “establishment of QC, QA and QMC system along with the effective monitoring and feedback systems”, “quality performance and quality policy of contractors” and “proper arrangement of resources throughout the project period” is vital for achieving good quality. Similarly, owners and contractors have the opinion that “proper mobilization of the equipments and machine during construction” is critical for achieving quality.

Table 41 further shows that, individually owners stressed for the need of good planning; use of appropriate technology; documentation system; and co-ordination among the key project participants; for achieving good quality. Similarly,

consultants emphasized on resources; such as available time and budget; utilities, qualified workforce; skilled and competent operator. Whereas, contractors focused on the need of good quality material; equipment mobilization; safety arrangement; owners' knowledge on different quality aspects; effective conflict resolution method; and updating of quality plan.

2.3.6 Factors affecting quality from the view of project types

Ranking of the factors affecting quality from the view of project types are given in Appendix Table F5. Ten most important project specific factors affecting quality in MSCPN are presented in Table 42.

Table 42 shows that, “establishment of QC, QA and QMC system along with the effective monitoring and feedback systems” is the most important factor common to the all project types. This unanimous opinion by all project types seems to be rational, since this factor has been the most vital for achieving quality in Nepalese construction situation and is explained earlier in detail.

From Table 42 it is apparent that, quality in the irrigation project was more affected by “material, equipment and labor related factors”. Whereas, in the road project; “management related factors” were predominant for affecting quality. Similarly, construction quality in hydropower project was found to be affected more by “management”, “project participants” and “material, equipment and labor related factors”. On the other hand, quality in water supply project was affected more by “management” and “project participants” related factors.

It can be observed that, irrigation projects are mostly located in inaccessible areas having no utilities. They also need good quality materials as well as properly planned and uninterrupted work operations for sensitive hydraulic structures. They also need uninterrupted supply of huge quantity of construction materials.

Table 42 Ten most important factors affecting quality in MSCPN from the view of project types

Factor Code	Factors affecting quality	Project type			
		Irrigation	Water supply	Road	Hydro power
D.4	Equipment breakdown during construction period	1	*	7	*
D.7	Lack of qualified workforce	2	8	*	*
B.7	Available time and budget	3	*	*	10
D.2	Good quality construction material not easily available	4	*	*	*
C.4	Proper arrangement of resources throughout the project period	5	4	1	*
D.6	Skill and competency of the operator using the machine and equipments	6	*	*	9
C.5	Use of modern construction management techniques and tools	7	7	*	*
B.6	Availability of the utilities and quality construction material in the construction area	8	*	*	*
D.5	Proper mobilization of the equipments and machine	9	6	8	*
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	10	1	6	7
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	*	2	3	5
A.5	Quality performance and quality policy of contractors	*	5	*	*

Table 42 (Continued)

Factor Code	Factors affecting quality	Project type			
		Irrigation	Water supply	Road	Hydro power
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	*	3	5	1
C.1	Good planning with the use of appropriate technology for construction	*	9	10	6
A.6	Coordination and relationship between the contractor, sub-contractors and material supplier	*	10	*	*
A.4	Quality commitment and co-ordination among the key project participants	*	*	2	*
C.10	Establishment of the safety system.	*	*	4	*
C.3	Proper project documentation system	*	*	9	*
D.1	Construction materials not easily available in the market.	*	*	*	2
E.2	Fluctuations in the material, machine and labor cost	*	*	*	3
A.2	Consultants knowledge and experience in QC, QA and QMS	*	*	*	4
C.8	Regular updating of quality plan	*	*	*	8

Symbol: ‘*’ Factor affecting quality that was not within the top 10 rank in MSCPN

Furthermore, irrigation projects were mostly undertaken by the Chinese contractors. It was noticed that, Chinese contractors generally bring high level and middle level technicians from their own country, but they mostly have communication problems. Besides that, they were found to be equipped with moderately conditioned machines and equipment compared to the Japanese and

German contractors working in MMHEP and BSBRP. As a result of location specific, work nature and contractor specific, problems; “material, equipment and labor related factors” were found predominant in irrigation projects affecting the quality.

Road projects involve comparatively smaller works scattered along the long stretch of project area. Due to this, road projects require involvement of number of sub-contractors. It has been noticed that, road projects mostly employed Nepalese contractors and sub-contractors having comparatively less managerial capability as compared to the foreign contractors. This shows that, road project has its own specific work nature and implemented mostly by Nepalese contractors and sub-contractors. Due to these facts, respondents from the road projects were found to give more emphasize on management related factor to achieve quality.

From Table 42, it can be observed that respondents from the water supply project emphasized on different management aspects affecting the quality such as, “establishment of QC, QA and QMC within the project”, “good planning and resource management”, “use of modern construction management techniques and tools” and “regular meeting and communications between the project parties”. They also stressed on the vital role of the contractors, sub-contractors and even material suppliers for achieving quality. As stated earlier, MWSP is in initial stage of its construction. Their major construction components have not started yet. It can be realized that, if the above stated basic aspects of quality are established and implemented from the earlier stage of implementation in MWSP, it will gradually move to the other aspects of quality in the future to achieve good quality in their major construction components.

Compared to the other three sample projects, MMHEP was noticed complex involving different nature of works and multiple parties. For example, civil works in hydropower projects were huge in volume, more sensitive and risky. Electrical, electromechanical, transmission line and tunnelling works were highly specialized in nature. Due to this diversified nature of works, hydropower projects require precise equipments, well planned operation and experienced project parties to

achieve good quality. Hence from Table 42, it was obvious to notice that, quality in hydropower projects have been affected by all categories of quality factors i.e. management, project participants, project characteristic; material, equipment and labor and external. This also shows that, the hydropower projects were the most sensitive to achieve quality of construction works.

2.4 Correlations of the opinions between the project parties for the causes of delay, causes of cost overrun and factors affecting quality.

The values of Spearman rank correlation coefficients (γ) between the project parties in pair calculated separately for 65 causes of delays; 19 causes of cost overrun; and 35 factors affecting quality are shown in Table 43, Table 44 and Table 45 respectively.

Table 43 shows that, all project parties in pair have ' γ ' values greater than 0.50 indicating large strengths of correlation in their opinions for the delay causes. Comparison of strengths of correlation between the project parties in pair shows that, there exists the highest correlation between the owners' and the consultants'; intermediate correlation between the owners' and the contractors;' and the lowest correlation between the consultants' and the contractors' views.

Table 43 Spearman rank correlation coefficient between the project parties in pair for the causes of delay in MSCPN

S. No.	Project parties in pair	Level of impact		Frequency of Occurrence	
		' γ '	Strength of correlation	' γ '	Strength of correlation
1.	Owners & Consultants	0.691	Large	0.714	Large
2.	Owners & Contractors	0.562	Large	0.611	Large
3.	Consultants & Contractors	0.515	Large	0.554	Large

Similarly Table 44 shows that, owners and the consultants; and owners and the contractors have large strengths of correlation in their opinions for the level of impact of the causes of cost overrun; but consultants and the contractors have medium strengths of correlation in their opinions for the level of impacts of the causes of cost overrun. Similarly, for the frequency of occurrence of the causes of cost overrun, there noticed large strengths of correlation between the owners and the consultants

Table 44 Spearman rank correlation coefficient between the project parties in pair for the causes of cost overrun in MSCPN

S. No.	Project parties in pair	Level of impact		Frequency of Occurrence	
		' γ '	Strength of correlation	' γ '	Strength of correlation
1.	Owners & Consultants	0.689	Large	0.701	Large
2.	Owners & Contractors	0.581	Large	0.444	Medium
3.	Consultants & Contractors	0.443	Medium	0.487	Medium

opinions, but noticed medium strengths of correlation between the owners and contractors and consultants and the contractors views. From Table 44, comparisons of the strengths of correlation between the project parties in pair shows that, there again exists the highest correlation between the owners' and the consultants' opinion both for the level of impact and frequency of occurrence of the causes of cost overrun. Contractors' opinion were noticed more close to the owners' for the level of impact of causes of cost overrun and more close to the consultants' for the frequency of occurrence of the causes of cost overrun.

Furthermore, regarding the strengths of correlation of their opinions between the project parties in pair for the factors affecting quality, Table 45 shows that, "owners and consultants" have large strengths of correlation in their opinions but "owners and contractors" and "consultants and contractors" have medium strengths of correlation in their opinions for the level of impact and frequency of occurrence of the factors affecting quality. Comparisons of the strengths of correlation

between the project parties shows that, as in the earlier case of causes of delay and causes of cost overrun; there again exists the highest correlation between the “owners and consultants” opinion both for the level of impact and frequency of occurrence of the factors affecting quality. But contractors’ opinion were noticed more close to the consultants regarding the level of impact and more close to the owners regarding the frequency of occurrence of factors affecting quality.

Table 45 Spearman rank correlation coefficient between the project parties in pair for the factors affecting quality in MSCPN

S. No.	Project parties in pair	Level of impact		Frequency of Occurrence	
		‘ γ ’	Strength of correlation	‘ γ ’	Strength of correlation
1.	Owner & Consultants	0.697	Large	0.547	Large
2.	Owner & Contractor	0.457	Medium	0.456	Medium
3.	Consultant & Contractor	0.473	Medium	0.397	Medium

From Table 43, 44 and 45, it was observed that, in all cases consultants, views were found more close to the owners. This was obvious because in practice, consultants also represented the owners’ hence always have their views close to the owners. Contractor’s views were noticed changing depending upon the issues because contractors and owners have differences in their objectives.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Scheduled completion of mega scaled construction projects within the budgeted cost and specified quality performance is prerequisite for achieving fast economic growth of the developing country like Nepal, since they consume significant part of the development resources. Project delay, cost overrun and unsatisfactory quality performance not only preclude for the rational utilization of the scarce national resources; getting project benefits timely and appropriately but also causes a magnitude of negative effects on the project and its participating parties i.e. owner, consultants and contractor. Unfortunately, delays and cost overrun are prevalent and there still exists number of hindrances for achieving satisfactory quality performances of mega scaled construction projects in Nepal.

In this context, an effort was made to study and analyze the schedule performance (SP), cost performance (CP) and quality performance (QP) of ongoing highly prioritized public mega scaled construction projects in Nepal. Furthermore, effort was also made to identify the causes of delay and cost overrun; and factors affecting the quality of mega scaled construction in Nepal. Middle Marshyangdi Hydro Electric Project (MMHEP), Sikta Irrigation Project (SIP), Bardibas-Sindhuli-Banepa Road Project (BSBRP) and Melamchi Water Supply Project (MWSP) were selected as sample projects for this study. These are the highly prioritized public projects representing the major infrastructure sectors in Nepal. This study employed an exploratory research methodology through literature review, field visit, project document study; and questionnaire survey.

This study revealed that, schedule performance and cost performance of the completed as well as ongoing components of the sample projects are not satisfactory; and particularly, in recently completed MMHEP, it is very poor. Similarly, it was noted that, quality performance of MWSP is not at the satisfactory level compared to the other sample projects. This study also identified some quality aspects required

to be incorporated in MSCPN to improve the quality performance in future.

Through this study, an effort was also made to quantitatively evaluate the relative importance of each causes of delays and causes of cost overrun; and each factors affecting the quality in Nepalese mega scaled construction; and further to identify the most critical causes and factors. The overall results indicates that, problems (strikes, blockade and obstructions) caused by different political parties, labor groups and trade unions; frequent obstruction in construction activities by the local communities, NGOs and INGOs; long time taken to make decisions and approvals; shortage of fuel, lubricants and construction materials; social and political conflicts; undue influence from the political sectors and other groups; adhoc management adopted by majority of the contractors and sub-contractors; lack of effective planning and scheduling technique, lack of co-ordination between the concerned agencies; are the most critical causes of delays.

Similarly, conflict situation inside the country; frequent strikes and closure of work by the workers trade unions; inflation at national and international markets; unexpected rise in price of fuel and lubricants; construction delay or time extension; price escalation of construction materials in the international markets; over dependency on foreign assistances, foreign contractors, construction materials and technologies for project execution; unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area; delay in decision making; and fluctuations in exchange rate are the most important causes of cost overrun in Nepalese mega scaled construction.

Furthermore, regarding the quality aspects of mega scaled construction in Nepal it was noted that, problems of establishing and maintaining regular formal and informal communication of the project teams; problems of proper arrangement of resources throughout the project period; contractors and sub-contractors lacking knowledge and experience in QC, QA and QMS aspects; problems of establishing QC, QA and QMS system along with the effective monitoring and feedback systems within the mega scaled project construction; equipment breakdown during construction

period; good quality construction material not easily available; contractors not having standard quality policy and good quality performance; problems in proper mobilization of the equipment and machine during construction; and problems in regular updating of quality plan; are the most critical factors affecting the quality.

This study concluded that, delays are always associated with the cost overrun in Nepalese mega scaled construction. This study also revealed that, social and political conflicts prevailing inside the country; frequently occurring strikes, closure, blockade and obstructions in the name of different political parties, labor groups and trade unions; frequent obstruction in construction activities by the local communities, NGOs and INGOs for their never ending demands; problems of decision making at the policy level and project level; problems (shortage as well as price rise) of fuel and lubricants are the most critical problems in mega scaled construction in Nepal which directly caused delays and cost overrun and to some extent, also affected the quality of construction.

Through this study altogether, 65 causes of delay; 19 causes of cost overrun; and 35 quality related factors; were tested for their relative importance for causing delays, cost overrun and affecting quality performance respectively in mega scaled construction in Nepal. Among them, 61(94%) of causes of delay, 19(100%) causes of cost overrun and 32(92%) of quality related factor got relative level of impact index (LOI) value greater than 0.500 in the respondents opinion. This showed that most of the causes of delays and cost overrun; and quality related factors selected for study are important from the view of their level of impacts causing respective effects in mega scaled construction in Nepal.

Through this study, causes of delays and cost overrun and factors affecting quality were also analyzed separately from the view of the project parties and project types. Values of spearman rank correlation coefficient for the project parties in pair showed that, all project parties have large strengths of correlation in their opinions for the ranking of delays but have large and medium strengths of correlation in their opinions for the ranking of causes of cost overrun and quality related factors.

In summary it can be concluded that, this study evaluated and analyzed the schedule, cost and quality performance of the ongoing public mega scaled construction projects in Nepal; and further revealed the critical causes of delays; causes of cost overrun; and factors affecting the quality.

Recommendations

Based on findings of this study, opinions from the respondents and discussions with the professionals and experts, some specific recommendations are made to mitigate the problems of project delays, cost overrun and quality related issues in mega scaled construction projects in Nepal; and to improve the performance of mega scaled construction projects in future particularly in the aspects of time, cost and quality.

1. National consensus and efforts for smooth project implementation

In order to mitigate the chronic problems of project delays and cost overrun including overall problems in mega scaled project implementation, joint efforts along with the national consensus should be required from the government, political sector, project parties, civil society and the local communities. This would create the national support, commitment and ownership for the mega scaled projects and is prerequisite for smooth project implementation.

2. End of social and political conflicts

Development and peace should be considered as the two wheels of a cart and stable politics would be the driving factor. Hence, ongoing peace process in Nepal should be concluded successfully thus ending social and political conflicts for ever. This would create favorable environment for development within the country and attract more investment in mega scaled projects.

3. Enforce stringent rules for mega scaled project implementation

Strikes, closures, obstructions and any kind of disturbing activities in the mega scaled projects should be prohibited by enforcing strong rules. This would help to create good working environment; implement project work schedule; and reduce project delay as well as claims and counter claims.

4. Enforce comprehensive guidelines for identifying and implementing local level development works

A comprehensive guideline should be enforced to identify and implement local level development works to be undertaken by mega scaled projects. Local level development works should be identified and implemented based on the comprehensive guidelines and adopting participatory approach. This would help to address the genuine local demands by the mega project; and to avoid the present trend of asking never ending and out of the project scope demands from the project in the name of local community, NGOs, INGOs and different groups.

5. Enforce fast track and single door decision making system

Delay in decision making at policy and project level normally leads to delayed completion of a project followed by number of claims and counter claims. It has been observed that, mega project related decisions were delayed generally due to the tendency of giving same priority to the all issues by the concerned authority and lack of coordination due to involvement of number of agencies for decision making. The value of timely decision making in mega scaled construction is very significant as compared to the value of decision making for general issues. For example, the contractors claim amount in MMHEP for one day delay was Euro 25000. Revenue loss to the owner due to delayed completion was about Euro 70000 per day. Hence, the total loss due to one day delay in decision making in MMHEP can be estimated as about Euro 95000 (Nrs. 9.50 millions). To avoid these sorts of huge loss to the country, fast track decision making system should be enforced separately for the mega

scaled projects at the policy level. At the project level directives should be enforced to make prompt decisions by the owner and consultants.

Similarly, it would be effective to keep the number of agencies required for decision making in mega scaled projects as minimum as possible. Furthermore, directives should be enforced for prompt coordination between concerned agencies and making decision under single door to avoid delay in decision due to lack of coordination between number of agencies.

Timely decision making would help to execute the project in time. This would minimize the project delays, cost overrun due to claims and counter claims; and also indirectly help to achieve better quality performance

6. Special provisions for the uninterrupted supply of fuel and lubricants; and construction materials

Mega scaled projects need huge quantity of fuel, lubricants and construction materials. Their uninterrupted supply plays a vital role for minimizing project delay and cost overrun, and achieving better quality performance. Considering the prevailing external and internal factors causing interruptions for the regular supply of fuels, lubricants and construction materials; special provisions should be made by the state for ensuring regular supply of construction materials for mega scaled projects. At the same time, proper material management strategy should be adopted by the contractors.

7. Enforcement of single procurement guidelines

Mega projects are executed by following their procurement guidelines. In this context, there is a strong need to have a single procurement guideline for implementing donor funded mega projects in Nepal. This would help to ease and shorten the decision making process; and further to avoid conflicts and confusion in project implementation due to having multiple guidelines.

8. Incentives to the contractors for early finish

Mega scaled projects in Nepal use FIDIC contract documents having provisions of claims and price escalation to compensate contractors for project delay. It has been noticed that, most of the contractors have tendency to intentionally delay the project. They have intention to stop the work even for minor cause. Sometime, they even indirectly provoke the labor to strike. With the help of these kinds of activities, they try to misuse this clause for getting more and more claims and price escalation by justifying their delays rather than focusing on timely completion of contract. This trend has been repeatedly and seriously noticed in Nepalese mega scaled construction especially in hydropower projects causing project delay and cost overrun. To avoid this, lump sum price contract or fixed price contract with provision of bonus for early finish should be adopted in place of existing practice of unit price contract with provisions of price escalation for delay.

9. Enforce stringent penalties for defaulting contractors

Most of the contractors in mega scaled projects intentionally try to delay and justify their delay contractually from the start of the construction by searching legal loopholes in the contract document. It has been noticed that, most of the established contractors prefer to hire good legal advisor rather than good project manager. Government agencies have been found weak to check this trend of contractors. As a result, there can be seen very rare case of imposing penalty or liquidity damage to the contractors for delay. Hence, it is recommended that, along with the incentives for early finish, penalty clauses for defaulters or late finish as prescribed in the contract should be strictly enforced.

10. Realistic time estimate for fixing contract duration

For mega scaled projects, it is important to estimate a realistic contract duration depending upon various factors that affects the construction. For example, complexities of work, work site accessibility, method of construction, availability of

resources and construction materials; social and political conditions; working seasons and others. In Nepalese construction industry, it has been observed that, a very important task of fixing project duration is not being done scientifically or correctly. In most cases, the project duration is being fixed in an adhoc basis or in other words whatever time is available or whatever intuition of a decision making person says is taken as the project duration. Hence, it is very important to fix the project duration scientifically so as to minimize the possibilities of claims and counter claims due to delays. It is recommended that, considering all prevailing conditions and situations, duration of future projects should be realistic and fixed scientifically.

11. Training on construction management tools and techniques for key personnel of main project parties

Key project personnel of the main project parties play the most vital role for effectively managing the project thus minimizing the project delays, cost overrun and achieving better quality performance. It has been observed that, most of the problems related to the time, cost and quality aspects of the construction projects in Nepal are being arised due to poor planning and adhoc management adopted by the owners, contractors and subcontractors. This is happening due to lack of knowledge on construction management tools and techniques. Most of the mega scaled project parties rarely use construction planning software for planning and schedulling the project activities. Most of the owners, consultants and contractors in mega project have been appointing persons with engineering background as the project manager or key project personnel. Hence, it would be effective if these key project personnel were enriched with the knowledge on construction management tools and techniques; use of planning and schedulling software; at the early stage or before the of the start of construction activities.

12. Prepare realistic project estimate

It has been observed that in most of the mega scaled projects, estimated cost is not realistic. Sometime it has been found very low and some time very high.

Furthermore, it has been found that, provisions for price changes during construction has not been made in the project estimate on the realistic basis. The main reason for these sorts of discrepancies in the project estimate has been noticed as, less time given for the project study, less involvement of Nepalese engineering professionals in the design and estimate process, adhoc estimation for the price changes and donor dominated conditions. As a results of unrealistic estimate, sometimes projects become unfeasible due to very high cost, some time projects looks attractive initially but have huge cost changes during constructions and most of the time there has been cost changes.

Hence it is recommended that, realistic project estimate should be prepared based on the precise study and by involving maximum Nepalese engineering professionals. There should be some provisions in the project estimate for, price changes due to variation and claims; price adjustments due to national and international inflation; price changes due to fluctuations in the price of fuels, lubricants and construction materials; negative effects due to exchange rates. These provisions should be based on the Nepalese ground reality and prevailing conditions.

13. Maximum use of local and internationally easily available materials.

It has been noticed that, mega scaled construction in Nepal has been predominated mostly by donors or money dictated use of foreign construction materials and machines which mainly caused cost overrun, delays and quality related problems. To minimize this, it is recommended that, Nepal government should enforce its own procurement guidelines. Besides that, prevailing design method should be reviewed to ensure the use of construction materials that are easily available in national and international markets. Cheapest source of supply of good quality materials should be identified and realistic material procurement plan should be prepared during design phase.

14. Adoption of international standard to Nepalese construction industry

It has been noticed that, most of the quality related issues are prevalent in Nepalese mega scaled construction due to lack of QC, QA and QMS aspects of quality in government organizations and Nepalese construction industries. In order to properly incorporate these quality aspects in construction works, it is recommended that Nepal should formally enter in to international standard or ISO 9000 and formally adopt the QMS as prescribed by it ISO 9000 in Nepalese construction industries. ISO 9000 certification should be included in the criteria for contractors prequalification for mega scaled projects.

15. Programs for improving present quality policy and upgrading the present quality performance of the Nepalese contractors.

It has been noticed that, although foreign contractors' are the principal and lead contractors in Nepalese mega scaled construction; Nepalese contractors also have significant inputs in those projects as J/V partner, subcontractors and petty contractors. Furthermore, "contractors and sub-contractors knowledge and experience in QC, QA and QMS"; and Nepalese contractors adopting the traditional quality policy; has been noticed as the common problems in all project types and all project parties. To address these problems in totality, it is recommended that, Nepal government and Federation of the Contractors Association in Nepal (FCAN) should jointly launch short, medium and long term program to upgrade the present quality policy and performance of Nepalese contractors. Besides that, Nepal government and FCAN should encourage and facilitate the potential contractors to receive ISO certification.

16. Equipment planning

Equipment planning (allocation, mobilization, operation and proper maintenance) has been noticed as the major issues for quality, delay and cost overrun.

Regarding this issue, it is recommended that all mega scaled project should identify the required equipment at the early stage, ensure the procurement and delivery of equipment at site before commencement of the works; maintain well equipped machine maintenance shop with required inventory of spare parts with particular emphasis on fast moving and vulnerable parts.

17. Quality planning.

Quality planning helps to formulate a course of action to implement the quality related activities from the beginning of the project to an end of the projects. It also helps to identify and allocate the necessary resources; establish proper monitoring, evaluation and feed back system to achieve quality objectives. Prompt updating of quality plan as needed has been also noticed vital for achieving quality objective. Regarding these issues it is recommended that, all mega scaled project should formulate explicit operational quality plan at the beginning of the project by involving all parties in the project. Quality planning should be an integral part of the project plan and there should have proper mechanisms for its regular updating during the project execution.

18. Establish good communication system

Good communication between the project parties helps to create environment for better understanding about the projects from different perspective; sharing of the project problems related to time, cost and quality issues; and exchange of innovative ideas to solve it. This has specific importance to implement the mega projects in Nepalese condition. Hence it is recommended that, mega scaled project management should give more importance and create conducive environment to establish and maintain good communication between the main project parties in the form of regular formal and informal meetings; gatherings and discussions.

19. Solve manpower related problems

It has been identified that, skill and competency of the operators and lack of qualified work force significantly affected the quality performance of the mega projects. For this, it is recommended that, regular and refresher training of skilled manpower and foreman should be initiated immediately with joint efforts from Nepal government, FCAN and contractors. Besides that, specialized area of non skilled labors i.e. excavation workers, material handlers, transporters, formwork workers and bar benders; concrete workers should be developed and trained at the job site.

20. Timely payment to the contractors

Delay in payment by the employer has been identified as the important factor causing cost overrun and delays. This directly caused cash flow problem to the contractors and hampered contractors all kinds of activities and also caused project delays. Therefore, it is recommended that owners should make arrangements for the timely payment to the contractors so as to solve the financial problems of the contractors.

21. Future research directions

Further researches are recommended to be carried out based on the results of this research. For example, identifying the causes of delays; causes of cost overrun and factors affecting quality in mega scaled projects in different countries, regions and situations. Further researches can also be done to find out the methods to fix the project duration scientifically for mega scaled construction projects in Nepal or in the different countries. In depth research can also be conducted separately in Nepal for different mega project types to find out the project specific root causes of delays, causes of cost overrun and factors affecting quality.

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APPENDICES

Appendix A
Questionnaire

QUESTIONNAIRE

“Study and Analysis of the Performance of Mega Scaled Construction Projects in Nepal”

Dear Sir/Madam,

I am a master degree student in **Construction Engineering and Management** under International Program in Civil Engineering (IPCE), Faculty of Engineering, Kasetsart University, Bangkok, Thailand. As a part of my thesis, I am conducting research on **“Study and Analysis of the Performance of Mega Scaled Construction Projects in Nepal”**, particularly focusing on the time, cost and quality aspects. In this context, I need to gain insight on causes of delay and cost overrun and factors affecting the quality in ongoing mega scaled construction projects (Project cost of greater than Nrs. 1.0 Billion) in Nepal.

The following are a series of questions about issues related to your experience in mega scaled construction projects. By using these questions, my objective is to collect your valuable experience necessary for my research and hence please do not take it as a “test” and there is no “right” and “wrong” answers to any questions. I request for small part of your valuable time to answer the following questions. Your answer will be kept completely confidential and used for this research purpose only.

Questionnaire for the Project Participant (Owner, Consultants and Contractor):

I. General Information:

1. Name of the Respondent:

2. Name and address of the Organization:

.....

3. Designation:

4. Years of Experience:

5. E-mail address:

6. Telephone/Mobile No:

Note:

1. Please select and put (√) mark on the Level of Impact based on your experience and following criteria.

1 = No impact

2 = Little impact

3 = Moderate impact

4 = Great impact

5 = Extreme impact

2. Please select and put (√) mark on the Frequency of occurrence based on your experience and following criteria.

1 = Very low or “Cause or factor happening \leq once in a year”

2 = Low or “Cause or factor happening once in a six month”

3 = Medium or “Cause or factor happening once in a three month”

4 = Often or “Cause or factor happening once in a two month”

5 = Very often or “Cause or factor happening \geq once in a month”

Appendix B

Details of the respondents

Appendix Table B1 Details of the respondents

S. No.	Name	Designation	Organization	Category	Exp. in years	Education	Email
SIKTA IRRIGATION PROJECT							
1.	Rakesh Kumar Jha	Deputy Project Manager	Sikta Irrigation Project	Owner	26	MSC Eng.	-
2.	Madhav Belbase	Senior Divisional Engineer	Sikta Irrigation Project	Owner	19	MSC Eng.	belbasem@gmail.com
3.	J. M Shrestha	Senior Divisional Engineer	Sikta Irrigation Project	Owner	17	MSC Eng.	praje_shrestha@hotmail.com
4.	Tek Bahadur Karki	Senior Divisional Engineer	Sikta Irrigation Project	Owner	23	MSC Eng.	-
5.	Raghu Nath Shrestha	Senior Divisional Engineer	Sikta Irrigation Project	Owner	19	MSC Eng.	-

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Education	Email
SIKTA IRRIGATION PROJECT (Continued):							
6.	Arun Kumar Shrivastava	Team Leader	CMS - ITECO - FBC - BDA J/V	Consultant	35	MSC Eng. -	
7.	Sashi Prasad Dhungana	Quality Control Engineer	CMS - ITECO - FBC - BDA J/V	Consultant	23	MSC Eng.	dhunganashashi@yahoo.cm
8.	Krishna Prasad Paudel	Construction Mgmt. Engineer	CMS - ITECO - FBC - BDA J/V	Consultant	19	MSC Eng.	kp.paudel@gmail.com
9.	Thalesh Purve	Construction Mgmt. Engineer	CMS - ITECO - FBC - BDA J/V	Consultant	13	BSC Eng.	thpve@hotmail.com
10.	Yang Shi Yong	Project Manager	Sinohydro - Lumbini J/V	Contractor	17	MSC Eng.	Yangshiyong70@163.com
11.	Lei Chun Hua	Chief Engineer	Sinohydro - Lumbini J/V	Contractor	11	BSC Eng.	leichunhuanepal@gmail.com
12.	Zhang Jiancang	Commercial Engineer	Sinohydro - Lumbini J/V	Contractor	11	BSC Eng.	zhangjiancang@gmail.com

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Education	Email
MELAMCHI WATER SUPPLY PROJECT							
1.	Sudershan Bhandari	Chief, Planning and Proc. Unit	Melamchi Water Supply Project	Owner	20	MSC Eng.	sudarshan_bhandari@hotmail.com
2.	Ram Chandra Devkota	Chief, Engineering Unit	Melamchi Water Supply Project	Owner	20	MSC Eng.	rcgorkha@gmail.com
3.	Som Nath Poudel	Deputy Team Leader	Melamchi Water Supply Project	Consultant	40	MSC Eng.	alek@wlink.com.np
4.	Mahendra Nath Sharma	Technical Director	Sidef - TAEC J/V	Consultant	30	MSC Eng.	mahendrans@mos.com.np
5.	Dhana Raj Sapkota	Site Engineer	Sidef - TAEC J/V	Consultant	32	MSC Eng.	drsapkota1950@yahoo.com

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Education	Email
MELAMCHI WATER SUPPLY PROJECT (Continued):							
6.	OM Kanta Dhakal	Engineer	Sidef - TAEC J/V	Consultant	12	BSC Eng.	okdhakal@yahoo.com
7.	G.M Pradhan	Contractor's Representative	Marusin Shitaka-Tundi J/V	Contractor	22	BSC Eng.	-
8.	Sandeep Pandey	Material Engineer	Marusin Shitaka-Tundi J/V	Contractor	13	BSC Eng.	sandeep_pandey@hotmail.com
BANEPA - SINDHULI - BARDIBAS ROAD PROJET							
1.	Ramesh Raj Bista	Deputy Director General	Road Department	Owner	30	MSC Eng.	ramesh_rbista@yahoo.co.uk
2.	Dinesh Man Singh Shrestha	Senior Divisional Engineer	Road Department	Owner	20	MSC Eng.	edms@wlink.com.np

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Qualification	Email
BANEPA - SINDHULI - BARDIBAS ROAD PROJET (Continued):							
3.	Buddhi Prasad Neupane	Senior Divisional Engineer	Road Department	Owner	20	MSC Eng.	-
4.	Shyam Prasad Kharel	Senior Divisional Engineer	Road Department	Owner	17	MSC Eng.	yespikharel@yahoo.com
5.	Shiva Raj Adhikari	Senior Divisional Engineer	Banepa - Sindhuli - Badibas Road	Owner	16	MSC Eng.	shivarajadhikari@hotmail.com
6.	Sunil Poudyal	Senior Divisional Engineer	Road Department	Owner	15	MSC Eng.	herzlichst@gmail.com
7.	Samir Dhakal	Deputy Resident Engineer	Nippon Koei Pvt. Ltd.	Consultant	18	MSC Eng.	samirdhakal@yahoo.com

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Qualification	Email
BANEPA - SINDHULI - BARDIBAS ROAD PROJET (Continued):							
8.	Bijaya Bazimaya	Engineer	Hazama Corporation	Contractor	18	MSC Eng.	bibazimaya@hotmail.com
9.	Pradhyumna Man Chitrakar	Project Engineer	Shrestha Construction	Principal Sub-Contractor	14	BSC Eng.	pradhyumna_63@yahoo.com
MIDDLE MARSHYANGDI HYDRO ELECTRIC PROJECT							
1.	Sunil Kumar Dhungel	Project Director	MMHEP	Owner	24	MSC Eng.	-
2.	Niaz Ahmad	Deputy Manager	MMHEP	Owner	25	MSC Eng.	ahmadniaz@yahoo.com
3.	Gynendra Prasad Kayastha	Deputy Manager	MMHEP	Owner	25	MSC Eng.	gkayastha@hotmail.com
4.	Dinesh Bhattarai	Project Engineer	MMHEP	Owner	5	MSC Eng.	dineshbhattarai@gmail.com
5.	Tirtha Bahadur Ghale	Deputy Resident Engineer	Fishner Joint Venture	Consultant	40	MSC Eng.	tb_ghale@hotmail.com
6.	Keshab Raj Wagle	Civil Engineer	Fishner J/V	Consultant	32	BSC Eng.	keshab_wagle@yahoo.com

Appendix Table B1 (Continued):

S. No.	Name	Designation	Organization	Category	Exp. in years	Qualification	Email
MIDDLE MARSHYANGDI HYDRO ELECTRIC PROJECT (Continued):							
7.	Surya Prakash Saha	Civil Engineer	DDC J/V	Contractor	9	BSC Eng.	sps_civil@yahoo.com
8.	Nabaraj Adhikari	Civil Engineer	DDC J/V	Contractor	8	BSC Eng.	nabadhikari@yahoo.com
OTHERS RELATED TO THE SAMPLE PROJECTS							
1.	Arjun Kumar Karki	Joint Secretary	Ministry of Water Resources	Owner	20	MSC Eng.	akkarki77@yahoo.com
2.	Pramendra Krishna Shrestha	Project Engineer	Chitawan Construction & Engineering	Contractor	13	MSC Eng.	chitawoncoe@chitawoncoe.com
3.	Deepak Vaidya	Engineer	United Builders & Engg. Pvt. Ltd.	Contractor	10	MSC Eng.	baidyadeepak@gmail.com
4.	Thakur Prasad Sharma	Principal Engineer	Fulbright Consultancy	Consultant	22	MSC Eng	thakur@enet.com.np

Appendix C

Evaluation of quality performance of the sample projects

Appendix Table C1 Evaluation of quality performance of the Sample Projects

S. No.	Name of the Project	Quality evaluation of construction process ¹					Quality evaluation of constructed product ¹			
		QC	QA	QM	QS	Total	Workmanship	Technical Quality	Functionality	Total
1	Sikta Irrigation Project Melamchi Water Supply	5	4	3	3	3.75	3	5	NA	4
2	Project Bardibas - Sindhuli -	4	3	3	3	3.25	3	4	NA	3.5
3	Banepa Road Project Middle Marshyangdi Hydro	5	4	4	4	4.25	4	5	NA	4.5
4	Electric Project	5	5	4	4	4.5	5	5	5	5

Symbol: ¹ Evaluation criteria, 1 = Poor; 2 = Fair; 3 = Good; 4= Great and 5 = Excellent

Appendix D

Ranking of the delay causes in MSCPN

Appendix Table D1 Result of the overall ranking of the delay causes in MSCPN

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	0.737	1	0.743	0.995	0.700	1.328
K.7	Various demand raised by the local communities, different NGOs and INGOS	0.724	2	0.662	1.115	0.714	1.438
A.5	Shortage of Fuel, Lubricants and construction material	0.692	3	0.804	0.987	0.605	0.924
F.4	Long time taken to make decision Shortage	0.692	4	0.732	0.962	0.657	1.175
K.9	Social and political conflict	0.653	5	0.691	1.107	0.643	1.298
F.1	Getting permits and approval takes long time	0.627	6	0.684	1.191	0.600	1.343
K.8	Influence from the political sector and other groups	0.625	7	0.662	1.115	0.614	1.438
G.11	Adhoc management adopted by majority of the contractors and sub- contractors	0.603	8	0.639	1.226	0.576	1.273
G.10	In-effective project planning and scheduling	0.598	9	0.685	1.273	0.543	1.419
D.5	Lack of co-ordination due to involvement of many agencies	0.586	10	0.635	1.234	0.576	1.173
G.2	Financial/Cash flow problem of the contractor	0.585	11	0.668	1.032	0.543	1.132

Appendix Table D1 (Continued)

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
C.4	Machinery, equipments and Spare parts not easily available	0.584	12	0.694	1.055	0.552	1.118
E.3	Delay in payment by the employer.	0.583	13	0.647	1.080	0.524	1.103
G.12	Lack of modern management knowledge	0.582	14	0.603	1.237	0.586	1.520
E.1	Arranging financial source for the project takes long time	0.582	15	0.716	1.326	0.500	1.293
C.3	Equipment breakdown and repeated failure during construction period	0.572	16	0.629	0.942	0.543	0.995
K.1	Problems of land acquisition, resettlement and EIA issues	0.569	17	0.694	1.109	0.510	1.292
F.6	Late approval of variation	0.568	18	0.686	1.194	0.495	1.273
D.4	Adhoc scheduling practice	0.567	19	0.628	1.208	0.548	1.170
E.2	Contractors and Sub-contractors financially not sound.	0.564	20	0.628	1.087	0.519	1.127
D.6	Management problem and inefficiency.	0.561	21	0.635	1.116	0.519	1.211
D.2	Lack of project control	0.558	22	0.628	1.167	0.524	1.103
E.6	Corruption and lack of transparency	0.552	23	0.625	1.292	0.514	1.364
J.4	Stoppage of work during frequently occurring festivals	0.549	24	0.597	0.869	0.519	1.308

Appendix Table D1 (Continued)

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
D.3	Lack of communication	0.546	25	0.586	0.854	0.538	0.924
E.4	Contractor's non workable low bidding rate.	0.546	26	0.695	1.274	0.467	1.141
E.5	Long reimbursement procedure	0.540	27	0.618	1.113	0.490	1.041
G.8	Delay in sub-contractor's work	0.538	28	0.579	1.122	0.510	1.041
D.1	Deficiency in planning	0.534	29	0.647	1.330	0.471	1.186
A.3	Dependency of construction material in other countries	0.524	30	0.675	1.058	0.443	0.842
G.1	Delay in site mobilization and problem in site management	0.516	31	0.657	1.259	0.443	1.260
G.3	Poor communication and lack of co-ordination with the other parties	0.514	32	0.569	0.942	0.468	0.966
I.3	Lack of know-how of the efficient construction technology	0.513	33	0.582	1.045	0.471	1.008
I.4	Problems in selection of the appropriate technology for the particular work	0.513	34	0.603	1.218	0.462	1.115
B.2	Shortage of highly skilled manpower	0.509	35	0.615	0.997	0.443	1.048
K.4	Restrictions from security and other agencies	0.502	36	0.557	1.335	0.471	1.265

Appendix Table D1 (Continued)

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
H.2	Mandatory to get approval from donor for all decisions	0.499	37	0.609	1.268	0.448	1.206
D.7	Lack of job description of the project staff	0.498	38	0.582	1.058	0.457	0.918
G.4	Conflicts between main contractor and other parties	0.498	39	0.555	1.100	0.471	1.008
J.3	Stoppage of work during rainy season and harsh cold season	0.498	40	0.607	1.024	0.419	1.055
F.7	Custom clearance of imported materials takes long time	0.497	41	0.567	1.042	0.452	1.106
F.2	Long time to approve material sample	0.496	42	0.545	0.918	0.476	0.882
H.1	Mandatory to follow donor's procurement guidelines	0.496	43	0.562	1.057	0.476	1.268
K.3	Unexpected underground conditions	0.495	44	0.645	1.167	0.400	0.988
G.6	Improper construction methods adopted by the contractor	0.493	45	0.566	1.026	0.443	1.180
F.5	Change in scope of works	0.490	46	0.590	1.199	0.419	1.144
G.9	Lack of site specific experience	0.486	47	0.551	1.159	0.448	1.122
F.8	Frequent change of project personnel	0.483	48	0.645	1.122	0.386	1.197
B.1	Shortage of managerial and supervisory level manpower	0.473	49	0.568	1.279	0.424	1.234

Appendix Table D1 (Continued)

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
A.1	Non availability of the construction materials.	0.471	50	0.589	1.218	0.405	0.924
F.9	Delay in contract award	0.471	51	0.639	1.358	0.395	1.199
F.3	Late handover of site	0.465	52	0.580	1.237	0.410	0.936
J.1	Unusual bad weather	0.464	53	0.566	1.292	0.386	0.778
G.5	Schedule conflicts between main and sub-contractors.	0.464	54	0.505	1.088	0.448	1.031
K.5	Lack of utilities	0.463	55	0.484	0.964	0.452	0.989
I.1	Traditional technology used in the construction project	0.462	56	0.535	1.119	0.419	1.008
C.1	Procurement of machinery or equipment takes long time and is complicated	0.455	57	0.570	1.042	0.386	0.947
G.7	Repetitive mistakes and rework during construction	0.449	58	0.532	1.179	0.405	1.070
A.2	Supplier make delay to supply the materials	0.447	59	0.536	0.950	0.400	0.937
K.2	Mismatch between the donor procurement guidelines and government financial regulations	0.446	60	0.565	1.042	0.376	0.916
C.2	Transportation of the equipment to the site is difficult	0.423	61	0.496	1.016	0.376	0.832

Appendix Table D1 (Continued)

Factor Code	Causes of Delay	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
A.4	Supply of manufactured components and employer supplied material is difficult and time taking.	0.423	62	0.504	1.087	0.376	0.832
B.3	Shortage of skilled and unskilled manpower	0.395	63	0.477	1.119	0.352	0.790
I.2	Use of unnecessary Hi-technology for the construction	0.382	64	0.432	1.124	0.362	1.110
J.2	Unprecedented harsh weather	0.370	65	0.533	1.388	0.281	0.627

Appendix Table D2 Result of the overall ranking of the delay causes in MSCPN based on their level of impact

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
A.5	Shortage of Fuel, Lubricants and construction material	0.790	1	3.952 ± 0.986	6
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions	0.776	2	3.880 ± 1.109	2
K.7	Various demand raised by the local communities, different NGOs and INGOS	0.743	3	3.714 ± 0.995	1
F.4	Long time taken to make decision	0.724	4	3.619 ± 0.962	3
E.1	Arranging financial source for the project takes long time.	0.719	5	3.595 ± 1.340	24
E.4	Contractor's non workable low bidding rate.	0.700	6	3.500 ± 1.274	33
G.10	In-effective project planning and scheduling	0.695	7	3.476 ± 1.273	15
K.1	Problems of land acquisition, resettlement, and EIA issues	0.690	8	3.452 ± 1.109	23
F.6	Late approval of variation	0.690	9	3.453 ± 1.194	25
K.9	Social and political conflict	0.686	10	3.429 ± 1.107	4
F.1	Getting permits and approval takes long time	0.681	11	3.405 ± 1.191	7
A.3	Dependency of construction material in other countries	0.676	12	3.381 ± 1.060	41
G.2	Financial/Cash flow problem of the contractor	0.671	13	3.357 ± 1.032	14

Appendix Table D2 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
C.4	Machinery, equipments and Spare parts not easily available.	0.671	14	3.357 ± 1.055	11
K.8	Influence from the political sector and other groups	0.662	15	3.310 ± 1.115	5
G.1	Delay in site mobilization and problem in site management	0.662	16	3.310 ± 1.259	44
D.1	Deficiency in planning	0.657	17	3.286 ± 1.330	31
F.8	Frequent change of project personnel	0.648	18	3.238 ± 1.122	57
G.11	Adhoc management adopted by majority of the contractors and sub-contractors	0.648	19	3.238 ± 1.226	10
F.9	Delay in contract award	0.648	20	3.238 ± 1.358	54
D.6	Management problem and inefficiency	0.643	21	3.214 ± 1.116	19
D.5	Lack of co-ordination due to involvement of many agencies	0.638	22	3.190 ± 1.235	9
E.3	Delay in payment by the employer.	0.633	23	3.167 ± 1.080	17(1)
D.2	Lack of project control	0.633	24(1)	3.167 ± 1.167	17(2)
K.3	Unexpected underground conditions	0.633	24(2)	3.167 ± 1.167	53
D.4	Adhoc scheduling practice	0.633	25	3.167 ± 1.208	12
C.3	Equipment breakdown and repeated failure during construction period	0.624	26	3.119 ± 0.942	13

Appendix Table D2 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
E.2	Contractors and Sub-contractors financially not sound	0.624	27	3.119 ± 1.086	18
E.6	Corruption and lack of transparency.	0.624	28	3.119 ± 1.252	21
B.2	Shortage of highly skilled manpower	0.614	29	3.071± 0.997	42
E.5	Long reimbursement procedure	0.614	30	3.071± 1.113	26
I.4	Problem in selection of the appropriate technology for the particular work.	0.614	31	3.071± 1.218	34
G.12	Lack of modern management knowledge	0.614	32	3.071± 1.237	8
H.2	Mandatory to get approval from donor for all the contractual decisions	0.610	33	3.048 ± 1.268	40
J.3	Stoppage of work during rainy season and harsh cold season	0.605	34	3.024 ± 1.187	47
J.4	Stoppage of work during frequently occurring festivals	0.595	35	2.976 ± 0.869	20
F.5	Change in scope of works	0.595	36	2.976 ± 1.200	48
D.3	Lack of communication	0.590	37	2.952 ± 0.854	16
G.9	Lack of site specific experience	0.590	38	2.952 ± 1.058	35
I.3	Lack of know-how of the efficient construction technology	0.586	39	2.929 ± 1.045	30(1)
A.1	Non availability of the construction materials.	0.586	40	2.929 ± 1.218	50

Appendix Table D2 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
F.3	Late handover of site	0.586	41	2.929 ± 1.237	49
G.8	Delay in sub-contractor's work	0.581	42	2.905 ± 1.122	22
G.3	Poor communication and lack of co-ordination with the other parties	0.576	43	2.881 ± 0.942	27
D.7	Lack of job description of the project staff	0.571	44	2.857 ± 1.026	43
H.1	Mandatory to follow donor's procurement guidelines	0.567	45	2.833 ± 1.057	29
C.1	Procurement of machinery or equipment takes long time and is complicated	0.562	46(1)	2.810 ± 1.041	56
F.7	Custom clearance of imported materials takes long time	0.562	46(2)	2.810 ± 1.041	37
G.8	Delay in sub-contractor's work	0.581	42	2.905 ± 1.122	22
G.3	Poor communication and lack of co-ordination with the other parties	0.576	43	2.881 ± 0.942	27
D.7	Lack of job description of the project staff	0.571	44	2.857 ± 1.026	43
H.1	Mandatory to follow donor's procurement guidelines	0.567	45	2.833 ± 1.057	29
C.1	Procurement of machinery or equipment takes long time and is complicated	0.562	46(1)	2.810 ± 1.041	56
F.7	Custom clearance of imported materials takes long time	0.562	46(2)	2.810 ± 1.041	37

Appendix Table D2 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
K.2	Mismatch between the donor procurement guidelines and government financial regulations	0.562	46(3)	2.810 ± 1.041	59
J.1	Unusual bad weather	0.562	47	2.810 ± 1.292	55
G.6	Improper construction methods adopted by the contractor	0.557	48	2.786 ± 1.159	39
B.1	Shortage of managerial and supervisory level manpower	0.557	49	2.786 ± 1.279	45
K.4	Restrictions from security and other agencies	0.557	50	2.786 ± 1.350	32
G.4	Conflicts between main contractor and other parties	0.552	51	2.762 ± 1.100	30(2)
F.2	Long time to approve material sample	0.543	52	2.714 ± 0.918	28
A.2	Supplier make delay to supply the materials	0.538	53	2.690 ± 0.950	52
G.7	Repetitive mistakes and rework during construction	0.538	54	2.690 ± 1.179	51
J.2	Unprecedented harsh weather	0.538	55	2.690 ± 1.926	62
I.1	Traditional technology used in the construction project	0.533	56	2.667 ± 1.119	46
A.4	Supply of manufactured components and employer supplied material is difficult and time taking.	0.510	57	2.547 ± 1.086	58(1)
G.5	Schedule conflicts between main and Sub - contractors.	0.500	58	2.500 ± 1.088	38

Appendix Table D2 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
C.2	Transportation of the equipment to the site is difficult	0.486	59	2.429 ± 1.015	58(2)
K.5	Lack of utilities	0.481	60	2.404 ± 0.964	36
B.3	Shortage of skilled and unskilled manpower	0.467	61	2.333 ± 1.119	61
I.2	Use of unnecessary Hi- technology for the construction	0.433	62	2.167 ± 1.124	60

Appendix Table D3 Result of the overall ranking of the delay causes in MSCPN based on their frequency of occurrence

Factor Code	Causes of Delay	Level of Impact			FOI
		FOI	Rank	Mean & SD	Rank
K.7	Various demand raised by the local communities, different NGOs and INGOS	0.714	1	3.571 ± 1.328	3
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	0.700	2	3.500 ± 1.502	2
F.4	Long time taken to make decision	0.657	3	3.286 ± 1.174	4
K.9	Social and political conflict	0.643	4	3.214 ± 1.298	10
K.8	Influence from the political sector and other groups	0.614	5	3.071 ± 1.438	15
A.5	Shortage of Fuel, Lubricants and construction material	0.605	6	3.024 ± 0.924	1
F.1	Getting permits and approval takes long time	0.600	7	3.000 ± 1.042	11
G.12	Lack of modern management knowledge	0.586	8	2.929 ± 1.521	32
D.5	Lack of co-ordination due to involvement of many agencies	0.576	9	2.881 ± 1.173	22
G.11	Adhoc management adopted by majority of the contractors and sub-contractors	0.576	10	2.881 ± 1.273	19
C.4	Machinery, equipments and Spare parts not easily available.	0.552	11	2.762 ± 1.118	14
D.4	Adhoc scheduling practice	0.548	12	2.738 ± 1.170	25
C.3	Equipment breakdown and during construction period	0.543	13	2.714 ± 0.995	26

Appendix Table D3 (Continued)

Factor Code	Causes of Delay	Level of Impact			FOI
		FOI	Rank	Mean & SD	Rank
G.2	Financial/Cash flow problem of the contractor	0.543	14	2.714 ± 1.132	13
G.10	In-effective project planning and scheduling	0.543	15	2.714 ± 1.419	7
D.3	Lack of communication	0.538	16	2.690 ± 0.924	37
E.3	Delay in payment by the employer.	0.524	17	2.619 ± 1.103	23
J.4	Stoppage of work during frequently occurring festivals	0.519	18	2.595 ± 1.308	35
E.6	Corruption and lack of transparency.	0.514	19	2.571 ± 1.364	28
G.8	Delay in sub-contractor's work	0.510	20	2.548 ± 1.041	42
K.1	Problems of land acquisition, resettlement and EIA issues.	0.510	23	2.548 ± 1.292	8
E.1	Arranging financial source for the project takes long time.	0.500	24	2.500 ± 1.292	5
F.6	Late approval of variation	0.495	25	2.476 ± 1.273	9
E.5	Long reimbursement procedure	0.490	26	2.452 ± 1.041	30
G.3	Poor communication and lack of co-ordination with the other parties	0.486	27	2.429 ± 0.966	43
F.2	Long time to approve material sample	0.476	28	2.381 ± 0.882	52
H.1	Mandatory to follow donor's procurement guidelines	0.476	29	2.381 ± 1.267	45
I.3	Lack of know-how of the efficient construction technology	0.471	30(1)	2.357 ± 1.008	39
G.4	Conflicts between main contractor and other parties	0.471	30(2)	2.357 ± 1.008	51

Appendix Table D3 (Continued)

Factor Code	Causes of Delay	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
D.1	Deficiency in planning	0.471	31	2.357 ± 1.186	17
K.4	Restrictions from security and other agencies	0.471	32	2.357 ± 1.265	50
E.4	Contractor's non workable low bidding rate.	0.467	33	2.333 ± 1.141	6
I.4	Problems in selection of the appropriate technology for the particular work.	0.462	34	2.310 ± 1.115	31
G.9	Lack of site specific experience	0.457	35	2.286 ± 0.918	38
K.5	Lack of utilities	0.452	36	2.262 ± 0.989	60
F.7	Custom clearance of imported materials takes long time	0.452	37	2.262 ± 1.105	46(2)
G.5	Schedule conflicts between main and sub-contractors.	0.448	38	2.238 ± 1.032	58
G.6	Improper construction methods adopted by the contractor	0.448	39	2.238 ± 1.122	48
H.2	Mandatory to get approval from donor for all the contractual decisions	0.448	40	2.238 ± 1.206	33
A.3	Dependency of construction material in other countries	0.443	41	2.214 ± 0.842	12
B.2	Shortage of highly skilled manpower	0.443	42	2.214 ± 1.048	29
D.7	Lack of job description of the project staff	0.443	43	2.214 ± 1.180	44
G.1	Delay in site mobilization and problem in site management	0.443	44	2.214 ± 1.260	16

Appendix Table D3 (Continued)

Factor Code	Causes of Delay	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
B.1	Shortage of managerial and supervisory level manpower	0.424	45	2.119 ± 1.234	49
I.1	Traditional technology used in the construction project	0.419	46	2.095 ± 1.007	56
J.3	Stoppage of work during rainy season and harsh cold season	0.419	47	2.095 ± 1.055	34
F.7	Change in scope of works	0.419	48	2.095 ± 1.144	36
F.3	Late handover of site	0.410	49	2.048 ± 0.936	41
A.1	Non availability of the construction materials.	0.405	50	2.024 ± 0.924	40
G.7	Repetitive mistakes and rework during construction	0.405	51	2.024 ± 1.071	54
A.2	Supplier make delay to supply the materials	0.400	52	2.000 ± 0.937	53
K.3	Unexpected underground conditions	0.400	53	2.000 ± 0.988	24(2)
F.9	Delay in contract award	0.395	54	1.976 ± 1.200	20
J.1	Unusual bad weather	0.386	55	1.929 ± 0.778	47
C.1	Procurement of machinery or equipment takes long time and is complicated	0.386	56	1.929 ± 0.947	46(1)
F.8	Frequent change of project personnel	0.386	57	1.929 ± 1.197	18
A.4	Supply of manufactured components and employer supplied material is difficult and time taking.	0.376	58(1)	1.881 ± 0.832	57

Appendix Table D3 (Continued)

Factor Code	Causes of Delay	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
C.2	Transportation of the equipment to the site is difficult	0.376	58(2)	1.881 ± 0.832	59
K.2	Mismatch between the donor procurement guidelines and government financial regulations	0.376	59	1.881 ± 0.964	46(3)
I.2	Use of unnecessary Hi-technology for the construction	0.362	60	1.810 ± 1.109	62
B.3	Shortage of skilled and unskilled manpower	0.352	61	1.762 ± 0.791	61
J.2	Unprecedented harsh weather	0.281	62	1.405 ± 0.627	55

Appendix Table D4 Result of the ranking of the delay causes in MSCPN from the view of project parties

Factor Code	Causes of Delay	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
K.7	Various demand raised by the local communities, different NGOs and INGOS	0.726	1	0.723	5	0.721	4
K.6	Problems (strikes, blockade and obstructions) caused by different labor groups of trade unions.	0.691	2	0.766	1	0.755	2
G.10	In-effective project planning and scheduling	0.691	3	0.676	13	0.433	53
A.5	Shortage of Fuel, Lubricants and construction material	0.631	4	0.684	10	0.760	1
G.2	Financial/Cash flow problem of the contractor	0.616	5	0.600	23	0.562	15
K.9	Social and political conflict	0.616	6	0.685	9	0.658	6
F.4	Long time taken to make decision	0.614	7	0.741	3	0.722	3
K.8	Influence from the political sector and other groups	0.613	8	0.730	4	0.530	17
F.6	Late approval of variation	0.612	9	0.504	43	0.587	11
G.12	Lack of modern management knowledge	0.611	10	0.684	11	0.450	48
G.11	Adhoc management adopted by majority of the contractors and sub-contractors	0.608	11	0.675	14	0.510	23

Appendix Table D4 (Continued)

Factor Code	Causes of Delay	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
K.1	Problems of land acquisition, resettlement, and EIA issues.	0.601	12	0.608	21	0.498	26
D.3	Lack of communication	0.586	13	0.534	34	0.519	20
F.1	Getting permits and approval takes long time	0.586	14	0.700	6	0.595	10
D.4	Adhoc scheduling practice	0.575	15	0.685	8	0.443	51
E.1	Arranging financial source for the project takes long time.	0.572	16	0.648	16	0.526	18
E.4	Contractors non workable low bidding rate	0.572	17	0.620	20	0.446	50
J.4	Stoppage of work during frequently occurring festivals	0.559	18	0.479	52	0.608	9
D.6	Management problem and inefficiency.	0.558	19	0.630	17	0.493	29
G.3	Poor communication and lack of co-ordination with the other parties	0.557	20	0.510	40	0.473	41
D.5	Lack of co-ordination due to involvement of many agencies	0.554	21	0.745	2	0.472	42
I.3	Lack of know-how of the efficient construction technology	0.552	22	0.518	38	0.469	43
D.2	Lack of project control	0.550	23	0.627	18	0.497	27
G.9	Lack of site specific experience	0.548	24	0.471	56	0.473	40
G.8	Delay in sub-contractor's work	0.543	25	0.447	60	0.625	7

Appendix Table D4 (Continued)

Factor Code	Causes of Delay	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
I.4	Problems in selection of the appropriate	0.541	26	0.550	30	0.448	49
H.2	Mandatory to get approval from donor for contract decisions	0.533	27	0.487	47	0.477	39
G.1	Delay in site mobilization and problem in site management	0.531	28	0.566	25	0.450	47
J.3	Stoppage of work during rainy season and harsh cold season	0.528	29	0.484	51	0.483	36
A.3	Dependency of construction material in other countries	0.525	30	0.539	33	0.507	24
E.2	Contractors and Sub-contractors financially not sound.	0.522	31	0.680	12	0.491	30
F.8	Frequent change of project personnel	0.516	32	0.523	36	0.411	55
F.9	Delay in contract award	0.515	33	0.520	37	0.377	63
H.1	Mandatory to follow donor's procurement guidelines	0.513	34	0.575	26	0.401	60
F.3	Late handover of site	0.513	35	0.486	48	0.398	61
E.6	Corruption and lack of transparency.	0.511	36	0.656	15	0.490	31
D.1	Deficiency in planning	0.510	37	0.606	22	0.486	32
C.3	Equipment breakdown during construction period	0.508	38	0.625	19	0.581	13
G.6	Improper construction methods adopted by the contractor	0.504	39	0.487	45	0.465	44

Appendix Table D4 (Continued)

Factor Code	Causes of Delay	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
E.3	Delay in payments by the employer	0.503	40	0.543	32	0.703	5
F.5	Change in scope of works	0.502	41	0.454	59	0.515	22
B.2	Shortage of highly skilled manpower	0.493	42	0.517	39	0.517	21
D.7	Lack of job description of the project staff	0.490	43	0.599	24	0.388	62
C.4	Machinery, equipments and Spare parts not easily available.	0.488	44	0.696	7	0.624	8
E.5	Long reimbursement procedure	0.488	45	0.550	31	0.583	12
F.2	Long time to approve material sample	0.484	46	0.484	49	0.521	19
F.7	Custom clearance of imported materials takes long time	0.483	47	0.473	53	0.534	16
G.4	Conflicts between main contractor and other	0.472	48	0.569	27	0.452	46
K.3	Unexpected underground conditions parties	0.468	49	0.455	58	0.562	14
G.7	Repetitive mistakes and rework during construction	0.459	50	0.413	62	0.477	38
K.4	Restrictions from security and other agencies	0.457	51	0.562	28	0.486	34
K.2	Mismatch between the donor procurement guidelines and government financial regulations	0.456	52	0.388	63	0.494	28

Appendix Table D4 (Continued)

Factor Code	Causes of Delay	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
K.5	Lack of utilities	0.444	53	0.487	46	0.458	45
J.1	Unusual bad weather	0.443	54	0.463	55	0.486	33
A.2	Supplier make delay to supply the materials	0.438	55	0.463	54	0.440	52
I.1	Traditional technology used in the construction project	0.435	56	0.524	35	0.428	54
A.1	Non availability of the construction materials.	0.432	57	0.504	42	0.477	37
G.5	Schedule conflicts between main and sub-contractors.	0.431	58	0.458	57	0.501	25
J.2	Unprecedented harsh weather	0.429	59	0.323	65	0.358	65
B.1	Shortage of managerial and supervisory level manpower	0.425	60	0.509	41	0.485	35
A.4	Supply of manufactured components and employer supplied material is difficult and time taking.	0.414	61	0.484	50	0.371	64
C.1	Procurement of machinery or equipment takes long time and is complicated	0.406	62	0.554	29	0.405	58
I.2	Use of unnecessary Hi-technology for the construction	0.405	63	0.337	64	0.406	57
C.2	Transportation of the equipment to the site is difficult	0.376	64	0.493	44	0.401	59
B.3	Shortage of skilled and unskilled manpower difficult	0.359	65	0.419	61	0.407	56

Appendix Table D5 Result of the ranking of the delay causes in MSCPN from the view of project types

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
K.6	Problems (strikes, blockade) caused by different labor groups.	0.748	1	0.783	0.717	0.820	2	0.822	0.822	0.657	5	0.727	0.618	0.711	3	0.780	0.660
A.5	Shortage of Fuel, Lubricants and construction material	0.736	2	0.850	0.650	0.633	24	0.711	0.578	0.650	6	0.782	0.564	0.694	4	0.800	0.620
F.4	Long time taken to make decision	0.685	3	0.667	0.700	0.785	4	0.756	0.822	0.629	10	0.727	0.564	0.642	5	0.760	0.560
F.1	Getting permits and approval takes long time	0.607	4	0.600	0.633	0.742	9	0.756	0.756	0.600	16	0.655	0.564	0.563	18	0.740	0.460
C.4	Machinery, and Spare parts not easily available.	0.590	5	0.633	0.600	0.627	25	0.733	0.556	0.554	30	0.600	0.545	0.588	14	0.740	0.500

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
E.5	Long reimbursement procedure	0.589	6	0.650	0.583	0.611	29	0.667	0.578	0.418	63	0.509	0.364	0.519	28	0.640	0.440
G.2	Financial/Cash flow problem of the contractor	0.585	7	0.633	0.500	0.670	19	0.733	0.644	0.670	3	0.764	0.618	0.464	40	0.560	0.420
K.7	Various demand raised by the local communities, different NGOs and INGOS	0.584	8	0.600	0.567	0.877	1	0.867	0.889	0.735	1	0.764	0.727	0.742	1	0.780	0.720
J.4	Stoppage of work during frequently occurring festivals	0.583	9	0.567	0.567	0.611	30	0.644	0.600	0.571	23	0.673	0.509	0.420	55	0.500	0.400
C.3	Equipment breakdown e during construction period	0.563	10	0.633	0.533	0.614	27	0.600	0.644	0.567	24	0.636	0.545	0.516	29	0.620	0.460

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
K.9	Social and political conflict	0.559	11	0.567	0.600	0.773	6	0.778	0.800	0.565	26	0.673	0.491	0.735	2	0.760	0.720
E.3	Delay in payment by the employer.	0.558	12	0.550	0.567	0.667	20	0.711	0.644	0.474	54	0.600	0.382	0.594	11	0.700	0.520
I.4	Problems in selection of the appropriate technology	0.558	13	0.617	0.483	0.493	53	0.511	0.489	0.565	25	0.655	0.527	0.447	46	0.660	0.340
G.12	Lack of modern management knowledge	0.548	14	0.517	0.567	0.819	3	0.800	0.844	0.641	9	0.691	0.636	0.383	62	0.480	0.320
I.3	Lack of efficient construction technology	0.546	15	0.533	0.517	0.564	38	0.644	0.511	0.522	39	0.636	0.455	0.446	47	0.540	0.400
D.7	Lack of job description	0.544	16	0.517	0.533	0.517	44	0.622	0.444	0.521	40	0.636	0.455	0.397	60	0.520	0.320

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.3	Dependency of construction material in other countries	0.543	17	0.850	0.400	0.483	56	0.511	0.467	0.509	45	0.636	0.436	0.558	19	0.660	0.480
E.6	Corruption	0.540	18	0.533	0.550	0.702	14	0.756	0.667	0.526	37	0.691	0.436	0.452	44	0.540	0.420
J.3	Stoppage of work during rainy season and harsh cold season	0.537	19	0.567	0.450	0.460	58	0.600	0.378	0.470	56	0.618	0.382	0.535	27	0.640	0.460
D.3	Lack of communication	0.527	20	0.533	0.550	0.592	36	0.622	0.578	0.547	32	0.545	0.564	0.552	20	0.680	0.460
B.2	Shortage of highly skilled manpower	0.525	21	0.583	0.500	0.533	41	0.667	0.444	0.524	38	0.655	0.455	0.442	50	0.560	0.360
D.5	Lack of co-ordination due to involvement of many agencies	0.521	22	0.517	0.567	0.691	18	0.756	0.644	0.607	15	0.636	0.600	0.570	17	0.680	0.500

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
G.11	Adhoc management adopted by majority of the contractors and sub- contractors	0.520	23	0.567	0.483	0.763	7	0.733	0.800	0.659	4	0.727	0.618	0.498	34	0.580	0.440
E.1	Arranging financial source for the project takes long time.	0.515	24	0.600	0.450	0.734	10	0.911	0.622	0.504	46	0.655	0.418	0.618	8	0.760	0.540
E.2	Contractors and Sub- contractors financially not sound.	0.510	25	0.550	0.467	0.706	12	0.756	0.667	0.596	17	0.673	0.545	0.461	42	0.540	0.420
K.8	Influence from the political sector and other groups	0.509	26	0.533	0.517	0.750	8	0.756	0.756	0.647	8	0.709	0.600	0.639	6	0.680	0.620

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
K.3	Unexpected underground conditions	0.491	27	0.583	0.417	0.386	63	0.533	0.311	0.555	28	0.709	0.455	0.504	33	0.700	0.400
B.1	Shortage of managerial and supervisory level manpower	0.479	28	0.550	0.433	0.489	54	0.622	0.400	0.484	52	0.527	0.509	0.411	57	0.540	0.340
D.4	Adhoc scheduling practice	0.478	29	0.450	0.533	0.679	16	0.756	0.622	0.595	18	0.691	0.527	0.573	16	0.680	0.520
G.8	Delay in sub-contractor's work	0.478	30	0.533	0.450	0.503	51	0.533	0.489	0.622	13	0.709	0.564	0.536	25	0.540	0.540
D.6	Management problem and inefficiency.	0.469	31	0.500	0.450	0.695	15	0.733	0.667	0.625	12	0.709	0.582	0.491	36	0.660	0.400
F.6	Corruption	0.468	32	0.533	0.400	0.599	35	0.733	0.511	0.628	11	0.800	0.527	0.612	10	0.720	0.560

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
G.3	Poor communication and lack of co-ordination with the other parties	0.464	33	0.483	0.433	0.582	37	0.600	0.578	0.584	22	0.655	0.545	0.463	41	0.580	0.400
A.1	Non availability of the construction materials.	0.457	34	0.617	0.383	0.517	46	0.578	0.489	0.456	60	0.564	0.400	0.441	51	0.580	0.360
G.10	In-effective project planning and scheduling	0.454	35	0.567	0.383	0.717	11	0.756	0.689	0.685	2	0.745	0.655	0.578	15	0.740	0.480
G.5	Schedule conflicts between main and sub-contractors.	0.440	36	0.417	0.483	0.508	49	0.533	0.511	0.473	55	0.545	0.436	0.418	56	0.520	0.360
K.5	Lack of utilities	0.437	37	0.450	0.400	0.502	52	0.489	0.533	0.468	57	0.491	0.473	0.445	48	0.500	0.420
F.2	Long time to approve material	0.436	38	0.467	0.450	0.487	55	0.511	0.489	0.517	41	0.564	0.491	0.543	22	0.640	0.480

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
G.4	Conflicts between main contractor and other parties	0.436	39	0.483	0.417	0.625	26	0.644	0.622	0.502	47	0.564	0.473	0.448	45	0.540	0.400
G.9	Lack of site specific experience	0.429	40	0.533	0.367	0.613	28	0.689	0.556	0.542	34	0.655	0.473	0.457	43	0.500	0.460
F.5	Change in scope	0.415	41	0.467	0.350	0.537	40	0.556	0.533	0.513	44	0.673	0.418	0.513	30	0.700	0.400
C.1	Procurement of machinery, equipment takes long time	0.412	42	0.500	0.333	0.517	47	0.644	0.444	0.467	58	0.545	0.436	0.425	54	0.580	0.340
H.1	Mandatory to follow donor's guidelines	0.411	43	0.417	0.417	0.642	21	0.689	0.622	0.458	59	0.527	0.436	0.536	26	0.680	0.460
H.2	Mandatory to get approval from donor for decisions	0.407	44	0.450	0.383	0.600	34	0.711	0.556	0.494	49	0.600	0.436	0.545	21	0.720	0.440

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.4	Supply of manufactured components and employer supplied material time taking.	0.406	45	0.450	0.400	0.414	62	0.467	0.378	0.440	62	0.600	0.345	0.438	52	0.520	0.380
D.2	Lack of project control	0.403	46	0.417	0.433	0.691	17	0.778	0.644	0.594	19	0.655	0.564	0.592	12	0.740	0.480
F.7	Custom clearance takes long time	0.402	47	0.417	0.383	0.522	43	0.578	0.489	0.529	35	0.618	0.491	0.539	23	0.660	0.460
K.1	Problems of land acquisition, resettlement, clearance and EIA	0.402	48	0.517	0.333	0.774	5	0.822	0.756	0.591	20	0.727	0.509	0.591	13	0.740	0.500
J.1	Unusual bad weather	0.400	49	0.450	0.317	0.562	39	0.622	0.511	0.500	48	0.655	0.400	0.399	59	0.540	0.340

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
E.4	Contractor's non workable low bidding rate.	0.400	50	0.517	0.350	0.638	23	0.733	0.578	0.589	21	0.818	0.455	0.624	7	0.760	0.520
D.1	Deficiency in planning	0.398	51	0.517	0.333	0.605	32	0.733	0.511	0.648	7	0.691	0.636	0.507	31	0.720	0.420
K.2	Mismatch between the donors guidelines and government financial regulation	0.395	52	0.467	0.367	0.432	61	0.600	0.333	0.454	61	0.600	0.364	0.505	32	0.600	0.440
G.6	Improper construction methods adopted by the contractor	0.395	53	0.417	0.367	0.640	22	0.644	0.644	0.555	29	0.655	0.491	0.392	61	0.540	0.320
A.2	Supplier delay to supply the materials	0.385	54	0.467	0.367	0.448	60	0.467	0.444	0.491	51	0.582	0.436	0.468	39	0.640	0.360

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
K.4	Restrictions from security and other agencies	0.378	55	0.383	0.400	0.505	50	0.556	0.489	0.515	42	0.655	0.436	0.613	9	0.660	0.580
F.9	Delay in contract award	0.378	56	0.517	0.300	0.611	31	0.822	0.489	0.528	36	0.636	0.491	0.434	53	0.660	0.320
C.2	Transportation of the equipment to the site is difficult	0.357	57	0.367	0.350	0.460	59	0.511	0.422	0.404	64	0.491	0.364	0.471	38	0.600	0.380
F.3	Late handover of site	0.354	58	0.367	0.350	0.518	45	0.622	0.467	0.513	43	0.691	0.400	0.537	24	0.700	0.440
I.1	Traditional technology used in the construction project	0.354	59	0.333	0.383	0.510	48	0.600	0.444	0.553	31	0.655	0.491	0.442	49	0.580	0.360
F.8	Frequent change of project personnel	0.353	60	0.483	0.250	0.604	33	0.822	0.467	0.545	33	0.691	0.455	0.494	35	0.640	0.400

Appendix Table D5 (Continued)

F C ¹	Causes of Delay	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
G.7	Repetitive mistake and rework during construction	0.345	61	0.400	0.317	0.531	42	0.556	0.533	0.555	27	0.691	0.473	0.384	63	0.520	0.320
I.2	Use of unnecessary hi-technology	0.336	62	0.333	0.350	0.325	65	0.378	0.289	0.493	50	0.545	0.473	0.376	64	0.480	0.320
B.3	Shortage of skilled and unskilled manpower	0.332	63	0.433	0.300	0.471	57	0.533	0.422	0.379	65	0.436	0.345	0.400	58	0.480	0.360
G.1	Delay in site mobilization and problem in site management	0.331	64	0.450	0.267	0.706	13	0.844	0.622	0.615	14	0.764	0.527	0.479	37	0.640	0.400
J.2	Unprecedented harsh weather	0.323	65	0.433	0.233	0.362	64	0.489	0.289	0.480	53	0.673	0.364	0.344	65	0.560	0.240

Symbol: ¹ = Factor Code; ² = LIFI; ³ = Rank

Appendix E

Ranking of the causes of cost overrun in MSCPN

Appendix Table E1 Result of the overall ranking of the causes of cost overruns in
MSCPN

Factor Code	Causes of Cost overrun	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
A.18	Conflict situation inside the country	0.705	1	0.794	1.147	0.651	1.415
A.16	Frequent strikes and closure of work by the workers trade unions.	0.669	2	0.742	1.024	0.621	1.322
A.8	Unexpected rise in price of fuel	0.659	3	0.779	0.824	0.578	1.041
A.2	Inflation (National and International).	0.640	4	0.740	0.928	0.584	1.431
A.6	Price escalation of construction materials in the international markets	0.626	5	0.739	0.811	0.560	1.080
A.1	Construction delay or time extension	0.608	6	0.792	1.229	0.503	1.366
A.3	Exchange rate	0.584	7	0.661	0.897	0.536	1.293
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people	0.582	8	0.658	1.137	0.549	1.335
A.11	Delay in decision making by the employer and the consultants	0.580	9	0.661	0.964	0.530	1.144
A.14	Over dependency on foreign assistance, contractor, construction material and technology.	0.580	10	0.671	1.262	0.527	1.449

Appendix Table E1 (Continued)

Factor Code	Causes of Cost overrun	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
A.10	Delay in payments	0.542	11	0.625	1.000	0.482	1.158
A.17	Corruption	0.530	12	0.613	1.316	0.483	1.186
A.9	Variation order due to increase in quantity of works and change in original scope.	0.528	13	0.641	1.048	0.459	1.199
A.5	Long time gap between estimation date and work execution date	0.511	14	0.637	1.122	0.443	1.127
A.13	Donor dominated procurement guidelines and specification	0.501	15	0.555	1.025	0.469	1.119
A.7	Unexpected sub-surface condition	0.474	16	0.596	1.070	0.396	0.826
A.4	Mistakes in first estimate	0.457	17	0.603	1.156	0.370	0.916
A.12	Change in specification and construction methods during construction stage	0.442	18	0.504	0.773	0.411	1.036
A.19	Change in legislation within or in the other countries from where the construction materials are imported	0.440	19	0.552	1.149	0.385	0.838

Appendix Table E2 Result of the ranking of causes of cost overrun in MSCPN
based on their level of impact

Factor Code	Causes of Cost overrun	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
A.18	Conflict situation inside the country	0.790	1	3.952 ± 1.147	1
A.1	Construction delay or time extension	0.790	2	3.952 ± 1.229	10
A.8	Unexpected rise in price of fuel	0.767	3	3.833 ± 0.824	4
A.6	Price escalation of construction materials in the international markets	0.738	4	3.690 ± 0.811	5
A.16	Frequent strikes and closure of work by the workers trade unions.	0.738	5	3.690 ± 1.023	2
A.2	Inflation (National and International).	0.733	6	3.667 ± 0.928	3
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology for project execution.	0.667	7	3.333 ± 1.262	9
A.3	Exchange rate	0.662	8	3.310 ± 0.897	7
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area that is not included in the estimate.	0.662	9	3.310 ± 1.137	6
A.5	Long time gap between estimation date and work execution date	0.648	10	3.238 ± 1.122	15
A.11	Delay in decision making by the employer and the consultants	0.652	11	3.262 ± 0.964	8

Appendix Table E2 (Continued)

Factor Code	Causes of Cost overrun	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
A.9	Variation order due to increase in quantity of works and change in original scope.	0.643	12	3.214 ± 1.048	14
A.4	Mistakes in first estimate	0.614	13	3.071 ± 1.156	19
A.10	Delay in payments	0.605	14	3.024 ± 0.999	13
A.17	Corruption	0.605	15	3.024 ± 1.316	11
A.7	Unexpected sub-surface condition	0.595	16	2.976 ± 1.070	16
A.13	Donor dominated procurement guidelines and specification	0.557	17	2.786 ± 1.025	12
A.19	Change in legislation within or in the other countries from where the construction materials are imported	0.548	18	2.738 ± 1.149	18
A.12	Change in specification and construction methods during construction stage	0.500	19	2.500 ± 0.773	17

Appendix Table E3 Result of the ranking of causes of cost overrun in MSCPN based on their frequency of occurrence

Factor Code	Causes of Cost overrun	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
A.18	Conflict situation inside the country	0.652	1	3.262 ± 1.415	1
A.16	Frequent strikes and closure of work by the workers trade unions.	0.619	2	3.095 ± 1.322	5
A.2	Inflation (National and International).	0.590	3	2.952 ± 1.430	6
A.8	Unexpected rise in price of fuel	0.576	4	2.881 ± 1.041	3
A.6	Price escalation of construction materials in the international markets	0.567	5	2.833 ± 1.080	4
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area that is not included in the estimate.	0.557	6	2.786 ± 1.335	9
A.3	Exchange rate	0.543	7	2.714 ± 1.293	8
A.11	Delay in decision making by the employer and the consultants	0.529	8	2.643 ± 1.144	11
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology for project execution.	0.519	9	2.595 ± 1.449	7
A.1	Construction delay or time extension	0.500	10	2.500 ± 1.366	2
A.17	Corruption	0.471	11	2.357 ± 1.186	15

Appendix Table E3 (Continued)

Factor Code	Causes of Cost overrun	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
A.13	Donor dominated procurement guidelines and specification	0.467	12	2.333 ± 1.119	17
A.10	Delay in payments	0.462	13	2.310 ± 1.158	14
A.9	Variation order due to increase in quantity of works and change in original scope.	0.462	14	2.310 ± 1.199	12
A.5	Long time gap between estimation date and work execution date	0.452	15	2.262 ± 1.271	10
A.7	Unexpected sub-surface condition	0.400	16	2.000 ± 0.826	16
A.12	Change in specification and construction methods during construction stage	0.400	17	2.000 ± 1.036	19
A.19	Change in legislation within or in the other countries from where the construction materials are imported	0.386	18	1.929 ± 0.838	18
A.4	Mistakes in first estimate	0.376	19	1.881 ± 0.916	13

Appendix Table E4 Result of the ranking of the causes of cost overrun in MSCPN
from the view of project parties

Factor Code	Causes of cost overrun	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
A.18	Conflict situation inside the country	0.693	1	0.742	1	0.680	3
A.16	Frequent strikes and closure of work by the workers trade unions.	0.653	2	0.652	5	0.575	6
A.6	Price escalation of construction materials in the international markets	0.653	3	0.652	6	0.575	7
A.2	Inflation (National and International).	0.640	4	0.691	2	0.590	5
A.8	Unexpected rise in price of fuel	0.625	5	0.645	7	0.706	2
A.15	Unexpected expenses on land acquisition, resettlement and fulfilling demand of local people near project area that is not included in the estimate.	0.623	6	0.576	10	0.547	12
A.3	Exchange rate	0.622	7	0.575	11	0.557	10
A.1	Construction delay or time extension	0.577	8	0.669	3	0.577	8
A.5	Long time gap between estimation date and work execution date	0.576	9	0.509	13	0.448	16

Appendix Table E4 (Continued)

Factor Code	Causes of cost overrun	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
A.11	Delay in decision making by the employer and the consultants	0.570	10	0.530	12	0.640	4
A.9	Variation order due to increase in quantity of works and change in original scope.	0.555	11	0.485	14	0.543	13
A.14	Over dependency on foreign assistance, foreign contractor, construction material and technology for project execution.	0.517	12	0.657	4	0.567	9
A.7	Unexpected sub-surface condition	0.510	13	0.421	18	0.492	15
A.4	Mistakes in first estimate	0.503	14	0.477	15	0.390	19
A.13	Donor dominated procurement guidelines and specification	0.479	15	0.578	9	0.446	17
A.17	Corruption	0.451	16	0.592	8	0.548	11
A.10	Delay in payments	0.448	17	0.443	17	0.734	1
A.19	Change in legislation within or in the other countries from where the construction materials are imported	0.437	18	0.455	16	0.427	18
A.12	Change in specification and construction methods during construction stage	0.401	19	0.412	19	0.515	14

Appendix Table E5 Result of the ranking of causes of cost overrun in MSCPN from the view of project types

F C ¹	Causes of Cost Overrun	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.8	Unexpected rise in price of fuel	0.693	1	0.783	0.617	0.647	8	0.800	0.533	0.597	6	0.745	0.527	0.668	5	0.740	0.620
A.6	Price escalation of construction materials in the international markets	0.660	2	0.717	0.600	0.588	12	0.733	0.489	0.594	8	0.727	0.545	0.680	3	0.780	0.620
A.3	Exchange rate	0.635	3	0.667	0.600	0.589	11	0.667	0.533	0.578	10	0.655	0.545	0.552	12	0.660	0.480
A.2	Inflation (National and International).	0.630	4	0.650	0.600	0.681	5	0.822	0.600	0.625	3	0.727	0.582	0.642	7	0.760	0.580
A.18	Conflict situation inside the country	0.630	5	0.700	0.583	0.829	1	0.889	0.800	0.656	2	0.782	0.582	0.736	1	0.820	0.680
A.16	Frequent strikes and closure of work by the workers trade unions	0.590	6	0.683	0.533	0.701	3	0.756	0.667	0.697	1	0.782	0.636	0.688	2	0.740	0.660
A.10	Delay in payments	0.585	7	0.650	0.533	0.513	14	0.578	0.467	0.433	19	0.564	0.345	0.551	13	0.620	0.500

Appendix Table E5 (Continued)

F C ¹	Causes of Cost Overrun	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.11	Delay in decision making by the employer and the consultants	0.539	8	0.600	0.500	0.680	6	0.689	0.689	0.515	14	0.600	0.455	0.594	9	0.740	0.500
A.1	Construction delay	0.518	9	0.667	0.433	0.696	4	0.867	0.600	0.584	7	0.764	0.473	0.652	6	0.900	0.520
A.14	Over dependency on foreign assistance, contractor, and technology	0.518	10	0.600	0.467	0.638	9	0.689	0.622	0.497	15	0.655	0.400	0.665	4	0.740	0.620
A.5	Long time gape between estimation date and execution	0.477	11	0.483	0.467	0.570	13	0.756	0.467	0.580	9	0.745	0.473	0.467	18	0.640	0.400
A.17	Corruption	0.468	12	0.550	0.417	0.679	7	0.733	0.644	0.519	13	0.636	0.455	0.441	19	0.520	0.400
A.7	Unexpected sub-surface condition	0.463	13	0.567	0.383	0.414	19	0.511	0.356	0.552	11	0.673	0.473	0.472	17	0.620	0.380

Appendix Table E5 (Continued)

F C ¹	Causes of Cost Overrun	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.15	Unexpected expenses on land acquisition and resettlement	0.459	14	0.517	0.450	0.763	2	0.800	0.756	0.604	5	0.727	0.527	0.570	11	0.640	0.540
A.19	Change in legislation within or in the other countries	0.441	15	0.583	0.400	0.450	16	0.556	0.378	0.393	17	0.491	0.327	0.483	15	0.560	0.440
A.9	Variation order due to increase in quantity and change in original scope	0.406	16	0.483	0.367	0.497	15	0.600	0.444	0.614	4	0.782	0.509	0.617	8	0.720	0.540
A.13	Donor dominated procurement guidelines and specification	0.406	17	0.450	0.383	0.608	10	0.689	0.556	0.437	18	0.491	0.400	0.589	10	0.640	0.560

Appendix Table E5 (Continued)

F C ¹	Causes of Cost Overrun	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.4	Mistakes in first estimate	0.396	18	0.500	0.333	0.439	17	0.578	0.356	0.541	12	0.745	0.418	0.489	14	0.640	0.400
A.12	Change in specification and construction methods during construction stage	0.393	19	0.433	0.383	0.432	18	0.489	0.400	0.439	16	0.545	0.364	0.479	16	0.540	0.460

Symbol: ¹ = Factor Code; ² = LIFI; ³ = Rank

Appendix F

Ranking of the factors affecting quality in MSCPN

Appendix Table F1 Result of the overall ranking of the factors affecting quality in MSCPN

Factor Code	Factors affecting quality	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams	0.604	1	0.648	1.106	0.605	1.463
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	0.601	2	0.665	1.078	0.563	1.801
C.4	Proper arrangement of resources throughout the project period	0.599	3	0.659	1.199	0.569	1.670
C.6	Establishment of QC, QA and QMC system along with the effective monitoring systems	0.597	4	0.715	1.127	0.510	1.425
D.4	Equipment breakdown during construction period	0.583	5	0.631	0.986	0.558	1.161
D.2	Good quality construction material not easily available	0.575	6	0.641	1.110	0.536	1.022
D.5	Proper mobilization of the equipments and machine during construction	0.571	7	0.611	1.078	0.556	1.320
C.8	Regular updating of quality plan	0.564	8	0.631	0.943	0.534	1.607
D.6	Skill and competency of the operator	0.564	9	0.625	1.072	0.533	1.260
A.5	Quality performance and quality policy of contractors	0.563	10	0.669	0.979	0.497	1.377

Appendix Table F1 (Continued)

Factor Code	Factors affecting quality	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
C.1	Good planning with the use of appropriate technology for construction	0.557	11	0.680	1.309	0.489	1.522
B.7	Available time and budget	0.556	12	0.640	1.226	0.504	1.568
D.1	Construction materials not easily available in the market.	0.549	13	0.620	1.234	0.510	1.037
D.7	Lack of qualified workforce	0.547	14	0.607	1.324	0.514	1.324
C.10	Establishment of the safety system.	0.554	15	0.594	0.909	0.533	1.308
C.9	Effective conflict resolution method to solve quality related issues among the project participants	0.544	16	0.583	1.091	0.522	1.278
B.6	Availability of the utilities and quality construction material in the construction area	0.542	17	0.625	1.109	0.494	1.226
C.2	Appropriate organizational structure for quality delivery	0.537	18	0.630	1.234	0.485	1.324
A.4	Quality commitment and co-ordination among the key project participants	0.534	19	0.623	1.214	0.494	1.524
C.3	Proper project documentation system	0.533	20	0.586	1.035	0.503	1.522
C.5	Use of modern construction management techniques	0.532	21	0.635	1.366	0.465	1.682

Appendix Table F1 (Continued)

Factor Code	Factors affecting quality	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
D.3	Equipment and machinery not easily available	0.531	22	0.599	1.059	0.507	1.182
A.6	Coordination and relationship between the contractor, sub-contractors and material supplier	0.519	23	0.577	1.087	0.496	1.622
A.2	Consultants knowledge and experience in QC, QA and QMS	0.508	24	0.609	1.361	0.464	1.438
E.2	Fluctuations in the material, machine and labor cost	0.505	25	0.573	0.889	0.469	1.113
A.1	Owner's level of Knowledge and experience in Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS)	0.504	26	0.554	1.154	0.483	1.406
A.7	Distribution of responsibility and authority among the key project participants	0.503	27	0.547	1.100	0.485	1.515
B.3	Constructability and clarity of the drawings	0.496	28	0.543	1.127	0.490	1.812
B.2	Project has well defined scope of works & quality requirement	0.495	29	0.554	1.153	0.474	1.260
B.5	Accessibility of the project site	0.486	30	0.565	1.310	0.450	1.343
B.4	Ambiguity in the contract documents	0.458	31	0.592	1.000	0.389	1.336

Appendix Table F1 (Continued)

Factor Code	Factors affecting quality	LIFI	Rank	Level of Impact		Frequency of occurrence	
				LOI	S.D	FOI	S.D
E.1	Underground and working condition of the project site	0.451	32	0.534	1.070	0.402	0.853
E.4	Weather	0.448	33	0.487	0.862	0.435	1.167
E.3	Government policy regarding quality	0.432	34	0.492	1.131	0.405	1.463
B.1	Use of appropriate contract type/Project delivery system	0.426	35	0.545	1.088	0.366	0.906

Appendix Table F2 Result of the ranking of the factors affecting quality in MSCPN based on their level of impact.

Factor Code	Factors affecting quality	Level of Impact			FOI
		LOI	Rank	Mean & SD	Rank
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	0.719	1	3.595 ± 1.127	13
C.1	Good planning with the use of appropriate technology for construction	0.686	2	3.429 ± 1.144	20
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	0.671	3	3.357 ± 1.038	2
B.7	Available time and budget	0.667	4	3.333 ± 0.989	18
C.4	Proper arrangement of resources throughout the project period	0.662	5	3.310 ± 1.095	3
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	0.652	6	3.262 ± 1.051	1
A.5	Quality performance and quality policy of contractors	0.648	7	3.238 ± 1.107	11
C.8	Regular updating of quality plan	0.638	8	3.190 ± 0.971	9
D.2	Good quality construction material not easily available	0.638	9	3.190 ± 1.053	8
C.2	Appropriate organizational structure for quality delivery	0.638	10	3.190 ± 1.111	22
C.5	Use of modern construction management techniques and tools.	0.638	11	3.190 ± 1.169	29

Appendix Table F2 (Continued)

Factor Code	Factors affecting quality	Level of Impact			FOI Rank
		LOI	Rank	Mean & SD	
D.4	Equipment breakdown during construction period	0.633	12	3.167 ± 0.993	4
D.6	Skill and competency of the operator	0.629	13	3.143 ± 1.035	6
B.6	Availability of the utilities and quality construction material in the construction area	0.624	14	3.119 ± 1.053	21
A.4	Quality commitment and co-ordination among the key project participants	0.624	15	3.119 ± 1.101	19
D.1	Construction materials not easily available in the market.	0.624	16	3.119 ± 1.110	15
D.5	Proper mobilization of the equipments and machine during construction	0.619	17	3.095 ± 1.038	5
D.7	Lack of qualified workforce	0.610	18	3.048 ± 1.151	10
A.2	Consultants knowledge and experience in QC, QA and QMS	0.610	19	3.048 ± 1.166	28
D.3	Equipment and machinery not easily available	0.600	20	3.000 ± 1.030	17
B.4	Ambiguity in the contract documents	0.595	21	2.976 ± 0.999	34
C.10	Establishment of the safety system.	0.590	22	2.952 ± 0.953	7
C.3	Proper project documentation system	0.590	23	2.952 ± 1.017	14
C.9	Effective conflict resolution method to solve quality related issues	0.586	24	2.929 ± 1.044	12

Appendix Table F2 (Continued)

Factor Code	Factors affecting quality	Frequency of occurrence			LOI Rank
		FOI	Rank	Mean & SD	
E.2	Fluctuations in the material, machine and labor cost	0.576	25	2.881 ± 0.943	25
A.6	Coordination and relationship between the contractor, between the contractor, sub-contractors and material supplier	0.576	26	2.881 ± 1.042	16
B.5	Accessibility of the project site	0.576	27	2.881 ± 1.144	30
B.2	Project has well defined scope of works including quality requirement	0.562	28	2.810 ± 1.074	26
A.7	Distribution of responsibility and authority among the key project	0.552	29	2.762 ± 1.049	24
B.3	Constructability and clarity of the drawings	0.548	30	2.738 ± 1.062	23
B.1	Use of appropriate contract type/Project delivery system	0.543	31	2.714 ± 1.043	35
A.1	Owner's level of Knowledge and experience in Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS)	0.543	32	2.714 ± 1.074	27
E.1	Underground and working condition of the project site	0.538	33	2.690 ± 1.034	33
E.4	Weather	0.495	34	2.476 ± 0.928	31
E.3	Government policy regarding quality	0.490	35	2.452 ± 1.063	32

Appendix Table F3 Result of ranking of the factors affecting quality in MSCPN based on their frequency of occurrence

Factor Code	Factors affecting quality	Frequency of occurrence			LOI Rank
		FOI	Rank	Mean & SD	
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	0.600	1	3.000 ± 1.100	6
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	0.567	2	2.833 ± 1.158	3
C.4	Proper arrangement of resources throughout the project period	0.562	3	2.810 ± 1.137	5
D.4	Equipment breakdown during construction period	0.552	4	2.762 ± 1.038	12
D.5	Proper mobilization of the equipments and machine during construction	0.548	5	2.738 ± 1.072	17
D.6	Skill and competency of the operator using the machine and equipments	0.529	6	2.643 ± 1.059	13
C.10	Establishment of the safety system.	0.529	7	2.643 ± 1.070	22
D.2	Good quality construction material not easily available	0.524	8	2.619 ± 1.005	9
C.8	Regular updating of quality plan	0.524	9	2.619 ± 1.126	8
D.7	Lack of qualified workforce	0.514	10	2.571 ± 1.073	18
A.5	Quality performance and quality policy of contractors	0.514	11	2.571 ± 1.119	7
C.9	Effective conflict resolution method to solve quality related issues among the project participants	0.510	12	2.548 ± 1.063	24

Appendix Table F3 (Continued)

Factor Code	Factors affecting quality	Frequency of occurrence			LOI Rank
		FOI	Rank	Mean & SD	
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	0.510	13	2.548 ± 1.093	1
C.3	Proper project documentation system	0.510	14	2.548 ± 1.110	23
D.1	Construction materials not easily available in the market.	0.500	15	2.500 ± 1.009	16
A.6	Coordination and relationship between the contractor, sub-contractors and material supplier	0.500	16	2.500 ± 1.129	26
D.3	Equipment and machinery not easily available	0.495	17	2.476 ± 1.043	20
B.7	Available time and budget	0.495	18	2.476 ± 1.083	4
A.4	Quality commitment and co-ordination among the key project participants	0.495	19	2.476 ± 1.111	15
C.1	Good planning with the use of appropriate technology.	0.490	20	2.452 ± 1.110	2
B.6	Availability of the utilities and quality construction material in the construction area	0.486	21	2.429 ± 1.052	14
C.2	Appropriate organizational structure for quality delivery	0.486	22	2.429 ± 1.073	10
B.3	Constructability and clarity of the drawings	0.486	23	2.429 ± 1.160	30
A.7	Distribution of responsibility and authority among the key project	0.481	24	2.405 ± 1.109	29

Appendix Table F3 (Continued)

Factor Code	Factors affecting quality	Frequency of occurrence			LOI
		FOI	Rank	Mean & SD	Rank
E.2	Fluctuations in the material, machine and labor cost	0.471	25	2.357 ± 1.027	25
B.2	Project has well defined scope of works including quality requirement	0.471	26	2.357 ± 1.059	28
A.1	Owner's level of Knowledge and experience in Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS)	0.471	27	2.357 ± 1.089	32
A.2	Consultants knowledge and experience in QC, QA and QMS	0.462	28	2.310 ± 1.095	19
C.5	Use of modern construction management techniques and tools.	0.462	29	2.310 ± 1.139	11
B.5	Accessibility of the project site	0.443	30	2.214 ± 1.076	27
E.4	Weather	0.433	31	2.167 ± 1.039	34
E.3	Government policy regarding quality	0.400	32	2.000 ± 1.110	35
E.1	Underground and working condition of the project site	0.395	33	1.976 ± 0.961	33
B.4	Ambiguity in the contract documents	0.386	34	1.929 ± 1.075	21
B.1	Use of appropriate contract type/Project delivery system	0.371	35	1.857 ± 0.976	31

Appendix Table F4 Result of the ranking of the factors affecting quality in MSCPN from the view of project parties

Factor Code	Factors affecting quality	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	0.629	1	0.624	6	0.549	10
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	0.601	2	0.649	2	0.541	12
A.5	Quality performance and quality policy of contractors	0.598	3	0.622	7	0.447	34
C.7	Establish and maintain regular formal and informal communication and regular meeting of the project teams.	0.585	4	0.629	5	0.597	5
C.3	Proper documentation system	0.576	5	0.511	22	0.512	20
C.1	Good planning with the use of appropriate technology for construction	0.576	6	0.593	12	0.501	22
D.5	Proper mobilization of the equipments and machine during construction	0.569	7	0.566	15	0.577	6
D.4	Equipment breakdown during construction period	0.563	8	0.633	3	0.553	9
C.4	Proper arrangement of resources throughout the project period	0.563	9	0.690	1	0.544	11

Appendix Table F4 (Continued)

Factor Code	Factors affecting quality	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
C.8	Regular updating of quality plan	0.562	10	0.532	21	0.599	2
C.2	Appropriate organizational structure for quality delivery	0.552	11	0.585	14	0.474	30
A.4	Quality commitment and coordination among the key project participants	0.552	12	0.535	20	0.514	17
C.10	Establishment of the safety system.	0.549	13	0.488	28	0.626	1
D.6	Skill and competency of the operator using the machine and equipments	0.548	14	0.603	10	0.540	13
B.7	Available time and budget	0.546	15	0.629	4	0.513	19
D.1	Construction materials not easily available in the market.	0.542	16	0.547	17	0.559	8
E.2	Fluctuations in the material, machine and labor cost	0.540	17	0.478	29	0.496	24
A.6	Coordination and relationship between the contractor, sub-contractors and material supplier	0.538	18	0.507	25	0.514	18
D.7	Lack of qualified workforce	0.536	19	0.616	9	0.490	26
D.2	Good quality construction material not easily available	0.530	20	0.599	11	0.597	4

Appendix Table F4 (Continued)

Factor Code	Factors affecting quality	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
C.9	Effective conflict resolution method to solve quality related issues among the project participants	0.528	21	0.506	26	0.599	3
C.5	Use of modern construction management techniques and tools.	0.519	22	0.586	13	0.491	25
B.3	Constructability and clarity of the drawings	0.513	23	0.440	30	0.536	15
A.2	Consultants knowledge and experience in QC, QA and QMS	0.509	24	0.496	24	0.521	16
B.6	Availability of the utilities and quality construction material in the construction area	0.503	25	0.620	8	0.502	21
B.2	Project has well defined scope of works including quality requirement	0.503	26	0.506	23	0.477	29
A.7	Distribution of responsibility and authority among the key project participants	0.500	27	0.520	19	0.488	27
D.3	Equipment and machinery not easily available	0.494	28	0.560	16	0.538	14
E.4	Weather	0.495	29	0.381	35	0.467	32
E.1	Underground and working condition of the project site	0.447	30	0.409	33	0.497	23

Appendix Table F4 (Continued)

Factor Code	Factors affecting quality	Owners view		Consultants view		Contractors view	
		LIFI	Rank	LIFI	Rank	LIFI	Rank
B.5	Accessibility of the project site	0.477	31	0.527	18	0.455	33
B.4	Ambiguity in the contract documents	0.464	32	0.428	31	0.483	28
B.1	Use of appropriate contract type/Project delivery system	0.446	33	0.435	32	0.396	35
A.1	Owner's level of Knowledge and experience in Quality Control (QC), Quality Assurance (QA) and Quality Management System (QMS)	0.442	34	0.502	27	0.566	7
E.3	Government policy regarding quality	0.423	35	0.401	34	0.472	31

Appendix Table F5 Result of the ranking of the factors affecting quality in MSCPN from the view of project types

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
D.4	Equipment breakdown during construction period	0.613	1	0.600	0.633	0.605	16	0.600	0.622	0.582	7	0.709	0.491	0.522	13	0.620	0.460
D.7	Lack of qualified workforce	0.604	2	0.650	0.567	0.651	8	0.644	0.667	0.549	20	0.636	0.491	0.390	33	0.500	0.340
B.7	Available time and budget	0.596	3	0.650	0.533	0.589	19	0.644	0.578	0.533	27	0.691	0.436	0.534	10	0.680	0.440
D.2	Good quality construction material not easily available	0.592	4	0.633	0.550	0.606	15	0.622	0.600	0.546	21	0.691	0.455	0.533	11	0.600	0.500
C.4	Proper arrangement of resources throughout the project period	0.592	5	0.617	0.567	0.704	4	0.733	0.689	0.630	1	0.800	0.527	0.471	21	0.500	0.480

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
D.6	Skill and competency of the operator using the machine and equipments	0.583	6	0.617	0.567	0.592	18	0.622	0.578	0.541	22	0.618	0.509	0.536	9	0.660	0.460
C.5	Use of modern construction management techniques and tools	0.578	7	0.667	0.483	0.660	7	0.711	0.622	0.512	29	0.691	0.418	0.384	35	0.480	0.340
B.6	Availability of the utilities and quality construction material in the construction area	0.577	8	0.633	0.500	0.580	21	0.600	0.600	0.572	11	0.673	0.509	0.421	30	0.580	0.340
D.5	Proper mobilization of the equipments and machine	0.575	9	0.533	0.600	0.670	6	0.711	0.644	0.581	8	0.673	0.527	0.464	22	0.580	0.420

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
C.6	Establishment of QC, QA and QMC system along with the effective monitoring and feedback systems.	0.563	10	0.700	0.417	0.731	1	0.711	0.756	0.584	6	0.800	0.455	0.545	7	0.660	0.460
A.3	Contractors and Sub-contractors knowledge and experience in QC, QA and QMS	0.553	11	0.600	0.517	0.725	2	0.733	0.733	0.608	3	0.745	0.527	0.561	5	0.620	0.520
C.3	Proper project documentation system	0.537	12	0.567	0.500	0.516	28	0.533	0.511	0.577	9	0.727	0.491	0.522	14	0.520	0.540
A.5	Quality performance and quality policy of contractors	0.534	13	0.600	0.483	0.693	5	0.756	0.667	0.569	13	0.691	0.491	0.487	17	0.560	0.440

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
D.1	Construction materials not easily available in the market.	0.533	14	0.583	0.500	0.502	31	0.556	0.467	0.554	18	0.673	0.473	0.600	2	0.680	0.560
C.9	Effective conflict resolution method to solve quality related issues	0.533	15	0.567	0.483	0.602	17	0.644	0.578	0.571	12	0.618	0.564	0.458	25	0.520	0.420
C.8	Regular updating of quality plan	0.531	16	0.600	0.483	0.635	11	0.689	0.600	0.557	16	0.673	0.527	0.541	8	0.600	0.500
C.7	Establish and maintain regular formal and informal communication and project teams.	0.518	17	0.583	0.517	0.710	3	0.689	0.756	0.589	5	0.691	0.564	0.621	1	0.660	0.600

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
C.2	Appropriate organizational structure for quality delivery	0.509	18	0.583	0.450	0.615	12	0.711	0.556	0.564	15	0.745	0.473	0.491	15	0.520	0.480
D.3	Equipment and machinery not easily available	0.501	19	0.533	0.483	0.569	22	0.600	0.556	0.566	14	0.691	0.491	0.474	20	0.580	0.460
A.7	Distribution of responsibility and authority among the key project participants	0.493	20	0.517	0.483	0.568	23	0.578	0.578	0.500	30	0.600	0.455	0.460	24	0.520	0.420
C.1	Good planning with the use of appropriate technology	0.492	21	0.617	0.400	0.646	9	0.733	0.600	0.577	10	0.782	0.473	0.553	6	0.620	0.520

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
B.2	Project has well defined scope of works and quality requirement	0.489	22	0.517	0.483	0.533	25	0.578	0.533	0.536	24	0.673	0.455	0.431	29	0.480	0.420
C.10	Establishment of the safety system.	0.486	23	0.517	0.467	0.613	13	0.644	0.600	0.589	4	0.636	0.564	0.527	12	0.580	0.500
E.2	Fluctuations in the material, machine and labor cost	0.473	24	0.467	0.467	0.507	30	0.600	0.467	0.487	33	0.618	0.418	0.580	3	0.640	0.540
B.5	Accessibility of the project site	0.471	25	0.517	0.433	0.539	26	0.556	0.556	0.552	19	0.655	0.491	0.387	34	0.580	0.300
A.6	Coordination and relationship between the contractor, sub-contractors and material supplier	0.464	26	0.533	0.417	0.639	10	0.622	0.667	0.554	17	0.655	0.509	0.451	27	0.500	0.440

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
A.4	Quality commitment and co-ordination among the key project participants	0.457	27	0.517	0.433	0.607	14	0.644	0.600	0.610	2	0.764	0.527	0.489	16	0.580	0.440
E.4	Weather	0.449	28	0.433	0.467	0.426	35	0.489	0.400	0.490	32	0.564	0.436	0.438	28	0.500	0.420
A.1	Owner's level of Knowledge and experience in QC, QA and QMS	0.448	29	0.450	0.450	0.585	20	0.622	0.578	0.498	31	0.600	0.436	0.461	23	0.520	0.440
B.3	Constructability and clarity of the drawings	0.445	30	0.483	0.417	0.531	27	0.533	0.556	0.540	23	0.636	0.491	0.479	18	0.540	0.500
A.4	Quality commitment and co-ordination among the project participants	0.457	27	0.517	0.433	0.607	14	0.644	0.600	0.610	2	0.764	0.527	0.489	16	0.580	0.440

Appendix Table F5 (Continued)

F C ¹	Factors affecting quality	Irrigation project				Water supply project				Road project				Hydro power project			
		L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI	L ²	R ³	LOI	FOI
B.4	Ambiguity in the contract documents	0.411	31	0.550	0.333	0.509	29	0.578	0.489	0.524	25	0.673	0.436	0.396	32	0.580	0.300
E.3	Government policy regarding quality	0.404	32	0.433	0.383	0.475	33	0.533	0.444	0.376	35	0.491	0.309	0.476	19	0.520	0.480
A.2	Consultants knowledge and experience in QC, QA and QMS	0.394	33	0.467	0.400	0.563	24	0.600	0.556	0.525	26	0.709	0.418	0.576	4	0.680	0.500
E.1	Underground and working condition of the project site	0.375	34	0.400	0.350	0.497	32	0.556	0.467	0.518	28	0.709	0.400	0.416	31	0.500	0.380
B.1	Use of appropriate contract type/Project delivery system	0.371	35	0.500	0.300	0.474	34	0.533	0.467	0.431	34	0.527	0.382	0.457	26	0.620	0.360

Symbol: ¹ = Factor Code; ² = LIFI; ³ = Rank

CURRICULUM VITAE

NAME : Mr. Dharma Kumar Neupane

BIRTH DATE : December 25, 1965

BIRTH PLACE : Kaski, Nepal

EDUCATION	YEAR	INSTITUTE	DEGREE/DIPLOMA
	1993	Tribhuvan University	B.E. (Civil)
	2009	Kasetsart University	M.Eng. (Civil Engineering)

POSITION/TITLE : Senior Engineer

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