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**RISK FACTORS LEADING TO COST OVERRUN IN  
ETHIOPIAN FEDERAL ROAD CONSTRUCTION  
PROJECTS AND ITS CONSEQUENCES**

**BY**

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## **ABBREVIATIONS AND NOTES**

AACE	Association for the Advancement of Cost Engineering
AACRA	Addis Ababa City Roads Authority
AC	Asphalt Concrete
ADB	African Development Bank
BADEA	Bank of Arab for Economic Development in Africa
CMS	Construction Management System
DB	Design-Build
DBB	Design- Bid- Build
DBST	Double Surface Treatment
EACE	Ethiopian Association of Civil Engineers
EEA	Ethiopian Engineers and Architects
ERA	Ethiopian Roads Authority
ETB	Ethiopian Birr (Ethiopian currency)
EU	European Union
FDRE	Federal Democratic Republic of Ethiopia
FIDIC	Federation International Des Ingenieurs Conseils
GC	General Contractors
GDP	Gross Domestic Product
GOE	Government of Ethiopia
IDA	International Development Association
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
MoWUD	Ministry of Works and Urban Development
MS	Mean score
NDF	Netherlands Development fund
NGO	Non Governmental Organization
NPV	Net Present Value
OECD	Organization for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PRAM	Project Risk Analysis and Management
RC	Road Contractors
ROW	Right of Way
RSDP	Road Sector Development Program
SIG	Special Interest Group
TOR	Terms of References
UK	United Kingdom
USD	United States Dollar
VAT	Value Added Tax
VE	Value Engineering

**Notes:**

- a) **Gross Domestic Product:** is the value of all final goods and services produced within a nation's borders in a given time period. It can be calculated either by adding the money values of the final products (expenditures), or adding up all of the incomes of the factors of production. The expenditures approach to GDP calculation is the primary method of measurement and is calculated as:

$$\text{GDP} = C + I + G + \text{NX} \dots \dots \dots \text{Eq. (i)}$$

Where:

C = Consumption, or Expenditures by the Household sector

I = Gross private domestic investment, or expenditures by the firms (or business) sector

G = Government purchases of goods and services, or expenditures by the government sector

NX = Net exports, or expenditures by the international sector

And NX = Exports minus Imports (X-M)

Source: <http://www.economicsonlinetutor.com/gdpexpenditures.html> (accessed, December 2010)

- b) **Value Engineering:** is defined as “an organized effort directed at analyzing the functions of projects, systems, equipment, facilities, services and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with the required performance, reliability, quality and safety”. Numerous other terms (value management, value analysis, etc.) are also used when referring to VE. While there are subtle differences among these terms they all refer to-generally the same process. (Source: U.S. General Services Administration, 1992).

## **ABSTRACT**

Infrastructure projects, such as road constructions, are one of the most important projects in Ethiopia. Growth in this sector is critical for growth in national income as it is among the largest sectors that generates employment within the country as well as a key driver for economic development of Ethiopia. Like many other developing countries, Ethiopia is also facing critical project management related problems among which cost overrun is quite prominent. The assessment of the accomplishment of the 12 years Road Sector Development Program (RSDP I, II and part of RSDP III) revealed this. There are several factors that are contributing to these cost overruns. Hence, identification and analysis of these factors for effective cost control in Ethiopian road infrastructure project needs to be done in order to better support the economic development.

Accordingly, this research attempts to identify the extent of cost overrun, the major risk factors leading to cost overrun and its consequential effects in the Ethiopian Federal road construction sector; which can serve as the way forward for future work in coping with these overruns. A thorough literature review and desk study was done, through which a number of cost overrun risk factors were identified in global and local construction industry scenarios. To obtain expert opinions from the sector, in total fifty four (54) factors and 16 possible effects were identified and made part of the survey questionnaire and the survey was conducted with stakeholders from contractors, client, construction professionals and consultants. In addition other questions which enable to achieve the objectives of the research were developed; and the research design was based on exploratory survey, desk study, and descriptive approaches for open ended questions.

The result of the desk study indicated that out of 30 upgrading and rehabilitation road construction projects investigated, 24 projects (80%) suffered cost overrun in their execution. The average rate of cost overrun in these projects was 26.95% of the contract amount. And 100% of the respondents to the questionnaire have recognized cost overrun as one of the major problems in Federal road construction projects.

Unexpected inflation/ material price escalation, delays on completion time, scope changes, unstable cost of manufactured materials, inadequate site investigation and right of way problems (access to site and quarry) are identified as major factors leading to cost overrun in

Ethiopian Federal road construction projects. Findings revealed that both internal and external aspects of risk factors contribute to cost overruns in local road construction projects. Consultants and clients/employers were identified to be more responsible in initiating most of the factors. The study also identified: reduction in planned increase of road network, damage professional relations, inability to secure project finance/securing it at higher costs, loss of clients' confidence in consultants, for professionals inability to deliver value to clients and decreased rate of national growth as a major effects and client as the most affected contracting party as a result of effects of cost overrun.

Results indicated that the majority of cost overrun risk factors (65%) lie in the medium severity impact range, indicating that major attention should be paid to these factors as they collectively cause considerable increase in the cost of the project initially estimated. It was also found that the cost estimating practices in local road construction industry varies greatly and needs standardization and proper database; this shows that the estimating practice itself is contributory to the problem of cost overrun.

Major recommendations include: Establish consistent guidelines for price escalation computation and forecasting, set adequate contract duration— providing for potential delays, stabilizing cost of materials, providing appropriate contingency allowances, more involved cost estimation processes, careful project planning, proper documentation of cost escalation trends in the sector and the country for better knowledge transfer, standardization of estimating practices among stakeholders and institutional capacity building.

## CHAPTER ONE

### 1. INTRODUCTION

#### 1.1 Background to the Research

In the context of Ethiopia's geography, pattern of settlement and economic activity road transport plays a crucial role in facilitating economic development. The need for people to move, utilization for natural resources, improved agricultural production and market condition, access to social facilities, land utilization and a sustainable growth, all require transport as a catalyst.

Ethiopia has an estimated population of 83 million widely spread over a territory of about 1.1million sq.km– African Development Bank (ADB/OECD, 2008). Although the country's economy is almost dependent on agricultural outputs, with 83% of the population engaged in farming sector (FDRE, 1994), only 20% of the population has access to road transportation facilities. Thus, 80% of the populations manage their daily activities using traditional and animal based transport system. Agriculture, having the contribution of over 46% to the GDP (Gross Domestic Product) as reported by Ministry of Finance and Economic Development (MoFED, 2007 & ADB/OECD, 2007), is dominated by small-farm holder farmers scattered in small rural communities. Whereas, the major markets and the collection and processing centers for crops, are concentrated in urban areas located at considerable distances from each other and 12.4 km away from all weather roads on average (ERA, 2008). Fig 1.1 shows the contribution of different sectors to GDP.

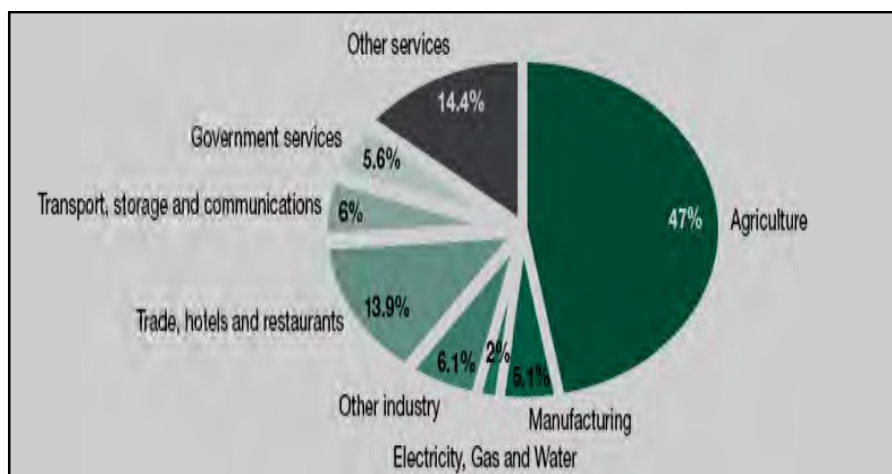


Figure 1.1; GDP by Sector in 2004/05 (Source: ADB/OECD, 2007)

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In a developing country like Ethiopia the growth in agricultural output, which will constitute the primary basis for growth in the economy for the foreseeable future, is heavily dependent on the transport system being able to effectively integrate the rural communities with the urban centers. Facilitating reliable and cost effective transportation of crops, other agricultural outputs to the market and processing centers, to distribute the agricultural inputs and other basic needs to the geographically dispersed farming communities and for overall economic growth to reduce poverty, infrastructure delivery is one of the key drivers.

Thus, it is apparent that quality of infrastructure has a direct impact on the level of people's life, and a well-functioning construction industry has an important role towards this end. However, the present state of the Ethiopian construction industry falls short of meeting domestic and international quality standards and the performance demand expected from the sector (MoWUD, 2006).

The contribution of construction industry to the gross domestic product (GDP) of many countries ranges between 6-9% (Chitkara, 2004). On the other hand Fetene (2008) pointed out that the contribution goes up to 10%. The contribution of Ethiopian construction industry as reported by MoFED, is about 5.7% during the years 2002/2003 up to 2007/08, which is lower than sub-Saharan average of 6%. This shows that road sector development, which contributes much to total national income from strengthened private sector within the economy (MoFED, 2007) thereby enabling to attain the poverty reduction theme of the Millennium Development Goals (MDGs), needs much emphasis to realize its potential.

The country's transport infrastructure as measured by density of the road network in 2007 stands at 38.6km per 1000 sq. km and 0.55km per 1000 population (ERA, 2007). Despite considerable efforts made to expand the road network over the past few decades, the density is still below the average density of 60 km per 1000 sq. km for Africa. The road network during same period is about 42,429km and this comprises of 20,080km Federal roads and 22,349km Regional roads; and the overall classified road network in good condition is only about 49 percent. Proportion of area more than 5km from all weather road and average distance to all weather roads during the same period are 68% and 13km respectively. Therefore, Ethiopia, being one of the countries with lowest road density in Africa deserves a massive expansion and restoration of its road asset (ERA, 2008).

Recognizing the importance of the road transport in supporting social and economic growth and in meeting poverty reduction objectives, the Government of Ethiopia (GOE) has placed increased emphasis on improving the quality and size of the road infrastructure. To this end, ERA with the support of other development partners launched the Road Sector Development Program (RSDP) in 1997 to tackle the shortcomings in the road sector and complement other sectorial development programs. This program provides a comprehensive approach of integrating the implementation of key road investments with major policy and institutional reforms.

The program was financed and is expected to be financed in parallel by IDA, EU, ADB, NDF, BADEA, OPEC fund, Japan, Germany, Italy, UK, Ireland, Sweden, several other NGO's, GOE, the road fund as well as community. To achieve its objectives, RSDP focused on the rehabilitation and upgrading of main roads, construction of link and regional roads and maintenance activities.

The first phase of this program (RSDP I) was officially launched in September 1997, and completed in June 2002. This phase has focused on the restoration of the road network to an acceptable condition. The second phase of the program (RSDP II: July 2002-June 2007) aims to strengthen the achievements of the first phase, increase the network connectivity and provide a sustainable road infrastructure to rural areas (ERA, 2007). During the 10 years period, a total of 78,569 km of roads were constructed, upgraded/rehabilitated and maintained; of which 10,282 km are federal roads and 10,523 km are newly constructed/maintained regional roads, while much of the recorded length (57,764 km) are community roads constructed since July 1997. However, many of the projects planned under RSDP I and II were not completed within the prescribed time and budget and did not meet the quality standard (Becker and Behailu, 2006).

The third phase, RSDP III, commenced in July 2007 and ended in June 2010. During the RSDP III 3,067 km of trunk and link roads were rehabilitated and upgraded against the planned 3,868 km; construction of 1,603 km of new gravel link roads were undertaken against the planned 1,980 km and emergency/heavy maintenance of 3,326 km of paved and gravel roads was carried out. This shows that, rehabilitation/upgrading and construction works were 79% and 81% respectively compared to the planned targets (ERA, 2011). Overall, during the

RSDP III, a total of ETB 35.0 billion (USD 2.6 billion) has been disbursed; indicating that the implementation of this program takes lion's share of the government's expenditures during the last 13 years.

The total disbursement of RSDP III is about 101% against the plan; while the corresponding physical accomplishment is only 93% of the plan. Similar program— RSDP IV has been prepared as part of the Government's overall Growth and Transformation Plan. The programs require not only capacity to execute, but also improvement of drawbacks from past performances.

The review of the implementation of RSDP I, II and part of RSDP III, shows that road projects in Ethiopia encounters a number of challenges. In addition to significant project variation, there are a number of themes contributing to this challenge. The development status of the domestic construction industry and the clarity and comprehensiveness of documents (survey, design, tender and contract documents) used in the process can be considered as the two major factors for the challenges faced by the Ethiopian Roads Authority (ERA) in road construction projects. The immediate consequence of such factors is an increase in project costs than originally budgeted, among others (Zerfu, 2009).

Expressed as a percentage of estimated cost, this is often termed cost escalation, cost overrun or cost growth, and occurs as a result of many factors some of which are related to each other, but all are associated with some forms of risks (Avots, 1983; Garry, 2006). The identification and analysis of these risks is often a necessary step for the improvement of any given cost estimating system and can be used to diagnose trouble spots and to pinpoint areas where the greatest improvement can be obtained.

There are several factors that are contributing to these cost overruns. This research attempts to identify the major risk factors leading to cost overrun in road construction sector of Ethiopia and can serve as the way forward for future work in coping with these overruns. It focuses on understanding how client projects' budgets go wrong, when dealing with project risk.

This research work will also attempt to review the project cost estimation practice in Ethiopia and assess ways in which cost overrun risks have been handled so far; and to identify their causes and propose recommendation as to their handling, particularly with focus on Federal road projects.

It is anticipated that the findings of this thesis will contribute towards the identification of the causes and frequency of such cost overruns and their impact on the construction industry as well as increasing the awareness of construction managers on cost overrun in general, and federal road construction cost management in particular.

## **1.2 Statement of the Problem**

One of the challenges facing the construction industry is to manage the risk of cost overruns and deliver projects within budget. At the beginning of the last decade, Brandon (1990) stated that in construction the new orthodoxy is to accept risk and uncertainty. Latham (1994) put forward that no construction project is risk free, and risk can only be managed, minimized, shared, transferred, or accepted: it cannot be ignored. The risks can cause losses that lead to increased costs, time delays and lack of quality of projects (Simu, 2006); while projects' objectives are most often related to time, cost, and quality. Shehu and Sommerville (2006) has also stressed that construction is a risk-prone industry, with a poor track record of coping with risks, as a result of which clients have been enduring the agonizing outcomes of failure in the form of unnecessary delays in project completion, cost overrun and sometimes failing to meet quality standards and operational requirements.

Contemporary project management practice is characterized by late delivery, exceeded budgets, reduced functionality and questionable quality (Williams, 1999) and while risk management is a recognized practice that helps clients deliver projects on schedule and within budget (Project Management Institute, 2000). The risk management performed in the construction industry has traditionally been that of gut feel or a series of rules-of-thumb (Al-Bahar and Crandall, 1990). Consequently, project risks are often not adequately dealt with (Thompson and Perry, 1992) and the complexities of projects, locations and types of contracts are significant contributors to risks in construction projects (Ahmed et al. 1999).

Transportation projects have historically experienced significant construction cost overruns from the time the decision to build has been taken by the client (Molenaar, 2005). Construction cost estimating on major transport infrastructure projects has not increased in accuracy over the past 70 years. The underestimation of cost today is in the same order of magnitude that it was then (Flyvbjerg et al., 2002).

Angelo and Reina (2002) state that the problem of cost overruns is critical and needs to be studied more to alleviate this issue in the future. They also pointed out that cost overruns are a major problem in both developing and developed countries (Angelo & Reina, 2002); stating that the trend is more severe in developing countries where these overruns sometimes exceeds 100% of the anticipated cost of the project. This is true in the Ethiopian situation as much as it is in developing countries.

On the other hand, the performance of construction industry is one of the major development constraints in developing countries since their development highly depends on the growth of their physical infrastructures (Wubshet, 2004). As a matter of this fact, developing countries allocate a considerable amount of their scarce financial resources towards the development of their infrastructure needs. However, most of these infrastructure projects in developing countries encounter considerable low performance in terms of time, cost and quality etc.

In Ethiopia, construction sector is an important sector. Although not working to its fullest potential, construction industry is of prime interest to the country. Growth in this sector is critical for growth in national income as it is among the largest sectors that generates employment within the country as well as a key indicator of the economy of Ethiopia.

According to Abebe (2003), construction industry employs about 20% of the workforce and covers about 30% of the capital budget of the governments in developing countries. Wubshet (2004) in his work, however, indicated that the construction industry accounts even for more than 50% of the capital budget in developing countries. According to him, for instance, in Ethiopia (1997/98 to 2001/02), the industry accounted for 58.2% of the capital budget. It should be noted, in both cases, that the industry covers a fairly large portion of the government's capital expenditure and so it needs to be developed.

Like many other developing countries, Ethiopia is also facing various project management related issues among which cost overrun is quite prominent. The assessment of the accomplishment of the 12 years Road Sector Development Program revealed that the execution of most of the Federal road construction projects resulted in significant cost overruns as shown in Table 1.1 below. From the table it can be seen that cost overrun of more than 230% of the estimated budget has been observed.

Table 1.1: Completed/ substantially completed federal road construction projects over 30 million birr that exceeded estimate by >15%

Item No.	Projects	Type of Surfacing/ Work	Financier	Physical (km)		Financial (million Br)		%		Percentage of Cost Overrun	Status
				Plan	Acco m.	Budget	Disb	Phy. Acco.	Fin. Disb.		
1	Semera - Elidar	AC	ADB	95	95	214.3	283.7	100	132	32.4	Completed
2	Mille – Assab	AC	IDA	100	100	293.9	471.8	100	161	61	Completed
3	Addis - Gohastion	AC	Japan	186	186	354.8	481.8	100	136	36	Completed
4	Addis -Tarmaber	AC	GOE	25	17.3	270.4	327.1	69	121	21	On-going
5	Tarmaber-Kombolcha	AC	EU	192	193	469.5	661.0	101	141	41	Completed
6	Kombolcha- Woldiya	AC	GOE	153	107	360.6	626.6	70	174	74	On-going
7	Ambo - Gedo	AC	Germany	30	16	68.6	113.7	54	166	66	On-going
8	Gewane-Mille	AC	GOE	146	146	249.0	357.6	100	144	44	Completed
9	Nazareth-Assela	AC	IDA	68	79	204.1	321.0	116	157	57	Completed
10	Gewane-Mille (Alternative Route)	AC	GOE	15	19	40.6	134.2	129	331	231	Completed
11	Alamata-Korem-B/Mera	AC	GOE	120	121	190.1	458.2	101	241	141	Completed
12	Debre Markos – Gondar	AC	IDA	408	421	704.1	1093.5	103	155	55	Completed
13	Awash – Kulubi	AC	IDA	232	232	130.3	319.9	100	246	146	Completed
14	Alemgena – Butajira	DBST	ADB	120	120	261.7	328.6	100	126	26	Completed
15	Jijiga-Degehabor	DBST	GOE	175	158	258.4	467.8	90	181	81	Completed

*Source: Ethiopian Roads Authority (progress and completion reports of each project)*

Moreover, according to the findings of Abebe & Girmay (2003), in road projects there has been a financial claim reaching up to 200-300% of the project cost. They also noticed that there is a considerable amount of delay in project completion. These scholars argue that one of the problems associated with financial claim is an excessive cost overrun among others. Zerfu (2009) also identified Cost overrun as one of the challenges in ERA road construction projects. This indicates that cost overrun is one of the critical project management problems which require attention for the successes of road construction projects in Ethiopia.

Unless a systematic approach of handling risk factors leading to cost overrun is formulated and awareness created, this issue will continue to affect the proper handling of projects and may significantly affect future construction endeavors. This thesis is therefore an attempt to address such issues and hence reduce its consequential effect.

### **1.3 Significance of the Research**

It is the goal of the client to estimate as accurately as possible the actual final cost of a project so as not to require funds to be diverted from other projects to cover additional project costs, due to cost overrun. In the area of road construction, accurate programming of projects is vitally important to highway organizations as their construction program outlines how highway funds are to be spent over time and any deviation from the stated program often brings a quick response from the public, the press, and politicians. When this occurs, the highway organization loses creditability and time is often taken defending deviation from the published program. On the other hand, if a highway organization can produce realistic program estimates that it is able to attain, then the image of the agency is enhanced.

Therefore, it is the responsibility of the client to make an accurate estimate of the project cost. For this purpose, the identification of road project construction risk factors leading to cost overrun can ultimately provide the client with a better guarantee that the final cost of a delivered project will not exceed the risk adjusted project budget estimate.

Besides, an understanding of the reasons for such consistent cost overruns should allow clients to focus on problem areas and implement systems into program budgeting procedures which may lead to more realistic project cost estimates. The realistic estimates thus made enable the project stakeholders to finish the project within/nearly within estimated budget and to reduce unnecessary delays and claims relating to financial matters.

Therefore, the finding of this research work is expected to:

- contribute towards the improvement of cost estimation and management skills in Ethiopian construction industry;
- suggest the best practice approach in project cost estimating;

- contribute towards the enhancement of cost estimation practice in Federal road construction projects, by analyzing past experiences;
- Serve in the preparation of risk adjusted cost/ budget estimate for: Local contractors, Local consultants & the client and/or regulatory body.

Thus the implementing agencies, private consulting and contracting firms plus practicing Engineers and/or surveyors etc may benefit from the results of this research.

## **1.4 Objectives and the Research Questions**

The main objective of this research is to identify the major risk factors leading to cost overrun in road construction projects and to analyze the ultimate consequences of cost overrun.

**The Specific objectives of the study are to:**

- ☞ assess the extent of cost overrun in federal road construction projects and its consequences;
- ☞ identify main risk factors leading to cost overrun in Ethiopian federal road construction projects;
- ☞ analyze the frequency and impact of the factors to rank their severity;
- ☞ identify which contracting part/parties are responsible for the cost overrun or contribution of each part;
- ☞ evaluate agreement between different project participants on the ranking of the factors;
- ☞ briefly review the cost estimating practices in Ethiopian Federal road construction projects;
- ☞ identify the best practices observed so far in cost estimating and to minimize project cost overrun in local situations; and
- ☞ forward recommendations which would help to avoid or minimize cost overrun in road construction projects based on the findings of the study, and hence reduce its consequential effects in Ethiopian construction industry.

To address the above objectives the research will have the following specific questions

- What is the extent of cost overrun in Ethiopian Federal road construction projects and its consequential effects?
- What are the major risk factors leading to cost overrun in local scenario?
- Which contracting party/parties are responsible or initiator of these factors and which are most affected?
- What are the possible measures to be taken in order to minimize/ mitigate cost overrun in Ethiopian Federal Road construction projects?

## **1.5 Methodology**

The research work has been started with problem identification, which was done through unstructured literature review, formal and informal discussion with professionals in the federal road construction sector.

The research has then proceeded through identification of risk factors relating to cost growth in road construction projects from literatures, which include magazines, books, journals, internet etc. In parallel with literature review, an in-depth desk study has been conducted to identify the risk factors leading to cost growth in local road construction projects by evaluating the results of historical case study data from completed design-bid-build (DBB) projects in Ethiopia.

During the desk study, various documents such as contract documents, claim documents, correspondences, progress reports, completion reports, payment certificates, statements on final account etc. has been critically evaluated and the root factors causing cost overrun in projects investigated were identified and used in the questionnaire. Whenever there was unclear primary data or ambiguity during the desk study, further explanation or information has been obtained through interviews with relevant bodies in Ethiopian Roads Authority: the implementing agency of the road sector development program in Ethiopia, in order to maximize the clarity and to gain adequate understanding of the data for its use in analysis.

The document search was also intended to collect values of cost overrun and their causes from some randomly selected upgrading and rehabilitation road construction projects which are completed/substantially completed. Besides this, a questionnaire/survey has been conducted to strengthen the study and observe the understanding of the problem by all

stakeholders/to see the prevalence of the problem in the industry. The questionnaires were distributed to contractors, consultants, the employer (ERA) and construction professionals.

Then analysis and discussion has been conducted based on the primary & secondary data obtained. Finally, conclusions have been drawn and recommendations forwarded based on the finding of the study and reviewed literature. The study has been conducted on projects with initial estimated cost exceeding 30 million birr, and on projects that has been completed or substantially completed.

The foregoing approach to the research has been summarized as shown in Figure 1.2 below.

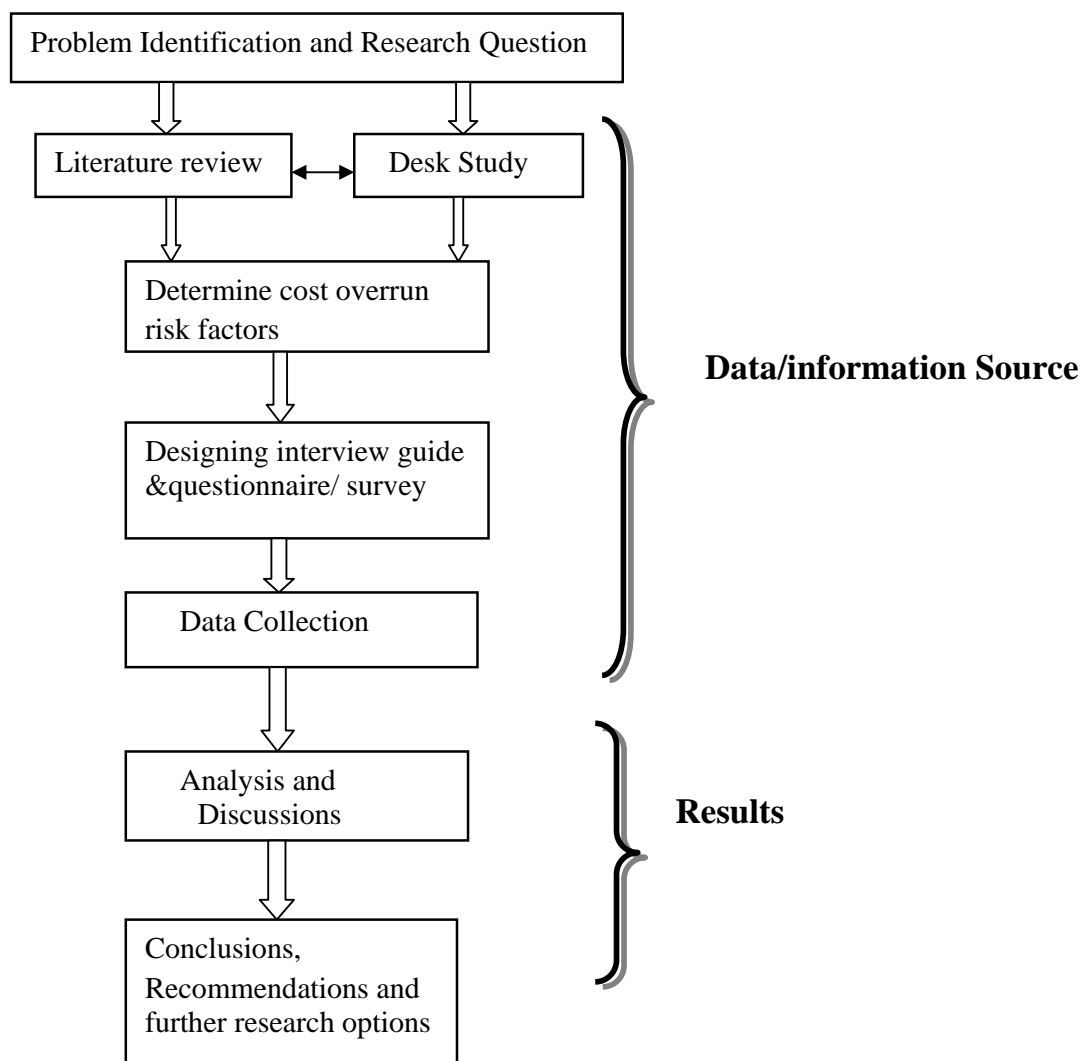


Figure 1.2; Research Main Activities/Methodology

## **1.6 Scope and Limitations of the Study**

The primary objectives of construction projects are to optimize quality, cost and time. In Ethiopia, where the development status of construction industry and its management is at an infant stage, fulfilling at least one of the requirements is difficult. This research work therefore, focuses on one of the basic requirement—cost. Hence, the scope of the study is restricted to the identification of risk factors leading to cost overrun, effects of cost overrun and review of estimating practices in local road construction sector.

Earlier studies concerning risk management in construction projects have found that risk management in the construction industry relies heavily on contracts, and contract clauses are estimated to raise project costs by 8-20 % (Hartman, 2000). Fetene (2008) has also identified contract clauses as the main causes of cost overrun in the construction projects. Therefore, Contracts in this study are treated only as a one risk management means, but not analyzed any further. The focus of the study are those risk factors hindering the successful project execution, known as operational risks, specifically leading to project cost escalation.

Although, Ethiopian government through its agencies: Ethiopian Roads Authority (ERA), Addis Ababa City Roads Authority (AACRA), and Regional Rural Roads Authorities have started a major road sector development program to increase the road network in the country which includes new, upgrading and rehabilitation projects, this study has focused on Federal road upgrading and rehabilitation projects implemented by ERA during the RSDP I and II as well as part of RSDP III, since 1997(1997-2010).

The scope of the study is, therefore, limited to evaluation of risk factors leading to cost overrun and cost estimation practices in Ethiopian Federal road projects. All projects selected for the desk study were from projects completed/substantially completed during the aforementioned period, and the data used came from published/ unpublished sources within Ethiopian Roads Authority (ERA) and all related to projects that were initially estimated to cost over 30 million Birr, which were selected randomly and those projects with higher cost overrun were investigated in detail.

Besides the identification of risk factors leading to cost overrun, this thesis work has attempted to assess the current cost estimating practices in Ethiopian Federal road

construction projects, and to examine methods that could improve the overall estimating accuracy and management of cost in local road construction industry. Every effort has been made to seek information from relevant stakeholders, and to review different standard literatures.

However, the thesis work is limited by several factors: due shortage of allocated budget for the research work, it has not been possible to get detail data for the projects undertaken by local contractors as most of the relevant documents for these projects are found at Districts and project offices requiring visiting the actual site of the project. Hence, some of the findings of the study are based on ten sample projects. The other limitation is that some of the open ended questions intended for assessing the current estimating practices have been discarded during analysis due to lack of adequate responses from the respondents.

## **1.7 Outline of the Research – Thesis Organization**

The thesis is organized into five chapters as follows:

Chapter 1–this chapter begins with the discussion on background and general introduction to the research, statement of the problem, objectives, scope, methodology adopted to achieve the objectives of the study and organization of the thesis.

Chapter 2 is a literature review from professional journals, books, internet searches and interview with road design, construction, and contract administration experts. This chapter essentially provides a review of the current state of the art in road construction risk, project cost estimating, cost control process used and its management and cost estimation of risk. Brief definition of aspects of construction risks, their root causes and management are also contained within this chapter.

Chapter 3 discusses the research methodology followed in order to achieve the objectives of the study. The results of the data obtained from the desk study on selected road construction projects and questionnaire survey were presented and discussed accordingly in Chapter 4. Finally, in Chapter 5, conclusions and recommendations were forwarded based on the major findings of the study and discussed how the research objectives align with the findings.

## **CHAPTER TWO**

### **2. LITERATURE REVIEW**

#### **2.1 Introduction**

In order to develop a better understanding of the research objective, a comprehensive literature review has been conducted focusing on identifying the road construction cost overrun risk factors, their effects and on the way how to manage these risks, control and administrate it.

The change in project cost, or cost escalation occurs as a result of many related factors all of which are associated with some form of risk (Flyvbjerg et al., 2004). Identification and management of the reasons for such recurrent construction project cost overrun is a necessary step for the improvement of any given estimating system and can be used to pinpoint areas where the greatest improvement can be obtained. As part of this process, chapter 2 provides a literature review on the aspects of road construction project risk factors which often contribute to the potential for cost overrun, risk management, and cost management in road construction.

Cost has its proven importance as the prime factor for project success. In spite of its proven importance, it is not uncommon to see a construction project failing to achieve its goal within the specified cost. Cost overrun is a very frequent phenomenon and is almost associated with all projects of construction industry (Avots, 1983).

Most of the significant factors affecting project costs are qualitative such as client priority on construction time; contractor's planning capability, procurement methods and market conditions including the level of construction activity (Elchaig et al, 2005). A project otherwise completed may not be regarded as a successful endeavor until and unless it satisfies the cost limitations applied to it.

In order to satisfy such cost limitations, accurate client budget estimates are critical to the initial decision-to-build process for the highway construction projects. This decision-to-build point in a project's development is seen as the international standard for measuring any

subsequent cost estimate inaccuracies involved (World Bank, 1994; Nijkamp and Ubbels, 1999), with accuracy being defined as the difference between initial project estimate at the decision-to-build stage and the real, accounted project cost determined at the time of project completion.

Thus, it is a desire of all stakeholders that Projects to be completed within the budgeted cost and time frame. Unfortunately, many projects take longer to complete and cost more than originally estimated budget because of lack of professional skills in the area and other various factors directly and/or indirectly related with it. In most developing countries this problem is more aggravated; as a result many project-sponsoring organizations are discouraged to sponsor projects in these poor countries.

Since they involve human and non human factors as well as many other variables, construction projects are complex which require close cooperation and coordination among stakeholders (Ahmed, 2005 & Fetene, 2008). This complexity together with the development status of developing country makes Cost estimation a particularly difficult task in the construction industry of these country, often leading to considerable cost overruns that are explained by large uncertainties and uniqueness of projects (Baker et al., 1999).

One might expect that cost overruns have the same probability as completing the project below the estimated cost. However, observations clearly indicate an overrepresentation of cost overruns (Emhjellen, 2003). Transportation infrastructure projects are particularly prone to cost overrun, with actual costs on average being 28% higher than estimated (Flyvbjerg et al., 2004). This figure is even higher in developing country due to the development status of their construction industry and the lack of clarity and comprehensiveness of documents used, which make the management of the major projects' objectives: time, cost and quality challenging.

Moreover, the delivery of projects is performed using mainly traditional process that has evolved from history and the industrial revolution, where specialization of professional organizations was the key trend (Pakkala, 2002). This means that architects, surveyors, engineers, contractors, and the industry have adopted a segmented rather than an integrated type of process. In developing countries, the majority of projects have used the project delivery method of design-bid-build (DBB) (Lema, 2006), alternatively known as the

traditional method, and typically consisting of discrete feasibility/preliminary design, final design, construction and operation phases (Fig 2.1).

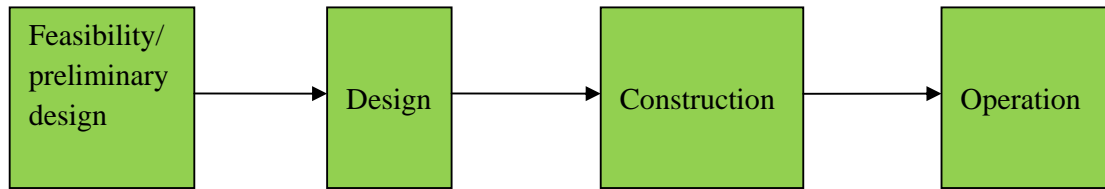


Figure 2.1; Traditional project development phases

Highway infrastructure project delivery in Ethiopia predominately use Design-Bid-Build (DBB), which allows the design/engineering service to be produced first, and then another procurement contract tendered for the actual construction that is based on the design.

The traditional procurement process has been developed to focus on clarity, separation of phases and provide a transparent and independent bidding stage. The process can be inefficient and take a long time and often sets up opposing stances between participants, however the clarity of this process is particularly attractive to clients who need to demonstrate probity (Sidwell et al., 2002).

Although lack of cost control in all of the project development phases can contribute to cost overrun problems, of particular interest is the time the client makes the decision to build (Hester et al., 1991). In the traditional method, this is often made towards the end of the design phase. Hence, accurate budget estimates are critical to the initial decision-to-build process for the construction of capital projects (Ward, 1999). These are usually based on a number of factors such as the complexity of the project, the speed of its construction, the location of the project and degree of unfamiliarity (Baker et al., 1999). Project cost overrun can be caused by rising costs from inflation and inadequate analysis of information and by costing methods (Akpan and Igwe, 2001).

Engineering designs have a high level of influence on project costs and sometimes unsatisfactory design performance can lead to cost overrun (Barrie and Paulson, 1992). There have been few instances where an engineering design is so complete that a project could be built to the exact specifications contained in the original design documents (Chang, 2002). Many construction problems are due to design defects and can be traced back to the design

process (Getachew, 2009; Bramble and Cipollini, 2004). Design and project specific factors such as vagueness in scope, design complexity and project size affect the cost estimate of a project (Akinci and Fischer, 1998).

For capital projects, cost estimates are first prepared to enable clients to make reliable decisions regarding economic feasibility and justification. Early project estimates are often prepared on limited scope definitions and little information regarding the specific parameters that are needed in the completed facilities (Zeitoun and Oberlender, 1993). As well, they are often prepared under severe time constraints (Chang, 2002). Estimates, even when grossly inaccurate, often become the basis upon which all future estimates are judged and for the project team, their performance and overall project success are often measured by the client by how well the final project cost compares to the initial cost estimate (Hester et al., 1991). These and other risk factors are the main contributors to project cost overrun and needs to be identified, and managed to alleviate the problem in the future.

Hence this research, called “Risk Factors Leading to Cost Overrun in Ethiopian Federal Road Construction Projects & its Consequences” attempts to survey and evaluate cost overrun risk factors and cost estimation practices in Ethiopian federal road construction projects. The goal of the thesis is, thus, to identify the major risk factors leading to cost overrun and their consequences on Ethiopian federal road construction projects, and to recommend mitigation measures to strategically cope up with these factors. Moreover, the thesis aims to share and/or adopt some of the best practices in risk and cost management or at least the most progressive methods used in the developed world from the literature.

With this background the subsequent sections will discuss the nature and sources of these risk factors, effects and strategies to control cost overrun and cost management in order to build the conceptual basis for the research.

## **2.2 Definitions**

The project management institute (PMI, 2000:21) defines a project as:

“A temporary endeavor undertaken to create a unique product or service: ‘Temporary’ meaning that every project has a definite beginning and a definite end: ‘Unique’

meaning that the product or service is different in some distinguishing way from all similar products or services” i.e. they are custom built.

Much earlier, Steiner (1969:16) defined a project as:

“An organization of people dedicated to a specific purpose or objective.”

Projects generally involve large, expensive, unique or high-risk undertakings that have to be completed by a certain date, for a certain amount of money, and deliver some expected or anticipated level of performance (with acceptable quality) .

A construction project can be considered successful when it achieves its predetermined goals and objectives. There is no unique definition for project success, particularly in the construction sector, although the concept has been explored for a long time. Project performances in time, cost and quality management functions are currently used for measuring project success. Accordingly, Atkinson (1999) initially identified these three components of project performance as the “iron triangle”. These three criteria of success have become widely used. It capture the essential task of the project manager, and the essential trade-offs that they can make. Various other key components may be found in the literature, for instance, Chan (2004) have proposed the following illustrated in figure 2.2.

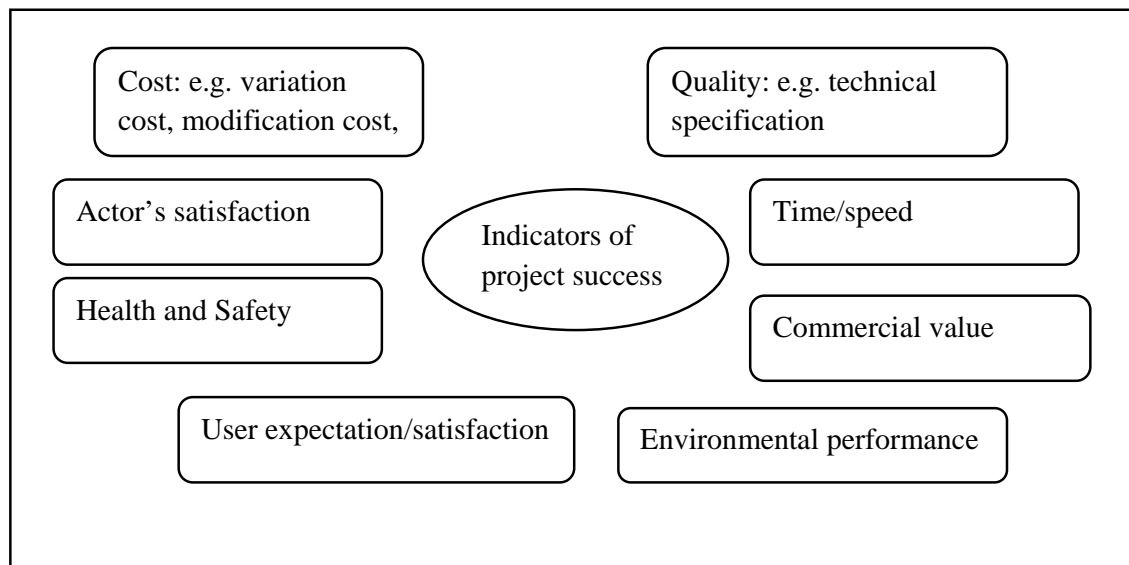


Figure 2.2; Indicators of project success (source: Chan, 2004)

Fulfilling the above management functions has been reported internationally as a measure of the competitiveness of the construction industry. However, measuring it is a difficult task due to its dynamic and heterogeneous nature. One measure may satisfy the perspective of one stakeholder but fail to recognize viewpoints of other key stakeholders, namely, financiers, clients, employees and society as a whole.

The lack of fulfillment of cost and time management functions often leads to project overruns producing immediate effects on construction stakeholders and on the country's economy.

McCoy (1986) has tried to develop an integrated success criteria based on this three-fold criterion. Avots (1984) suggests that schedule is most important early in the project, but during the project implementation cost becomes most important and after the project only technical performance is remembered. Salapatas and Sawle (1986) define success to have been achieved only when three groups perceive success: the client (based on performance, budget and reputation), the contractor (based on profitability, reputation, client and public satisfaction) and the customer/public (based on environment, reliability and cost). Potter (1987) has found from experience that success and failure can in fact be very close and Sykes (1982) support this by pointing out that many large projects have been saved from disaster only because of fortuitous circumstances.

The Project Management Institute (2000:22) defines project management as the

“application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project.”

Project management invariably involves balancing competing demands of:

- scope, time, cost and quality;
- stakeholders with differing needs and expectations
- Identified requirements (needs) and unidentified requirements (expectation)  
(Project Management Institute, 2000).

In project development, the project client plays a very important role. The term client refers to that person or organization investing in the construction of built facilities (Mak and Picken, 2000).

The Project Management Institute (2000) defines ‘stakeholders’ as individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.

Dake (1992) examines the concept of risk from an historical perspective. In the seventeenth century, risk was defined as the probability of an event occurring, with a focus on either the loss or gains that the event would represent if it occurred. The interesting aspect of this early definition is that there was as much attention paid to benefits as to losses. This is a perspective that has been lost in the twentieth and now twenty-first centuries. In the popular sense, the term risk carries largely negative connotations of loss or harm that generally has implications of negative or adverse results from an uncertain event. For example, Fishburn (1984) calls a certain bad event ‘risky’ and Statman and Tyebjee (1984) see risk as being a high probability of failure.

Jaafari (1990) on the other hand, sees risk as being the presence of potential or actual constraints that could stand in the way of project performance by causing partial or complete failure during construction and commissioning, or at the time of using the project.

Young (1996) sees risk in the project management environment as being any event that could prevent the project realizing the expectations of the stakeholders as stated in the agreed project brief or agreed definition.

Adameitz (2003:43) has described various aspects of risk as follows:

“Risk can be viewed as a four-letter word. There can be economic boundaries from the addition of extra ‘overhead’ activities, and political/cultural boundaries from an unwillingness to acknowledge that a risk exists and must be mitigated. To prevent this budget pressure, risk management mitigation activities need to be factored into the project plans from the very beginning of a project. Construction projects involve numerous unpredictable and complex processes.”

### **2.2.1 Classifications of Risk**

Classification of risk is an important step in the risk management process, as it attempts to structure the various risks affecting a construction project. Project risks can be categorized in a number of ways according to the level of detail or a selected viewpoint (Smith et al., 2006). In order to manage risks effectively, many approaches have been suggested in the literature for classifying risks.

According to Smith et al. (2006), all project risks can be divided into three main categories: known risks, known unknowns and unknown unknowns. The difference between the categories is the decreasing ability to predict or foresee the risks. A known is an item or situation containing no uncertainty. Unknowns are things we know but we do not know how they will affect us. A known-unknown is an identifiable uncertainty. An unknown-unknown is simply an item or situation whose existence has yet to be encountered or imagined. Taking into account the probability of the occurrence and their consequence on project objectives, those events that have high probability and high impact are subject to risk management.

The PMI (2000) classify risks as internal or external. Internal risks are those that arise within the scope and control of the project team. Most internal risks can be referenced to a specific project document such as design document, technical specifications, and cost estimate or a schedule. Internal risks usually refer to items that are inherently variable. External risks are items that are generally imposed on the project from establishments beyond the limits of the project. Interactions with regulators are typical external risks. Funding constraints and restrictions are other common external risks. External risks tend to refer to items that are inherently unpredictable but generally foreseeable (Caltrans, 2007).

Dias and Ioannou (1995) conclude that there are two types of risk:

1. *Pure risk*: that exists when there is the possibility of financial loss but no possibility of financial gain (e.g. physical damages)
2. *Speculative risk*: that involves the possibility of both gains and losses (i.e. financial and production risk).

Hilson (2002) argues that the common usage of the word ‘risk’ only centers on the negative outcomes. Ward and Chapman (2003) argue that risk is often associated with adversity, things that may go wrong, and threats to projects.

The risks for infrastructure projects, according to Yoyjie (2001) cited in Getachew (2009) have a wide range of sources and can be classified into the following broad categories:

- i. Technical, quality or performance risk such as employment of inexperienced designers, changes to the technology used or to industry standards during the project.
- ii. Organizational risks such as cost, time and scope objectives that are internally inconsistent, lack of prioritization of projects, inadequacy or interruption of funding, and resource conflicts with other projects in the organization.
- iii. External risks such as shifting legal or regulatory environment including institutional changes, poor geological conditions and weather, force majeure risks such as earthquake, floods and other natural catastrophic events.
- iv. Project management risks such as poor allocation of time and resources, inadequate quality of the project plan, poor use of project management disciplines.

In the previous sections the definition and classifications of risk were discussed, it was clear that seeing risk only as an event-type phenomenon is not sufficient, but the ambiguity and unpredictability related to the future conditions must also be considered. Many sources describe the risks resulting from ambiguity, variability and lack of data.

Ward and Chapman (2003) have identified five different categories of risks:

- i. variability associated with estimates;
- ii. risk about the basis of estimates;
- iii. risk about design and logistics;
- iv. risk about objectives and priorities;
- v. Risk about fundamental relationships between project parties (stakeholders).

From their list of five risk areas, fifth is the most interesting. Here authors have recognized that difficulty to identify responsibilities, capabilities and proper mechanisms for coordination and control is “a pervasive source of Risk”. They add that these relationships may or may not include formal contracts. Wubishet (2006), also pointed out that the stakeholders relationship

management is among the challenges faced by developing countries construction industry, due to their being many in number in these countries.

### **2.2.2 The Nature of Risk**

All construction project risks are not foreseeable, while the nature and extent of even commonly foreseen risks may change considerably with time. Although risk is fairly well documented in the literature, the terminology is not consistently applied across construction, project management, engineering, health and safety, environment, business and other industries (del Cano and de la Cruz, 2002). Risk can be classified as voluntary or involuntary, depending on whether or not the events leading to the risk are under the control of the persons at risk or not (del Cano and de la Cruz, 2002). In the theoretical sense, Cvethovich and Earle (1992) view risk not as an inherent quality of the physical world but as a representation of the interaction between physical and psychosocial characteristics with the assessment of risk involving judgments about what is valued.

Kumamoto and Henley (1996) identified five attributes of risk. These are:

- i. likelihood
- ii. outcome
- iii. significance
- iv. causal scenario
- v. Population

Uher (1994) identified 34 individual risks in construction and categorizes them into a single model, referring to some as *activity* risks that may affect individual activities, while others were *global* risks that were common to all activities. The majority of risks Uher identified were global risks. Rutgers and Haley (1997) developed a model that identifies four distinct phases of risks in a project:

- developmental risks – technical, commercial/financial feasibility;
- project economics, permits/authorization, third-party intervention and political change;
- construction risks – schedule, cost, performance, design changes, interest rate escalation, consequential damage, force majeure/country risk, currency changes;

- Operational risks – market changes, statutory changes, unrest/strikes, acts of God, third-party liability etc.

### **2.2.3 Risk and Uncertainty**

As Pouliquen (1970) states, risk analysis is a method for dealing with uncertainty. However, risk and uncertainty are not synonymous. Frame (2003) explains the difference is that when making decisions under conditions of risk, we know or can estimate the probability distribution of this risk event, whereas under conditions of uncertainty, we are unable to estimate the probability distribution. So Frame distinguishes risk and uncertainty according to information availability. Figure 2.3 roughly depicts this difference.

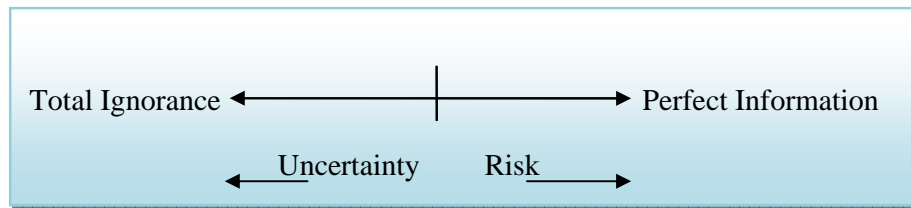


Figure 2.3; Risk, Uncertainty and Information Availability for Risk Events (Source: Frame, 2003)

Raftery (1994) points out that risk and uncertainty characterize situations where the actual outcome for a particular event or activity is likely to deviate from the estimate or forecast value. As well, risks exist in projects because of their uniqueness and temporary nature and can impact on the project contractor and sub-contractors, stakeholders and project owner in a variety of ways. Leu et al. (2001) point out that during project implementation, many uncertain variables dynamically affect the project duration and the costs can thus change accordingly.

### **2.2.4 Sources and Components of Risk**

Ayyub (2003) discusses potential risk events for projects, including technological risks, economic climate risks, political risks, large project risks, and contractual or legal risks.

Technological risk refers to the fact that rapidly improving technology may make a project out-dated and abandoned. Technology planned for a project can require replacement by newer

technology during the project construction period, adding to project costs. The decision to replace the old technology or not should be based on whether the benefit of the new technology will at least compensate for the cost of replacing the old one. In some situations, there may be no option: the new technology will be necessary due to technological improvement throughout the industry or technological improvements of complementary equipment.

Project outcomes are influenced by social and domestic economic trends, called economic climate. The economic growth of the society has high impacts on traffic volume, financial market stability, equipment costs and project performance.

Political risk refers to the circumstances under which projects are subjective to political factors. For example, foreign investors in some developing countries may face unfriendly local governments, or potential expropriation. Since large transportation projects often require approval and financial support from local and federal governments, conflicts between and within governments may bring about project failure (Frame, 2003).

Contractual and legal risks arise from inappropriate responsibility division among contractors. During the whole project period, land using, payment dispute, and other legal issues might be raised unexpectedly. These contractual and legal issues may cause cost overrun, delay, suspension or even abandonment of the projects.

For transportation infrastructure projects specifically, Flyvbjerg (2003) emphasizes the financial risks, including: cost overrun, revenue shortage (lower than expected revenues, caused by insufficient traffic volume leading to decreased social benefit) and increased financing costs (exchange rate for cross-nation projects and interest rate). Inefficient project management, contractor conflicts and accidents may cause construction cost overrun. Benefit shortage is caused directly by insufficient users, probably due to poor project design or social economy changes. Given the huge amount of debt required for financing transportation projects, even a small change in interest rates can increase financing costs dramatically and affect the viability of the projects. Investors finance their investments in capital markets via bonds, stocks and other borrowing tools. Changes in interest rates influence the values of these financing tools and influence project financing costs. For those projects financed in international capital markets, exchange rates are another concern.

With regard to large projects, Jaafari (2001) suggests project risks include: market, political, technical, financing, environmental, cost estimate, operating, etc. Market risks refer to the adverse changes in costs of labor, material or any other supply markets, which may increase project costs. Political risks are caused by policy or regulation changes from political sectors. Technical risks refer to situations in which new technologies create the possibility of not achieving budget, schedule or other targets. Financing risk is correlated with cost overrun, and benefit shortage. Environmental risks refer to the possibility of natural hazards. Cost estimate risk arises from estimated costs that are insufficient compared with actual costs. Operating risks refers to contractor's inappropriate policies like poor procurement process of resources, high equipment maintenance costs as well as stealing and waste on site.

Based on their surveys on the Kuwait construction industry, Kartam *et al.* (2001) present their findings about Kuwait contractors' perceptions on sources of risk. Financial factors are regarded as the most significant risks, followed by contractual and labor, material and equipment availability. Kartam *et al.* also find that sub-contracting is a powerful tool for minimizing project risks, as long as risks are properly allocated between the investors and contractors. Moreover these scholars indicated that lack of transparency by project sponsors during bidding and/or poor collusion detection, inadequate study by client and/or consultant and inadequate pre-contract assessment by contractors—related to site visit prior to bidding are factors that are contributory to final project cost increase.

According to Akintoye (1997), construction project risks can be defined as variables causing variability in construction project costs, duration and quality. They identified environmental, design, financial, legal, political, construction and operation risks. According to their survey on UK project contractors and managers, there exist some differences between these two groups' perceptions for individual risk source premium ranking. However, the two groups draw similar conclusions regarding the relative importance of these risk sources. They both regard financial and contractual risks as the most important types of risks to projects, consistent with Kuwait contractors' views according to Kartam. Their views are summarized in Table 2.1.

Table 2.1: Akintoye’s Survey Conclusions

Risk Sources	Perception of Risk Premium	
	Contractor	Manager
Environmental (e.g. weather)	Low	Moderate
Political, Social & Economic (e.g. inflation)	Moderate	High
Contractual agreement (e.g. responsibilities)	High	High
Financial	High	High
Construction (productivity, injury, safety)	Moderate	High
Market/industry (availability of workload)	High	High
Company (corporate)	Moderate	Moderate
Development in IT	Low	Low
Project (design information)	High	High

*(Source: Akintoye, 1997)*

The risk factors discussed above are mostly in project investors and contractors' perceptions. Since project cost benefit analysis is made from society's perspective, externalities may be another significant concern for project risk sources. For example, the construction of road projects in and around cities may expose residents along its route to noise and safety issues, which may lead to conflicts or even law suits between the project operators and the residents. Therefore, Externality risks should be included in project risk management.

Sources of project risk and their relationships are presented in Figure 2.4. This will be used as the basis for questionnaire surveys to be conducted.

As reflected in Figure 2.4, transportation project failure can be caused by negative project net present value (NPV), funding risk, externality risk and design risk. Funding risk refers to the possibility that investors may fail to provide further funding or financiers unwilling to provide additional fund in case of excessive project cost overrun. Externality risk materializes when large negative externality of the project causes legal suits from the affected community, which may lead to construction delay, additional project cost, suspension or even project abandonment. Poor project designs not only influence costs and benefits, but also affect quality adversely, making projects vulnerable to other risks such as natural hazards.

Negative project NPV is directly caused by cost overrun and benefit shortage. Cost overrun can be caused by construction risk, project design risk, environmental risk, contractual risk and economic risk. Design, financial, economic and construction risks are the major contributors to project benefit shortage.

These risk factors are somehow correlated. For example, economic risk may influence financial and construction risk, due to their sensitivities to social economic changes. Environmental and contractual risks may increase construction risk. Changes in weather and natural hazards may cause construction delays, safety issues and so on. Contractual disputes may cease project construction, causing project construction delay, cost overrun and productivity or quality issues.

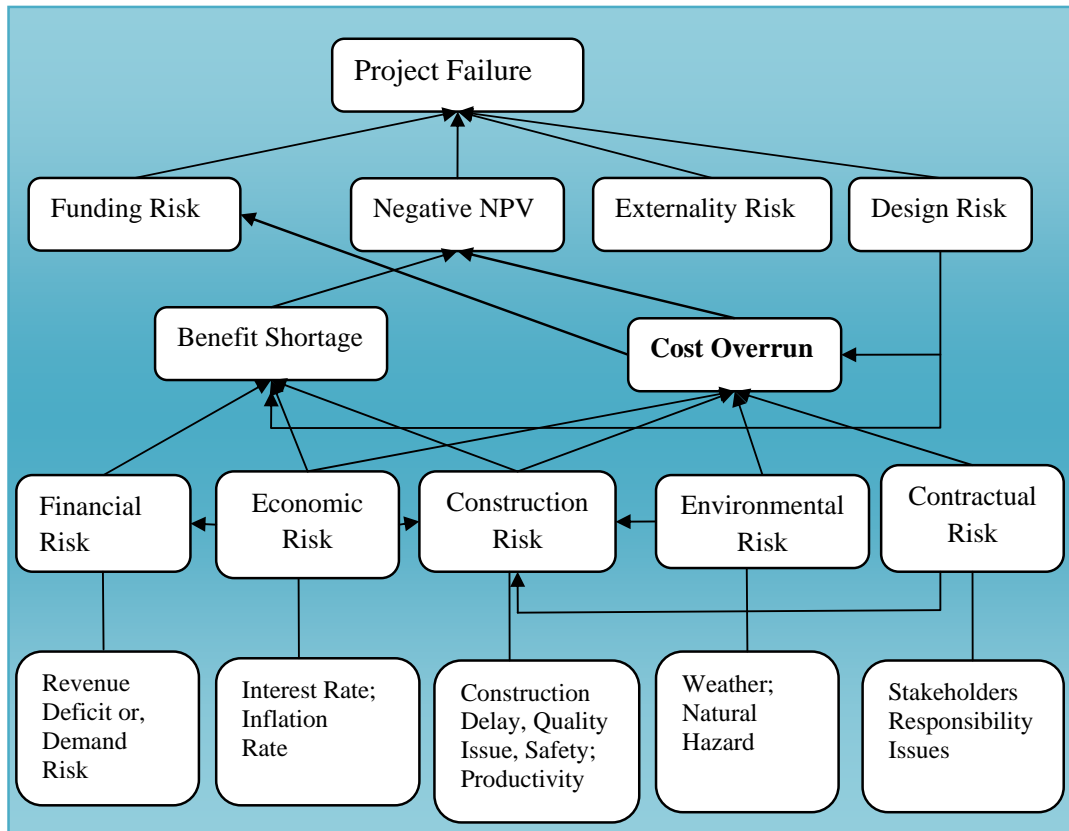


Figure 2.4; Main Risks for Transportation Projects, adapted from Frame (2003)

## **2.3 Project Risk Management**

According to the Project Management Body of Knowledge (PMBOK, 2000), risk management is seen as the processes concerned with identifying, analyzing and responding to uncertainty throughout the project's lifecycle. It includes maximizing the results of positive events and minimizing the consequences of adverse events.

Shehu and Sommerville (2006) defined Risk management as a process of controlling the level of risk and to mitigate its effects. (Nummedal et al., 1996) cited in Getachew (2009), defined risk management as a systematic approach for identifying, evaluating and responding to risks encountered in a project. Kerzner (2003) defined same as the act or practice of identifying, analyzing, and evaluating risk. Angelo and Rubin (2001) see risk management as an important part of any project management that limits delays, budget overruns, and claims between parties.

Risk management is the process by which clients and their project managers make decisions based on data generated in risk assessments. Risk management involves making educated decisions about different configurations, construction scenarios and operational parameters.

Risk management is thus one of the most critical project management practices to ensure a project is successfully completed (Chapman, 1997). Royer (2000) stated:

“Experience has shown that risk management must be of critical concern to project managers, as unmanaged or unmitigated risks are one of the primary causes of project failure.”

Royer sees risk management as:

- deciding what is an acceptable risk;
- how the level of the risk can be brought down to a level that is acceptable;
- Monitoring the reduction in risk, after exposure control actions have been taken.

Moreover, Royer also points out that having such a focus of risk on adversity means project risk management tends to focus more on processes and methods that reduce the effect of threats.

Risk management is thus in direct relation to the successful project completion. Project management literature describes a detailed and widely accepted risk management process, which is constructed basically from four iterative phases: risk identification, risk estimation, risk response planning and execution, often managing the risk management process is included. The first three phases are discussed later in this chapter.

The overall objective of the risk management process is to maximize the opportunities and minimize the consequences of risk events (Shehu and Sommerville, 2006). Dealing with risk involves planning for risk, assessing risk issues, developing risk handling strategies, and monitoring risks to determine how they have changed.

Strategies for mitigating risks on projects include (Turner, 1999):

- reducing the uncertainty associated with the project;
- avoiding the risk by finding a different way of doing the project;
- abandoning the project;
- reducing the likelihood of the risk occurring or the impact on the project;
- transferring the risk to other parties such as contractors or insurance companies; and
- Accepting the risk and creating a contingency plan.

Risk management is also dependent on numerous factors such as industry sector, the size of the project, and the stage of the project life cycle (Baker et al., 1999). To include some of these ideas for the management of risk, the risk register is often been seen as the starting point (Williams, 1993a). Also, Williams (1993b) provides a discussion of how the risk register can assist in the allocation of risk and the preparation of risk management plans. The use of project risk registers is often seen as an important step in the reuse of historical project information (del Cano and de la Cruz, 2002). They can be seen as repositories of personal knowledge or organizational memories where experiences about risks and responses are continuously recorded (Tah and Carr, 2001).

Many risk management processes comprise iterations of identifying, analysing, managing and reviewing risks. The Project Risk Analysis and Management (PRAM) process, which was developed by the Association for Project Management risk SIG in the UK (Simon et al., 1997), is an ideal starting point. An overview of the PRAM process is shown in Figure 2.5.

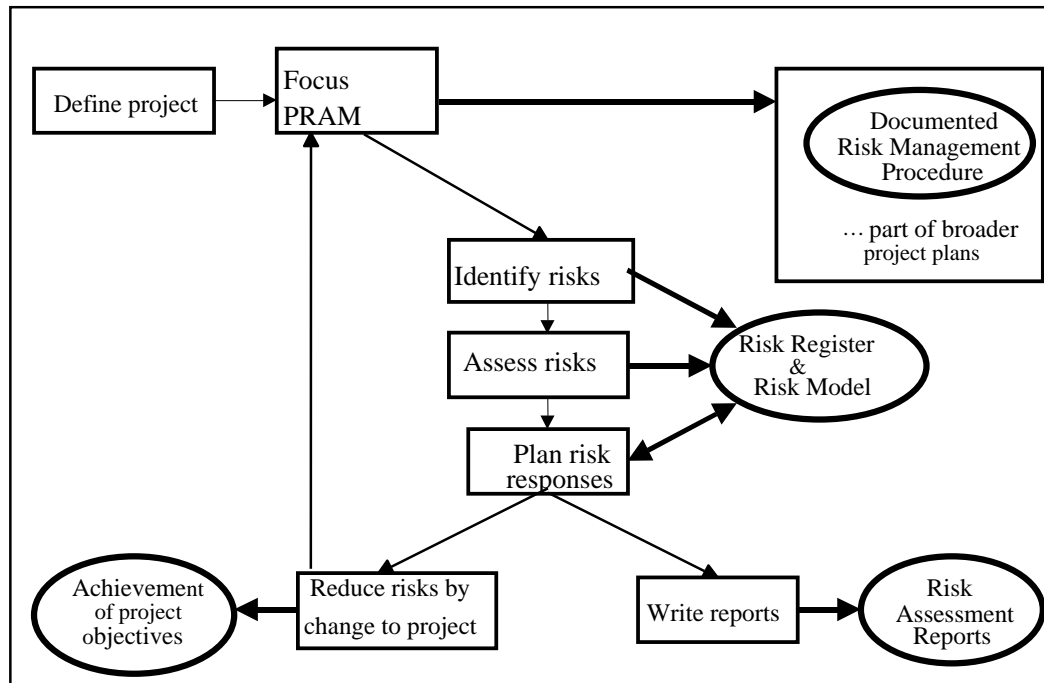


Figure 2.5; The Project Risk Analysis and Management process (Source: Simon *et al.*, 1997)

Dey (2001) has identified the following as general benefits that can be achieved from the application of risk management in any type of project:

- issues of the project are clarified and allowed for right from the start;
- decisions are supported by thorough analysis of available data;
- structure and definition of the project are continually and objectively monitored;
- contingency planning allows controlled and pre-evaluated responses to risks that materialize;
- clearer definitions of the specific risk associated with a project;
- encourages problem-solving and innovative solutions to problems within a project;
- provides a basis for project organization structure and appropriate responsibility matrices;
- helps project sponsors and project teams to make informed decisions regarding project alternatives;
- Builds up a statistical profile of historical risk for modeling future projects.

### **2.3.1 Risk management planning**

Risk Management Planning is the process of deciding how to approach and conduct the risk management activities for a project. Planning of risk management processes is important to ensure that the level, type, and visibility of risk management are commensurate with both the risk and importance of the project to the organization, to provide sufficient resources and time for risk management activities, and to establish an agreed-upon basis for evaluating risks (Caltrans, 2007). Careful and explicit planning also enhances the possibility of success of the other risk management processes. The Planning process should be completed early during project planning, since it is crucial to successfully perform the other processes.

In this phase, the scope and objectives of the risk management process are defined, the techniques and tools to be used, the thresholds of acceptable risk to various stakeholders are stated, roles and responsibilities are detailed, etc (Getachew, 2009). The outcome of the planning phase is a Risk Management Plan, which identifies and establishes the activities of risk management for the project.

Each risk plan should be documented, but the level of detail will vary with the unique attributes of each project. Large projects or projects with high levels of uncertainty will benefit from detailed and formal risk management plans that record all aspects of risk identification, risk analysis, risk response planning, and risk monitoring and control. Projects that are smaller or contain minimal uncertainties may require only the documentation of items that can potentially impact the project cost or schedule in a significant way. The lists can then be updated at critical milestones throughout the project development and construction.

### **2.3.2 Risk Identification**

Risk identification involves identifying, categorizing and recording potential risks, together with information on their cause(s) and possible effect(s), which might affect the project objectives (Shehu and Sommerville, 2006). It is the first step of the risk management process. It is aimed at determining potential risks, i.e. those that may affect the project significantly.

Ward and Chapman (1995) suggest that it is often said that the real risks in any project are the ones that the project team fails to identify. Jenkins (1998) explains that risk identification at

the operational level is very effective and can help with on-the-spot improvements and day-to-day management. Tasmania (2002) also suggests that before risks can be properly managed, they need to be identified. One useful way of doing this is defining categories under which risks might be identified: for example, in terms of risks external to the project and those that are internal. It is also desirable to identify risks based on the determined objectives, which are generally related to cost, time, and quality aspects.

The identification process will vary, depending on the nature of the project and the risk management skills of the team members, but most identification processes begin with an examination of issues and concerns created by the project development team. These issues and concerns can be derived from an assessment of the project description, work breakdown structure, cost estimate, design and construction schedule, procurement plan, or general risk checklists. This is a practical way of addressing the large and diverse numbers of potential risks that often occur on highway design and construction projects. Risks are those events that team members determine would adversely affect the project (Caltrans, 2007).

The identification phase is stressed by many researchers (Chapman, C., 2002, Chapman, R.J., 2001, Turner, J.R., 1999). It is quite obvious that if we are unaware of the risks, it's difficult to manage them, though this view is limited to the event-type scope of risk management. Chapman (2001) pointed out that since the risk management process builds heavily on the primary identification phase, the success of later risk management phases is directly comparable to the quality of the first identification phase.

Skitmore and Lyons (2004) conclusions contrast previous statements. Their study showed that risk management processes are applied the most in the execution phase, not in the conceptual phase. Still their study and usage of different risk management techniques showed that identification is the most frequently used risk management element. This proves that risk identification needs to be a continuous process and an efficient identification process requires many iterative rounds in even the later stages of project execution to successfully meet the expected targets.

Detailed steps and methods in identifying and categorizing risks are presented in many literature sources (Artto et al., 2005; PMI PMBoK, 2000 and Turner, 1999). Methods

generally include brainstorming, risk checklists, expert opinion/ structured interviews, questionnaires, historical data, previous experience, testing and modeling, evaluation of other projects, analyzing different scenarios and analyzing project plans. Additionally, sources of risk or uncertainty and sources of known unknowns should be listed. Empirical studies of risk management practice (Akintoye and MacLeod, 1997, Skitmore and Lyons, 2004, Uher, 1994) showed that checklists and brainstorming are the most usable techniques in risk identification. They also highlighted that risk identification often relies on individual judgments of the project participants. Brainstorming, scenario planning, and expert interviews are tools highway engineers commonly use in routine engineering and construction management tasks (Osipova, 2008).

PMBOK (2000) stipulates that as many project stakeholders as possible should participate in the risk identification process. Participants in risk identification activities can include the following, where appropriate: project manager, project team members, risk management team (if assigned), subject matter experts both from the project and from outside the project team, customers, end users, other project managers, stakeholders, and risk management experts. While these personnel are often key participants for risk identification, all project personnel should be encouraged to identify risks.

The assigned project stakeholders identify the potential risks (threats and opportunities), using:

- Their own knowledge of the project or similar projects;
- Consultation with others who have significant knowledge of the project or its environment;
- Consultation with others who have significant knowledge of similar projects (Caltrans, 2007).

Ward and Chapman (2003) emphasize using an uncertainty perspective in the project risk identification phase, since they consider such an approach to be the best way to determine all possible sources of opportunities (positive risks), not just threats. These identification lists need to be followed and updated as our knowledge and understanding of the project environment increases.

### 2.3.3 Risk Register

The risk register is an important product of the risk identification process. The register is a listing of risks/opportunities identified for the project along with their impact on cost and/or schedule (Chapman & Ward, 1997). In order to quantify the effect of risk, one needs to consider the probability of occurrence of each risk event and the range of cost or schedule impact if the event occurs (Fig.2.6). Combining the probability of each risk event and the cost range will result in the expected value of the risk. The expected value of the risk is the average cost (duration) of the risk factor.

$$\text{Expected cost or duration impact} = (\text{Probability of occurrence}) \times (\text{Estimate of cost or duration impact}) \dots\dots\dots \text{Eq. (1)}$$

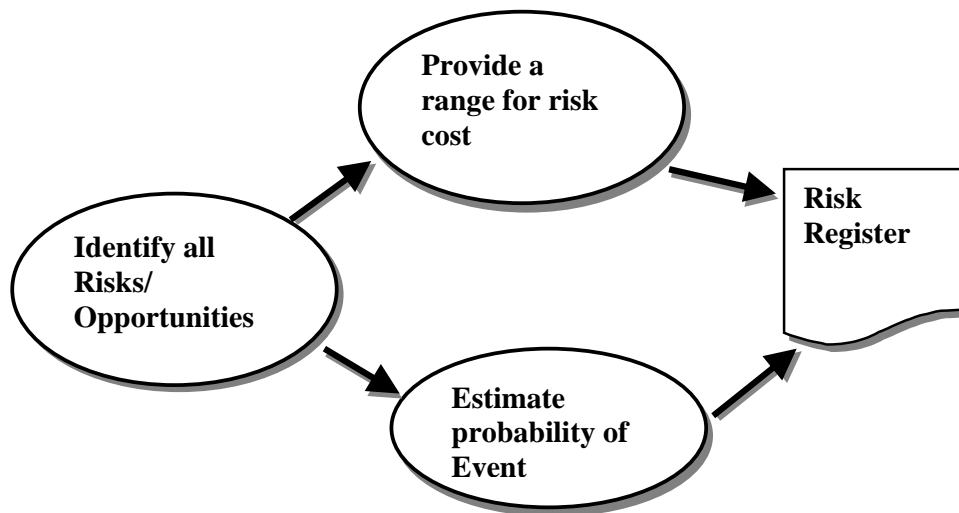


Figure 2.6; Development of Risk Register (adapted from Hopkinson, 2006)

A simple example of a risk register is shown in Table 2.2. Note that depending on the project this table can be expanded. As an example, an additional column can link the risk factor to a certain project component, or another column can be added to show the effect of risk on schedule. The last column in Table 2.2 is the range that describes the cost impact of the risk. For example, the first risk factor (Utility relocation) can have an additional cost for the project ranging from 1 million birr to 3 million birr, with a most probable cost of 2 million birr. Further, this cost will follow a triangular distribution (Fig.2.7). The choice of the distribution depends on the risk modeler’s preference, previous experience with similar projects, and mathematical convenience. It is also possible that the situation in the field turns out to be as

predicted by design documents and hence no extra budget may be needed. This is estimated by assessing a 50% probability of risk event in the risk register.

Table 2.2: Example of a partial Risk Register (adapted from: Shehu et al., 2006)

<b>Risk ID</b>	<b>Risk/Opportunity</b>	<b>Description of Risk</b>	<b>Prob. Of Risk Event</b>	<b>Risk Cost/Range</b>
xyz	Utility relocation	Location of certain utilities is unknown due to lack of data; may result in extra costs	50%	Triangular dist.: 1m, 2m, 3m birr
yxz	Price of cement	The current trend in escalation can extend into Construction phase	75%	Triangular dist.: 0.5m, 0.75m, 1m birr

There is a wide range of statistical distributions that can be used for the representation of almost any cost pattern. Much has been done and presented in the literature that can help the modeler choose appropriate cost and schedule distributions.

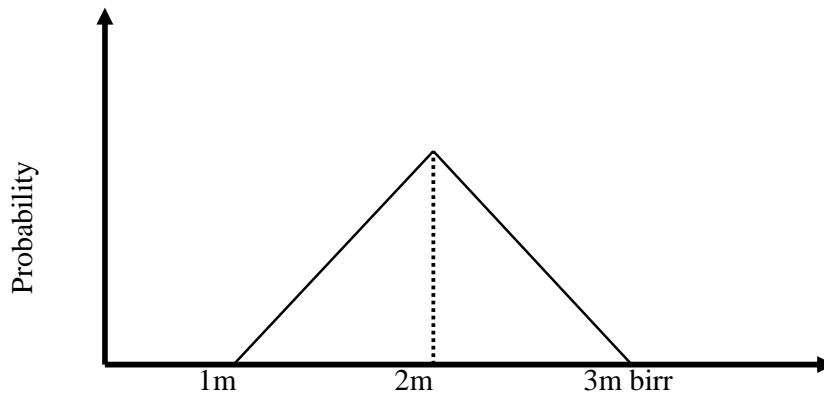


Figure 2.7: Triangular Distribution for the Risk Factor “Utility Relocation” of Table 2.2

Sometimes it is advisable to assign ranking to risk factors and only consider those risks that meet certain criteria. A typical approach is to consider two main risk characteristics: *severity* and *frequency*. Severity is a measure of the negative magnitude of the risk event if it occurs.

As an example, a risk that can cause fatalities would have the largest severity rating. Frequency is an indication of how often one expects the risk event to occur. Instead of frequency, sometimes probability or likelihood of occurrence of risk event is used. Fig.2.8 gives a typical matrix that can be used in ranking a risk. Frequency is measured with a scale of 1 (improbable) to 4 (very probable); severity is measured with a scale of 1 (minor) to 4 (catastrophic). The product of severity and probability will be used to rate the risk factor. Depending on the value of this rating, a mitigation strategy may be adapted.

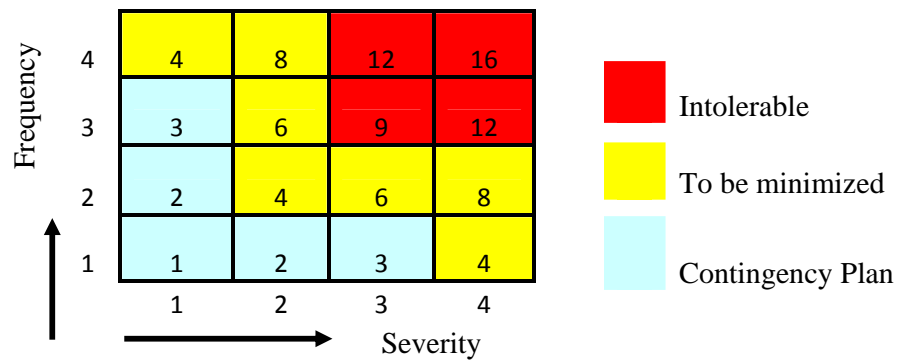


Figure 2.8: Ranking of risk factors (Adapted from Richards, 1999)

Another way to filter risks is to only consider those risks that meet a certain monetary threshold. As an example, in a 100 million birr project, the participants may decide to ignore risk factors with a most likely value of less than 200,000 birr (or say a pessimistic value of less than 500,000 birr).

### 2.3.4 Risk Estimation

After the risks have been identified and properly registered, they must be evaluated in terms of the probability of occurrence and impact. There is a range of options for measurement of risks in construction projects. In very preliminary stages of project development, when project data is lacking, a qualitative approach might be employed. Brainstorming, risk checklist, risk register, rating major risks according to their perceived impact on budget or schedule (such as *High, Moderate, Low*) are examples of qualitative risk measurement (Akintoye *et al.*, 2001).

The risk estimation or assessment process is the vital link between systematic identification of risks and rational management of the significant risks (Chapman, 2001). An understanding of

the possible effects on project objectives is needed: since most projects have only a limited amount of resources to use for risk management, concentration on only the major risks is essential (Baccarini & Archer, 2001 ). Reliable estimates of likelihoods and consequences are needed for prioritization.

Risks can be assessed either using a quantitative or qualitative analysis (Ayyub, 2003). The most common ways are to estimate risk probability and impact in simple scales; for example, from 1 to 5 or from high to low, boundaries can also be numerically defined. In figure 2.9 a probability-impact grid is introduced, which is one typical and simple way to map risks. On the grid, risks that require the most attention are easily detectable. Lower left corner risks are noted, but actions to control them are taken only if there are sufficient resources or if mitigating the risk costs less than the product of possibility of risk's occurrence and its impact on project objectives (expected value).

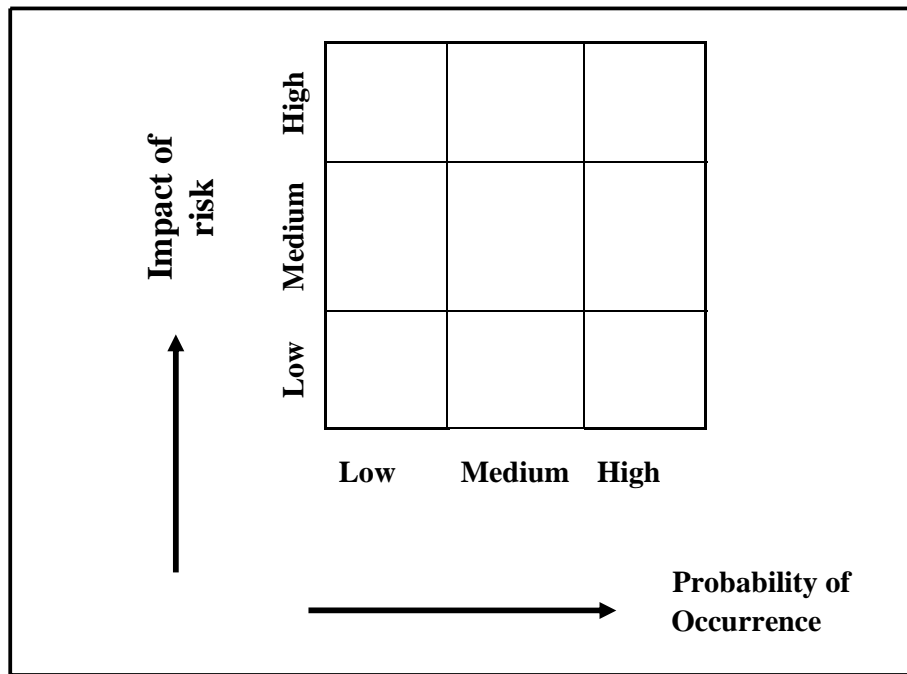


Figure 2.9; Probability-Impact Grid of risks, adapted from Chapman & Ward (1997)

Risk identification and evaluation does not provide enough support for the later risk management processes: the large amount of risk data from these two phases should be structured to aid in the interpretation and comprehension (Hillson, 2003). Risks also need to

be assessed in relation to other risks, since these relations may cause minor risks to become more relevant to the risk management process if they are significant sources for other risks.

Empirical research on risk assessment practice investigates the use of the different risk assessment techniques in construction projects. A study by Baker et al. (1999) shows that construction companies in UK use both qualitative and quantitative techniques for assessing the project risks. Personal and corporate experience and engineering judgment are the most successful qualitative techniques, while quantitative techniques include break-even analysis, expected monetary value and scenario analysis. The studies of risk management practice in the UK construction industry show that the practitioners rely mostly on professional judgment, intuition and experience (Akintoye and MacLeod 1997, Wood and Ellis 2003). A questionnaire survey conducted by Tang et al. (2007) shows that qualitative analysis is the most commonly used technique in the Chinese construction industry, while the use of quantitative methods is very low. The results of the study conducted by Simu (2006) show that the Swedish contractors mostly use professional experience and gut-feeling in risk assessment. Flyvbjerg (2003) argues that the quantitative methods used in risk management have advantages in comparison with the qualitative methods but their use is limited due to difficulties that practitioners face. He also discussed the elements that contribute to development of a workable solution for quantitative risk assessment.

Three basic risk analyses can be conducted during a project risk analysis: technical performance analysis (will the project work?), schedule risk analysis (when will the project be completed?), and cost risk analysis (what will the project cost?) (Getachew, 2009). This overall assessment of risks can be used by a Highway agency to make informed decisions about a project. More commonly, the overall risk assessment is used to determine cost and schedule contingency values and to quantify individual impacts of high-risk events. The ultimate purpose of the analysis, however, is not only to compute numerical risk values but also to provide a basis for evaluating the effectiveness of risk management or risk allocation strategies (Guo, 2004), cited in Getachew (2009).

The ultimate deliverables of risk analysis process are probability of occurrence and impact level of risks. For the impact of risk, possible consequences of risk are defined and quantified in terms of (Smith 1999):

- Increased cost: i.e. additional cost above the estimate of the final cost of the project;

- Increased time: i.e. additional time beyond the completion date of the project through delays in construction;
- Reduced quality and performance: i.e. the extent to which the project would fail to meet the user performance based on quality, standards and specification.

### **2.3.5 Risk Monitoring and Control**

An essential function of the construction project manager is the control of projects and hence the control of risks. Risk monitoring is required so as to respond to events that occur over the course of a project. Risk control can be achieved through the updating of risk management plans with new information, identifying alternatives to unplanned risk events, and by mitigating unplanned risks (del Cano and de la Cruz, 2002). Risk monitoring and control keeps track of the identified risks, residual risks, and new risks (Caltrans, 2007). It also monitors the execution of planned strategies on the identified risks and evaluates their effectiveness.

Risk monitoring and control continues for the life of the project. The list of project risks changes as the project matures, new risks develop, or anticipated risks disappear. Typically during project execution there should be regularly held risk meetings during which all or a part of the Risk Register is reviewed for the effectiveness of their handling and new risks are discussed and assigned owners. Periodic project risk reviews repeat the process of identification, Register, analysis, and response planning. The project manager ensures that project risk is an agenda item at all Project developing team meetings. Risk ratings and prioritization commonly change during the project lifecycle. If an unanticipated risk emerges, or a risk's impact is greater than expected, the planned response may not be adequate. The project manager and the Project developing team must perform additional response planning to control the risk.

According to Caltrans (2007), Risk control involves:

- Choosing alternative response strategies;
- Implementing a contingency plan;
- Taking corrective actions; and
- Re-planning the project, as applicable.

The individual or a group assigned to each risk (the risk owner) reports periodically to the project manager and the risk team leader on the status of the risk and the effectiveness of the response plan. The risk owner also reports on any unanticipated effects, and any mid-course correction that the Project developing team must consider in order to mitigate the risk.

### **2.3.6 Risk Response Planning and Mitigation**

The outcome of risk assessment is a quantified risk register and possible impact of risk factors on main project objectives (cost, schedule and performance). Some risk assessment exercises are considered complete at this stage. The risk team is now aware of the major risk factors and they embark on the execution of project with that knowledge. It is strongly recommended however that the risk analysis process be a continuous process during the project life cycle (Chapman, 2002). As a minimum, a formal risk mitigation effort should be administered and implemented so as to make the earlier effort worthwhile.

Risk response planning and mitigation efforts may require that agencies set policies, procedures, goals, and responsibility standards. Formalizing risk mitigation and planning throughout a highway organization will help establish a risk culture that should result in better cost management from planning through construction and better allocation of project risks that align teams with Client-oriented performance goals.

It is usually recommended if the team members are the same individuals that took part in the assessment process. It is possible that because of the insight gained during the assessment process; however, new individuals may also be added to the mitigation team. Likewise, some members may not be invited to mitigation if their area is sufficiently covered by others.

Figure 2.10 shows the steps in the mitigation process. The first step is prioritization of risk factors listed in the risk register. Dealing with a large number of risk factors is not efficient and the team's effort should be concentrated on tackling major issues facing the project. The risk assessment exercise has quantified each risk, so it would be easy to rank the risks in terms of their effect on cost and schedule. One approach is to rank the risks according to their expected values (average values). Another approach gives more weight to the ability of each risk factor to vary the total cost and hence may rank the risks according to their standard

deviations (or variances). As a rule of thumb, some risk management teams decide to consider only the top 10 or the top 15 risk factors. Others might use other criteria. One such criterion is the Pareto's Law: i.e., 20% of risk items are responsible for 80% of cost increase (Parsons *et al.*, 2004), so those are the risks that need to be considered. The same process can be applied for ranking *opportunities*. Opportunities are those factors that have the potential to save costs or expedite the project.

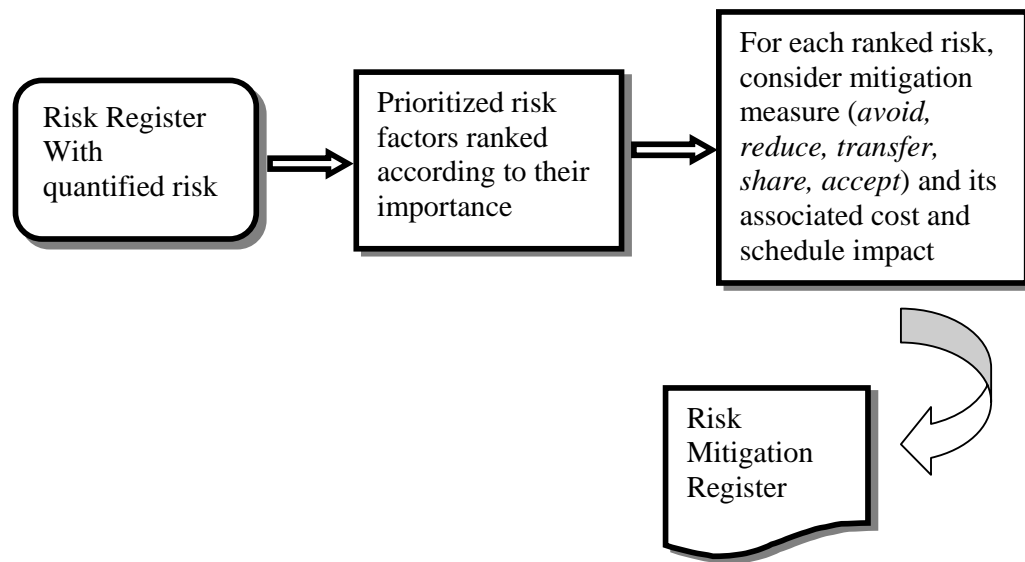


Figure 2.10; Risk Mitigation Process (Source: Wideman, 1992)

After the most important risks and opportunities are ranked, each risk factor should be carefully evaluated and mitigation measures should be planned. Often, a mitigation measure has a price. This will mean that deflecting a risk or realizing an opportunity may have upfront costs. These should be carefully calculated. Also, sometimes there is uncertainty associated with some mitigation measures. Because of this, a probability of success should be considered for the realization of a mitigation measure.

The following range of options is available to the owner according to risk literature (Wideman 1992; Touran *et al.*, 1994; Baker *et al.*, 1999):

- **Accept the risk** – Sometimes the nature of the risk is such that the most effective way is to accept its existence and absorb the consequences. As an example, project contingency is meant to counter some of these risks.
- **Reduce the risk** – Often, while it is impossible to eliminate a risk, the owner can reduce the adverse effect of risk. As an example, if ground conditions are critical to a

project, the owner may spend money to treat the ground before starting the construction. There is some upfront cost but it is hoped that the money spent is less than justified in the face of larger risk of constructing in untreated ground. Despite the implementation of the mitigation measure, there still may be some chance that the treating does not work, hence *probability of success* of the mitigation measure should be estimated and considered also.

- **Share the risk** – Sharing the risk could be considered in a variety of situations. As an example, in dealing with utility companies for utility relocation in infrastructure projects, the owner may be able to negotiate a limit for the cost of utility relocations. Sharing the risk also involves Allocating ownership to a third party who is best able to capture the opportunity for the benefit of the project or capable of managing the risk . Examples include: forming risk-sharing partnerships, teams, joint ventures, etc.
- **Transferring the risk** –Risk transfer requires shifting the negative impact of a threat, along with ownership of the response, to a third party. An example would be the team transfers the financial impact of risk by contracting out some aspect of the work. Risk transfer reduces the risk only if the contractor is more capable of taking steps to reduce the risk and does so. Risk transfer nearly always involves payment of a risk premium to the party taking on the risk. Transfer tools can be quite diverse and include, but are not limited to the use of: insurance, performance bonds, warranties, guarantees, incentive/disincentive clauses, A+B Contracts, etc.
- **Avoiding the risk** – Involves changing the project plan to eliminate the risk or to protect the project objectives (time, cost, scope, quality) from its impact. The team might achieve this by changing scope, adding time, or adding resources (thus relaxing the so-called “triple constraint”). Some negative risks (threats) that arise early in the project can be avoided by clarifying requirements, obtaining information, improving communication, or acquiring expertise.

When an organization or parties or individual refuse to accept risk, then risk is avoided. This means the exposure of risk is not allowed to exist. If risk avoidance is used extensively, the opportunity to receive profit or achieve objectives may be decreased. A contractor not placing a bid or the owner not proceeding with project funding are two examples of eliminating risk totally. There are a number of ways through which risks can be avoided, for examples, tendering a very high bid, placing

conditions on the bid, and not bidding on the high-risk portion of the contract (Baker *et al.*, 1999).

Sometimes a risk is of such magnitude that the owner would be prudent to avoid it at all costs, even at the cost of not pursuing the project. However, this would be an extreme case. A less dramatic example could be avoiding the risk of errors and omissions in design by utilizing a Design-Build approach.

In summary, the aim of risk mitigation exercise should be to reduce the uncertainty in project cost and schedule and to reduce the magnitude of risk effects. Figure 2.11 provides the overview. The curve titled “Project cost, unmitigated,” shows the total cost distribution before mitigation. The curve titled “Project costs, mitigated and opportunities realized,” shows the distribution for total costs after mitigation, assuming that the mitigation measures are successful. It shows the range of cost savings, to the left of the range of costs of unmitigated costs (indicating overall lower total costs). Moreover, the spread is smaller for the mitigated case, showing that because of mitigation measures, the cost uncertainty has been reduced.

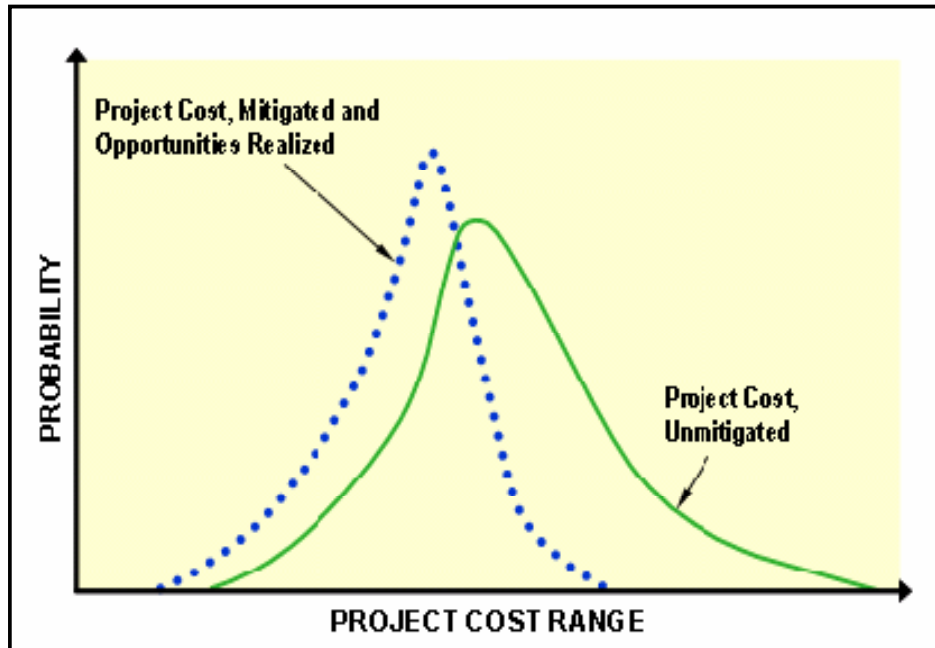


Figure 2.11; The Effect of Mitigation on Project Cost (Source: *Parsons et al.*, 2004)

A reasonable approach for documenting risk mitigation strategies and their estimated impacts is to develop a *risk mitigation register*. The format is similar to the risk register described before, but the list is much shorter. The mitigation register will only contain ranked risks that can be mitigated. Mitigation strategies formulated by the team members should be documented in the register.

Other information that should be included in the risk mitigation registers (Molenaar, 2005):

- Cost of mitigation strategy;
- Probability of success of mitigation;
- Party responsible for mitigation; and
- Possible unintended consequences.

### **2.3.7 Risk Allocation**

Risk management is not limited to a few processes, but includes much more in order to have a complete view of the suggested risk management process. One of the most crucial decisions in a project relates to the allocation of risks: who carries which risks (Artto et al, 2005). This is directly linked to the proper risk management strategy; as it will examine how risks are mitigated and handled in construction projects and which actors take responsibility for risk management. Before the decisions of risk allocations are ready to be made, the attitude that project actors have towards the risk has to be determined. Before a project starts, every actor's strategy, as well as the ability to bear and manage risks, has to be known before risks are assigned to them. It is clear that a major part of risk management/mitigation is allocation of risks to various parties. Allocation of risks is usually implemented through a construction contract (Fisk, 1997).

The importance of risk allocation should be recognized since unfair and misallocations of several inherent risks in construction contract inevitably affect all project parties - client, contractors, and consultant (Piattanapiwong, 2004). It is important that the contract clauses allocating the risk are clear and unambiguous. The meaning the owner wishes to convey should be what the contractor interprets (Hartman and Snelgrove, 1996). Unforeseen ground conditions, unknown utilities, and inclement weather are examples of typical construction

risks, facing problems regarding inappropriate risk allocation in contract occurring in practice (Macdonald, 2001).

The contract is the vehicle for risk allocation. Whether the contract is for construction, construction engineering and inspection, design, design-build, or some other aspect of highway construction management, it defines the roles and responsibilities for risks. Risk allocation in any contract affects cost, time, quality, and the potential for disputes, delays, and claims (Youge, 2001). One measure of contract's efficiency and effectiveness is its ability to clearly assign risk between contracting parties. Clear risk assignment means that both contracting parties have the same understanding of risk apportionment and risk management accountability. Contracting parties who do not have an identical understanding of risk accountability may mismanage a risk event by assuming the event or its consequences are not their responsibility. Mismanaged events cause project inefficiencies and make contract relationships adversarial. The resulting impacts on project execution ultimately increase project costs (Hartman, 1996).

The owner controls the contract and because of this the owner is generally in charge of assigning risks to designers and contractors. Despite this authority, the owner has to deal with many restrictions in preparing the contract. A contract that tries to protect the owner against all risks could have many negative consequences and eventually be more costly to the owner. Information about the principles and practice of risk allocation is available in published literature from academic researchers, the construction industry, and other organizations (Touran *et al.*, 2004; Thompson *et al.*, 1992; Sykes, 1982; Wideman, 1992).

### **2.3.7.1 Principle of Risk Allocation**

Several literatures related to risk allocation inevitably describe the common principle that “the risks in a project should be apportioned to those project parties who can best manage them” (Macdonald, 2001), though, this principle is too conceptual. The broad doctrines of risk allocation according to the relevant literature are as follows.

- Allocate risk to the party in the best position to control it.
- Consider the consequences to the receiving party.

- Consider whether the cost incurred or charged by the receiving party is acceptable.
- Evaluate the potential for new risks being transferred back to the project owner.

Moreover, the objectives of risk allocation can vary depending on unique project goals, but four fundamental principles of sound risk allocation should always be followed (Pipattanapiwong, 2004) cited in Getachew (2009):

- i. Allocate risks to the party best able to manage them**—A fundamental principle of risk management is to allocate the risks to the party best able to manage them. The party assuming the risk should be able to best evaluate, control, bear the cost of, and benefit from its assumption. Inappropriate risk shifting from the owner to the contractor can result in misaligned incentives, mistrust, and an increase in disputes.
- ii. Allocate the risk in alignment with project goals**—Risks should be allocated in a manner that maximizes the probability of project success. The definition of a clear and concise set of project objectives is essential to project success and these objectives must be understood to properly allocate project risks. Allocating risks in alignment with project objectives begins with a clear understanding of the project objectives by the agency and a clear communication of these objectives to the contracting, consulting, or design community. While this idea seems simple, in practice it is often difficult to identify and prioritize concise objectives because of the complex nature of highway construction projects.
- iii. Share risk when appropriate to accomplish project goals.**
- iv. Ultimately seek to allocate risks to promote team alignment with customer oriented performance goals**—while the concept of allocating risks in alignment with customer-oriented performance goals may seem to be a significant departure from traditional practices, highway agencies are already doing this through the use of alternative contracting techniques. For example, A+B (time plus cost) procurement is used on selected projects in the majority of highway agencies in the United States. In essence, A+B procurement passes the risk for early completion to the contractor to achieve a customer goal of satisfaction with the service. Agencies and the industry should strive to innovate and develop new risk allocation techniques that align all team members with customer goals.

Apart from the contract clauses, the owner can select the project procurement method and the contract type to mitigate and manage risks. As an example, the Design-Build (DB) method reduces the delivery time, reduces the contractor's claims regarding the engineer's error and omissions, and creates a single point of responsibility: all positive for the owner. However, DB may reduce the competition during the bidding, and open up the door for future claims due to lack of clarity of scope.

### **2.3.7.2 Risk Allocation Approach**

Theoretically, the approaches to allocate the risk can be classified into two main approaches i.e. qualitative and quantitative approaches (Yamaguchi *et al.*, 2001). The quantitative approaches objectively focus on quantification of magnitude of the allocated risks, which is the main difference and extension from the qualitative approaches.

#### **i) Qualitative approach**

A common qualitative approach is considered as standardized form of contract, which specify the obligation of contractual parties and some relief such as time extension for the party bearing the risk associated with that obligations. Ashley (1977) cited in Getachew (2009) stated that the standardized form of contract provides a framework of risk allocation by a government owner based on the principle that each risk element should be distributed so that the total effect on the total expected cost is minimized.

#### **ii) Quantitative Approach**

The quantitative approaches to risk allocation have been developed to overcome the limitation of qualitative approaches especially the issue of how much risk should be borne by each party. Most of quantitative approaches discussed their risk allocation model based on the optimality of allocating the risk. The quantitative approaches could be classified into two different concepts of optimality: cooperative and competitive risk allocation considering the different aims and views (Yamaguchi *et al.*, 2001).

Cooperative risk allocation assumes that the stakeholders jointly search for an agreement that is mutually acceptable. Most cooperative risk allocations define the optimum solution as where the total contingency costs of the project are minimized. On the other hand, the competitive risk allocation is the allocation where each of the stakeholders employs the strategy that best achieve their own goals without any concern for the other stakeholders (Yamguchi, 2001). The insurance theory for example is the concept, which the competitive risk allocation was relied on. Another model considered that actual risk allocation is relied on the combination of cooperative and competitive allocation of risks. It means the solutions provide room for negotiation. The potential solutions together constitute the negotiation space.

It is impossible to eliminate all potential risks in a construction project. Therefore, an appropriate allocation of risks among project actors is very important. Risk allocation influences the behavior of project actors and, therefore, has a significant impact on the project performance in terms of the total cost. Unclear allocation of the project risks leads to disputes between the client and the contractor. One of the problems identified in the literature is the actors' different perceptions of to whom a specific risk or group of risks should be allocated. Usually, contractors indicate that they have to bear the majority of project risks and price these risks through adding a contingency to the bid price (Andi, 2006).

The contract can also be defined as a trade-off between the contractor's price for executing the project and his willingness to take the risks (Flanagan and Norman, 1993). The objective of clients is to choose a strategy that ensures achievement of the project objectives in the most efficient way (Osipova, 2008).

### **2.3.8 Project Risk Management at the Company Level**

Risk management at the company level has aspects that are not found at project level risk management. The main point is that a company has to have some kind of risk strategy to determine a common behavior towards risks.

Florice and Miller (2001) developed five risk mitigation strategies for projects, intended for large-scale projects (e.g. highway construction projects) that described how risks in large-

scale projects should be dealt with. They state that regardless of project-level strategies, a number of institutional anchoring elements must be put in place to tie project strategy to organizational strategy. It means that all organization's projects (called 'project portfolio') should be treated as stock portfolio. Also Ward and Chapman (2003) promoted the corporate scale view on risks rather than just a project scale view. They introduced the concept of risk efficiency as a prerequisite of the holistic risk management process and formed a 'decision rule' for efficient risk management:

“Always minimize the expected cost of a project unless the risk implications at a corporate level are unacceptable, in which case the minimum expected cost increase to yield an acceptable level of corporate risk should be sought.”

It was pointed out that project level 'local optimality' may be in contrast with a 'global, company level' optimality. Project portfolio view, where all company's projects are managed in relation to others, is also convenient in risk management. If uncertainties and risks are seen as a portfolio and their interrelations and links to opportunities, then future potential gains could be better understood than they are at present.

Projects should be seen as a part of a bigger entity. Like an investor, a company might want to allocate its funds to projects with different levels of risk, so certain projects have higher risks, while other projects are allowed to bear only a limited amount of risk. It is important that risk management is not separated from the company's strategy. Risk management efforts and decisions should match the previously defined company risk profile (Arto *et al.*, 2000).

Practical tools for making risk management at the company level include, for example, Baccarini and Archer's (2001) suggestion that in addition to a single project risks, whole projects could be assessed due to their level of riskiness. Projects could be prioritized according to their riskiness, for example using numerical scale from 1 to 5, where 5 is being generally unsure of the targets of cost, time and quality and 1 referring to a project with modest risks. Risk management efforts and assigned resources could be planned according to these categories.

Similarly like a single corporate perspective, in a single large project, where multiple actors work on one site, risks are most efficiently managed if the risks are managed using a whole project perspective, not just from every actor's own perspective. Projects where several actors

are required to co-operate demonstrate how many dimensions need to be fitted together to ensure the successful completion of the project (Arto *et al.*, 2000). Structures to fairly allocate risks and rewards among project actors in order to motivate the entire stakeholders to adopt a wider, whole project risk management perspective, is of extreme importance to successfully implement this new whole project perspective.

### **2.3.9 Literature Summary on Project Risk Management in Construction Industry**

Typical construction project risks and sources of risks in a construction project have been already discussed. Risks in construction projects are a significant element of the total project costs and thus their allocation has a major effect on project budget (Zaghloul & Hartman, 2003). Construction projects are open systems, rather than closed systems, which adds to the variability and riskiness of the project (Baloi & Price, 2003). The risk management process has to be adjusted to the cooperative environment in construction projects, but unfortunately this has not yet happened. Risk management in the construction industry still relies heavily on contracts, and the industry has the bad reputation of excessive cost and time overruns and becoming involved in numerous disputes and claims. According to various studies, contractual structures are the main sources of the lack of flexibility and they have a significant negative effect on the stakeholder relationships (Florice & Miller, 2001). Contractual arrangements are also found to increase the final cost of the project (Fetene, 2008).

The first improvement effort to be made in the construction industry to meet the performance goals in time, cost and quality management, is an attempt to promote the risk management process. Risk management should be implemented; contracting risks to other parties does not mean they are managed since nothing is done to deal with these risks, rather only the final cost of the contract is increased. Contract clauses are estimated to raise project costs by 8-20% of the total costs (Hartman, 2000). This supports and motivates efforts to find alternative methods in managing risks to achieve the main project objectives (cost, time and quality).

Apart from contracts, studies show that construction risks are mainly handled with experience, assumption and human judgment (Baloi & Price, 2003). Since risks are highly situation-specific, expert judgment provides sufficient means of risk management. Problems

occur when this expert knowledge isn't documented (which is common in the construction industry) and knowledge is not transferable. Other risks relate to possibly biased decision making, when personal background and assumptions inevitably reflect on the person's evaluation.

The usage of risk management techniques is varied in the construction industry. Brainstorming and team analysis for identifying risks are the most frequently used techniques, computer-aided methods are rarely used (Skitmore & Lyons, 2004). Often risk management is restricted only to the identification phase, events can be known in advance, but their extent is not quantified and managed (Mills, 2001). The biggest barriers in construction project risk management are a drive for cost effectiveness; risk management is seen only to consume resources and benefits are difficult to measure in financial terms. Lack of risk management resources and know-how restricts the use of risk management techniques. There are not enough capable personnel to conduct the risk management process and risk management is only in the heads of a few key people (Skitmore & Lyons, 2004; Uher & Toakley, 1999). Also cultural issues such as negative attitudes and mistrust of risk analysis, affects the results of the process (Uher & Toakley, 1999). Simply a lack of knowledge and communication causes risk management failures.

Construction projects face a significant amount of uncertainty that is not related only to the early phases of the project. Ford *et al.* (2002) came to the conclusion that great project value remains hidden in the project, in positive risks (or uncertainty) that is not actively searched. Floricel and Miller (2001) made a similar finding that, in large scale projects managers often try to secure favorable conditions for projects by identifying and pre-empting possible adverse effects by ignoring possibilities for positive ones.

Odeh and Battaineh (2002) recommended the following improvements to construction risk management: incentives for early completion should be included in to the contracts and adopting a new approach to awarding experience instead of the lowest price. That way an experience would have the weight it seems to deserve. In a construction industry the co-operative viewpoint among the stakeholders and the financial allocation of risks is critical. Zaghoul and Hartman (2003) said an adequate risk sharing system should be the kind that would give the benefits of risks not occurring in all parties. Floricel and Miller (2001)

suggested establishing shared financial safety reserves for mitigating crises when they happen.

## **2.4 Project Cost Overrun**

The problem of cost overrun, especially in the construction industry, is a worldwide phenomenon, and its consequences are normally a source of friction among clients, consultants and contractors on the issue of project cost variation. Project cost overruns create a significant financial risk to clients. However, in spite of the risks involved, the history of the construction industry is full of projects that were completed with significant cost overruns (Garry, 2006; Molenaar, 2005).

The literature shows that a wide variety of factors influence construction costs. In a study conducted in Newfoundland on highways, Hegazy and Ayed (1998) found that season, location, type of project, contract duration and contract size had a significant impact on individual contract costs. Some factors are intrinsically related to construction organizations which are solely responsible for managing them, whereas others are closely related to socio-cultural, economic, technological and political environments within which most organizations operate.

Cost overrun arises primarily because of four factors (Frame, 2003; Molenaar, 2005):

- i. External risk due to:
  - modifications in the scope of a project
  - changes in the legal, economic and technologic environments
- ii. Technical complexity of the project due to:
  - Size
  - Duration
  - technical difficulty
- iii. Inadequate project management due to:
  - poor control of internal resources
  - poor labor relations
  - low productivity
- iv. Unrealistic estimates because of the uncertainties involved.

Transportation projects have historically experienced significant construction cost overruns from the time the decision to build has been taken by the client. Construction cost estimating on major transport infrastructure projects has not increased in accuracy over the past 70 years. The underestimation of cost today is in the same order of magnitude that it was then (Flyvbjerg et al., 2002; Molenaar, 2005).

Angelo and Reina (2002) state that the problem of cost overruns is critical and needs to be studied more to alleviate this issue in the future. They also point out that cost overruns are a major problem in both developing and developed countries (Angelo & Reina, 2002). The trend is more severe in developing countries where these overruns sometimes exceeds 100% of the anticipated cost of the project (Flyvbjerg et al., 2002).

#### **2.4.1 Definition of Cost Overrun**

Literature shows that wide varieties of risk factors influence construction costs and result in substantial increase of project costs than originally budgeted. Expressed as a percentage of estimated cost, this is often termed cost escalation, cost overrun or cost growth, and occurs as a result of many factors some of which are related to each other, but all are associated with some forms of risks (Avots, 1983; Garry, 2006).

Different scholars defined project cost overrun in construction industry in their works and some of them are outlined as follow:

- **Cost overrun:** the amount by which actual costs exceed the baseline or approved costs during the contract agreement (Wideman, 1992).
- **Cost overrun:** An instance in which the provision of contracted goods or services are claimed to require more financial resources than was originally agreed between a project sponsor and a contractor (User Guide, 2005)
- **Cost overrun:** The difference between the original cost and the actual cost when the project is completed (Avots, 1983; Angelo & Reina, 2002).

These scholars used the words cost growth, cost escalation and cost overrun interchangeably. For the purpose of this research cost overrun is defined as the increase of the final actual cost

of a construction project (usually expressed as a percentage of original contract amount) at a completion over the original contract amount, agreed by and between the client (the project owner) and the contractor during the signing of the contract.

#### **2.4.2 Causes of Cost Overrun**

Angelo & Reina (2002) has attributed cost overruns to several factors that are either not controllable or that to a varying degree are unmanageable. They include the accuracy of original cost estimate, degree of government regulation and control, construction completion delays, number of design changes, and labor related matters such as their availability, skills, and increases in fringe benefits.

According to Robert (2007), project owners identified five reasons for project cost overruns: these reasons were incomplete drawings, poor pre-planning process, escalating cost of materials, lack of timely decisions and excessive change orders.

According to User's Guide (2005), the following are the factors that change the cost of the construction projects through time: poor project management, design changes, unexpected ground conditions, inflation, shortages of materials, change in exchange rates, inappropriate contractors, funding problems and force majeure.

In developing countries the lack of proper phasing of construction projects and lack of proper planning can contribute to the discrepancy of supply and demand. This leads to shortage of construction materials as the demand will exceed the supply, which in turn leads to a climb in the cost of construction materials; this inevitably gives rise to project cost overruns, with consequential effects on inflation and a decline on efficient activity in the construction industry (Flyvbjerg et al., 2002; Molenaar, 2005). They also found that the size of the project, the difference between lowest bid and engineer's cost estimate, the type of delivery method, the level of competition, quality of contract documents, and the nature of interpersonal relations on the project influence the cost overrun rates.

Chang (2002), stated that the cost of a construction project is affected by a large number of factors because of the fact that construction is a multidisciplinary industry and its work involve many parties such as the project owner and various professionals, contractors and

suppliers. Thus, a construction project cost not only depends on a single factor but a cluster of variables that are related to the characteristics of the project and to the construction team as well as the market conditions.

Factors which affect the cost of a construction project have been identified in literatures (Chang, 2002; Molenaar, 2005; Fetene, 2008), and outlined below:

**i. Poor Project Management:** The role of the project manager or project management team is probably the most important element in controlling and/or managing the costs of a construction project. It is often true that good project, if combined with poor project management, will usually face serious difficulties.

A poor project management structure will have an impact at all stages of the construction process (User's Guide, 2005), leading to:

- Lack of planning and coordination;
- Poor communication between members of the project team and the project sponsor;
- Failure to identify problems and institute necessary and timely design and programming changes;
- Lack of control over time and cost inputs; and
- Lack of end user involvement.

Good project management, on the other hand, manages costs by careful estimating, scheduling, forecasting and analyzing cost data, and finally implementing measure to correct cost related problems proactively.

**ii. Unexpected Ground Conditions:** unforeseen ground conditions are frequently reported to cause construction project cost growth (Garry, 2006). Ground conditions can be assessed by the use of trial pits and borehole sampling onsite or using hi-tech equipment. However, the actual site conditions for full extent of a project, particularly for road projects, are not usually determined until the actual construction is started. It is sometimes possible that those difficult conditions are overlooked by the initial review or conditions have changed due to adverse weather conditions or changes in sub-grade soil conditions. Unexpected sub surface conditions can, at times, require fundamental redesign of projects at high expense. Furthermore, changes in sub-surface ground

conditions can lead to problems of moving machinery and supplies around the site, and in undertaking excavation and replacing the unsuitable material. This can also increase costs and add to the construction time required.

**iii. Shortage of Construction Materials:** During periods of high development where the level of construction activity is usually high in a particular region, there may be shortages of some construction materials. Sometimes the local market may not be able to supply the full demand of these construction materials; hence, there may be a need to import these construction materials from abroad. If this was not anticipated in the original cost estimate, delays may occur and/or the prices of these elements may increase which consequently lead to project cost overrun.

**iv. Change in Foreign Exchange Rates:** The change in foreign exchange rate is particularly relevant if materials or other elements of the construction project are being purchased from foreign countries. If the foreign exchange rates change beyond the expected level; then the cost of the project may increase.

**v. Inexperienced Contractor:** Contractors are selected on the basis of price, experience in undertaking particular types of construction project and their reputation or track record in producing high quality work within budget and on time. In some cases there is a trade-off between price, experience and track record but the desire to accept the lowest tender does not always lead to a project that is completed within time and budget. Yates et al (2003) concluded that in contracts where the Engineer's estimate is at least 15% greater than the contractor's bid amount there is a strong likelihood of cost overruns. Therefore, these projects need to be carefully tracked and documented.

There are cases where the prime contractor and sub-contractors go into bankruptcy during the construction period. This can lead to significant delays and extra costs arising as the project owner has to re-tender the remaining work to be undertaken by another contractor.

**vi. Force Majeure:** This term covers a range of events which are also commonly referred to as "Acts of God". They include revolution, war, riot, earthquake, landslide, fire, political instability, hostilities, contamination and other such risks. Where they do

occur, they will normally lead to significant delays and cost overrun to construction projects.

**vii. Construction Cost Underestimation:** A more serious situation can confront an owner when there has been deliberate underestimation of costs in order to obtain project approval or for fraudulent practices. According to studies made by Flyvbjerg (2003) large projects have intentionally underestimated in order to obtain voter support for the financing approvals. He stated that whatever the cause, almost all large public projects contain initial cost estimating errors that result in the need for increased funding to complete the projects.

Construction cost increases seem to materialize after the commencement of the construction but the problem is deep-rooted during contract cost estimation and tendering stage (Warsame, 2006).

Flyvbjerg (2003) has explained four reasons of cost underestimation in megaprojects:

- Technical;
- Economic;
- Psychological; and
- Political.

- a) **Technical Explanations:** Most studies that compare actual cost at completion and estimated cost at the beginning of bid award of construction projects explain what they call “forecasting errors” in technical terms, such as imperfect techniques, inadequate data, honest mistakes, inherent problems in predicting the future, lack of experience on the part of forecasters etc.
- b) **Economical Explanations:** Economic explanations consider cost underestimation in terms of economic rationality. Flyvbjerg (2003) stated that two types of economic explanations exist: the first explained in terms of economic self-interest, the other in terms of the public interest. As self-interest is considered, when a project goes forward, it creates work for engineers and construction firms, and many stakeholders make money. If stakeholders are involved in or indirectly influence the forecasting process, then this may influence the outcomes.

As the public interest is regarded, project promoters and forecasters may deliberately underestimate costs in order to provide public officials with an incentive to cut costs and thereby to save the public's money. Empirical studies by Wachs (1990) have identified promoters and forecasters who say they underestimate costs in order to save public money.

Both types of economic explanation account well for the systematic underestimation of costs. Both depict such underestimation as deliberate, and as economically rational.

- c) **Psychological Explanations:** Psychological explanations attempt to explain biases in the mental makeup of project promoters and forecasters. Politicians may want a monument complex or museums, and transportation officials sometimes have the mentality of building roads and bridges. The most common psychological explanation is probably "appraisal optimism." According to this explanation, promoters and forecasters are held to be overly optimistic about project outcomes in the appraisal phase, when projects are planned and decided (Florice et al. 2001). An optimistic cost estimate is a low one. The existence of appraisal optimism in promoters and forecasters would result in actual construction cost being higher than estimated costs.
  
- d) **Political Explanations:** Political explanations interpret cost underestimation in terms of interests and power (Flyvbjerg et al., 2002). A key question for political explanations is whether forecasters are intentionally biased to serve the interests of project promoters in getting projects started. For legal, economic, moral, and other reasons, if promoters and forecasters have intentionally fabricated a deceptive cost estimate for a project to get it started, they are unlikely to tell researchers.
  
- viii. **Change Orders or Variation Orders:** Change orders are common in all types of construction projects (Tadesse, 2009). Changes in construction projects can cause substantial adjustment to the contract duration and construction cost (Ibbs et al., 2007). According to them, changes can be deleterious in any project and can cause cost overrun, if not considered collectively by all project participants.

Variations are inevitable in any construction projects (Ibbs et al., 2007). In an ideal world, changes will be confined to the planning stages. However, late changes often occur during construction, and frequently cause serious disruption to the

project. Project variations were identified as a major source of conflicts and disputes in the construction industries of many countries (Yates and Hardcastle, 2003). The need to make changes in a construction project is a matter of practical reality. Even the most thoughtfully planned project may necessitate changes due to various factors (O'Brien, 1998). Needs of the owner may change in the course of design or construction, market conditions may impose changes to the project, and technological developments may alter the design and the choice of the engineer. Furthermore, errors, additions and omissions during construction may force a change.

Changes can be originated from numerous factors pertinent to the construction projects. According to O'Brien, (1998), causes of change orders include the following:

- Additions and/or enhancement required by owners;
- Accident or damage;
- Force Majeure;
- Unforeseen conditions;
- Change in Plans and/or specifications;
- Acceleration; &
- Scope change.

Researches in construction projects in some developing countries indicate that by the time a construction project is completed change orders or variations result in an 8.3 % cost overrun [Al-Momani, A., 1996]. According to Michel Gibeault (2007), change orders typically average between 2-5 % of construction costs, but can easily rise to more than 10 % depending up on the degree of changes.

Thomas (1985) studied highway construction programs and reported on selected claims for project changes and cost/schedule overrun on these same projects. The study concludes that project change has a direct effect on costs and schedules of construction projects, primarily cost/schedule overrun.

Constructability in the highway industry has also gained considerable attention for adding costs to designed projects. O'Connor et al. (1991) identified that poor specifications can cause construction rework and delays. Their findings suggest that 22% of all constructability problems are related to ineffective communication of engineering information, plans, and specifications, especially inadequacies in project specifications. Anderson et al. (1999) also confirmed the issue of inadequacies in project specifications in their research on state highways in the United States.

**ix. Inflation:** Adamson (1996) defines inflation as the rate of increase in general price level in an economy. Generally, inflation is the term used when paper money loses value, or buying power of money becomes less.

Kayode (1979) reports that project cost overrun are caused by rising costs largely due to inflation, inadequate analysis and inadequate information. Orji (1988) stated that the causes include certain government fiscal/monetary policies, poor costing of projects, inflation within the economy and some practices of project participants, especially those involving government projects. A further reason advanced for the incidence of project cost overrun is attributed to costing methods (Akpan and Igwe, 2001).

Inflation can increase the costs of construction project as it affects material and other resources required for construction. If the rate of inflation increases above the predicted level during the construction period, then the original cost estimate will be exceeded. Obviously any factor that delays a construction project will expose the project to the risk of further inflationary cost increases. Due to the nature of the process and the rate of return for work undertaken on construction projects, the effects of inflation can cause loss of profit to contractors and higher cost overrun to project owners.

Cost estimates for construction work are produced at a specific point in time and the prices used therein are relevant only for that time and for short near future. This is because prices for items supplied and work undertaken are continually subject to market forces. In study carried out by Pohl and Mihaljek (1992) in which 1,015 World

Bank projects were surveyed, it was found that the nominal cost overruns were primarily due to unexpected inflation.

- x. **Acceleration Costs:** Acceleration occurs when a project has been delayed, yet the owner demands that the contractor complete the contracted work before the contract completion date; or agreed-upon changed completion date, which is before the completion date stipulated in the original contract.

When acceleration occur the contractor typically will incur additional direct and indirect costs. While direct costs are relatively easy to quantify, indirect costs are difficult to identify (William, 2002). If the contractor establishes a valid acceleration claim, he/she is entitled to recover the costs incurred. These costs may include increased mobilization and demobilization costs due to the need to commit additional resources in terms of labor, equipment and supervision at the project than originally contemplated by the original schedule; specifically, direct labor costs include such items as increased wage costs for additional workers, overtime pay and rental costs for additional equipment. Further, the contractor may incur additional costs for inefficiencies in labor. These inefficiencies may include congestion or fatigue from extensive overtime work. Labor inefficiencies are a hidden but very expensive cost of an acceleration. Nevertheless, while labor inefficiencies are a very real part of an acceleration cost, they are extremely difficult to quantify.

- xi. **Delay on Completion Time and Delay on Payments:** Delays defer income, while interest and interest of interest, keep accumulating. Long delays may result in projects ending up in the so-called 'interest trap' (Flyvbjerg et al., 2004), where a combination of escalating construction costs, delays and increasing interest payments result in cost overrun. They also concluded that lengthy delays in inflationary environments increase cost overruns tremendously.

The overall lack of finance to complete a project, or delays in the payments for services by the project owners or clients can lead to significant problems. If the costs of a project have increased significantly beyond the original estimate, then the work on the project may have to be stopped or be delayed until additional fund can be found. Delays on payment may sometimes provoke the contractor to claim for interest

rates. If the payment by a project owner is slow, the contractor may begin to commit fewer resources to a project, and may even cease work if cash flow becomes a problem.

- xii. Late Site Hand Over or Change of Location of Construction Site:** Late hand over of construction sites, sometimes may happen and substantially increase the cost of construction projects. In most international projects in Ethiopia late site hand over is a common form of claim sources for compensation for contractors (Girmay, 2003). For example, the Addis Ababa Bole International Airport Project has suffered an additional cost of about 1,000,000.00 USD due to late site hand over (Girmay, 2003).

Sometimes the owner may decide to change the location of the project after the award to the winning contractor. This could result in road projects due to unexpected sub-surface condition which may leads to the redesign and relocation of the original route. This is a rare phenomenon but it does happen due to sudden and unavoidable circumstances. The change of location of a project might extensively change the entire character of the work that was initially required under the contract or the new location of the construction site may have different sub-surface condition and additional drainage structures that may necessitate the structure to be designed. In such case it is rightly alleged that the changes do alter the “general scope of work” and therefore, the final cost of the project might exceed the original contract amount.

In addition to the foregoing factors, it is found that the provisions of contract clauses are the main source of project cost overrun (Hartman, 2000; Floricel & Miller, 2001; Fetene, 2008). Hartman (2000) found that contract clauses are estimated to raise project costs by 8-20%. Fetene (2008) has also summarized the FIDIC 1987 and MoWUD 1994 standard conditions of contract clauses that are related to costs. He pointed out that these clauses consequently alter the construction cost of projects unless and otherwise they are deleted or replaced by some other sentences in the special conditions of the contract for the specific construction projects.

From section 2.2.4 (pp24) and the preceding section of the literature review, the following risk factors are identified as variables for use in the survey:

1. Improper planning
2. Lowest bidding procurement method
3. Inadequate labor/ skill availability
4. Ambiguity of contract documents
5. High transportation costs
6. Long period between design and time of bidding/tendering
7. Wrong method of cost estimation
8. Provision of contract clauses
9. Design risk/ Frequent design changes  
Absence of construction cost data
10. Domination of construction industry by foreign firms and aids
11. Change in government regulation
12. Inadequate duration of contract period
13. Bureaucracy in bidding
14. Litigation
16. Work suspensions owing to conflicts
17. Technology changes
18. High cost of machineries
19. Disputes on site
20. High interest rates charged by bankers on loans received by contractors
21. Lack of coordination between general contractor and subcontractors
22. Inappropriate government policies
23. High cost of skilled labor
24. Environmental issues
25. Inadequate preconstruction study
26. Unexpected Inflation/ material Price escalation
27. Inappropriate contractor policies
28. Scope changes arising from redesign and extensive variation occasioned by change in brief
29. Lack of contractors proper evaluation (review) of tender documents at tendering phase
30. Poor site management/ Poor cost control
31. Adverse effect of weather
32. Inadequate site investigation/unexpected ground conditions
33. Poor relationship between management and labor
34. Inaccurate cost estimation/underestimation
35. Fraudulent practices, kickbacks, corruption
36. Unstable cost of manufactured materials
37. Acceleration Costs
38. Contractors poor procurement processes
39. Poor financial control on site
40. High machineries maintenance costs
41. Inadequate production of raw materials in the country
42. Lack of specialized Construction manager
43. Lack of prompt decision making (quick response) by client
44. Stealing and waste on site
45. High Service relocation costs
46. Right of way problems (access to site and quarry)
47. Lack of proper communication and coordination
48. Lack of knowledge of available resources
49. Shortage of construction materials
50. Delays on completion time
51. Scope changes occasioned by inadequate pre-contract study
52. Poor Contract administration
53. Additional work/Direct change orders by client
54. Mode of financing and payment for completed work

### **2.4.3 Effects of Cost Overrun**

Cost overruns in public and in private construction projects are often the stuff of scandal in the news and media. Typically owners and contractors are treated as eager participants in bribes, illegal financing and other forms of corruption and waste (Oberndorfer, 1994). It also leads to loss of clients' confidence in consultants, added investment risks, inability to deliver value to clients, and disinvestment in the construction industry (Flyvbjerg et al., 2002).

Cost overruns have obvious effects for the key stakeholders in particular, and on the construction industry in general. To the client, cost overrun implies added costs over and above those initially agreed upon at the onset, resulting in less returns on investment. To the end user, the added costs are passed on as higher rental/lease costs or service prices. To the professionals, cost overrun implies inability to deliver value for money and could well tarnish their reputations and result in loss of confidence reposed in them by clients. To the contractor, it implies loss of profit for non completion, and defamation that could jeopardize his/her chances of winning further jobs, if at fault. To the industry as a whole, cost overruns could bring about project abandonment and a drop in construction activities, bad reputation, and inability to secure project finance or securing it at higher costs due to added risks (Mbachu and Nkado, 2004 quoted in Fetene, 2008). All these consequences affect the reputation and sustainability of the construction industry and the country's economy in general.

The effects of cost overrun are not confined to the construction industry, but are reflected in the state of the overall economy of a country (Arditi et al., 1985). They stated that delays and cost overruns in construction projects prevent the planned increase in property and service production from taking place, and this phenomenon in turn affects, in a negative way the rate of national growth.

Angelo and Reina (2002) pointed out that the problem of cost overrun is critical and needs to be studied further to minimize the effects in the future construction endeavor. They also stated that cost overruns are a major problem in both developing and developed country, the trend being more severe in developing countries.

The following effects of cost overrun are identified and summarized as variables for use in survey:

1. Losses of credibility to highway organization/bad reputation
2. Loss of clients' confidence in consultants
3. Added investment risks/Funding risk
4. For professionals -inability to deliver value to clients
5. Discourages sponsors to invest in construction industry
6. Less returns on investment for client
7. Delay in payment
8. Loss of profit to the contractor
9. Abandonment of future projects
10. Drop in construction activities
11. Inability to secure project finance/securing it at higher costs
12. Prevent planned increase in road network
13. Damage professional relations
14. Suspension of work
15. Dispute among parties
16. Decreased rate of national growth

## **2.5 Project Cost Management**

The Project Management Institute (PMI, 2000:45) defines the Project Cost Management as

"the processes required to ensure that the project is completed within the approved budget" and provides an overview of the following major processes:

- **Resource Planning.** Determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.
- **Cost Estimating.** Developing an approximation (estimate) of the costs of the resources needed to complete project activities.
- **Cost Budgeting.** Allocating the overall cost estimate to individual work activities.
- **Cost Control.** Controlling changes to the project budget.

All these major processes are used in Construction Projects. Lifecycle costing together with value engineering techniques and constructability analysis are used in Construction Projects to reduce cost and time, improve quality and performance, and optimize the decision making.

Jonathon (2002) has concluded that lifecycle costing is an important consideration in project development and should generally be considered at the conceptual design phase. He reported that life cycle cost analysis can be used in the conceptual stage to determine the materials to be used in the project, as well as to perform initial value engineering studies.

Managing construction costs includes planning, estimating, scheduling, forecasting and analyzing cost data, and finally implementing measures to correct construction cost problems. Throughout a project's planning, design, and construction phases, cost management is employed as a means of balancing a project's scope, expectation of quality and budget.

The approach can be summarized as requiring the following three steps (Fetene, 2008):

- i. Define the scope, the level of quality desired, time for completion and the budget,
- ii. Ensure that the scope, quality, time and budget are aligned, and
- iii. Monitor and manage the balance of these components throughout the life of the construction project.

Project cost management begins with the identification of the owner's objectives and ends when these objectives have been met. The purpose of project control is to ensure that the project's design, budget, and schedule are met by the project team. If any objective begins to slip, the project manager and/or the project team will identify this deviation early so that appropriate correction can be made timely. Project cost control provides management with cost related information for making decisions with a view to complete the project with specified quality, on time and within budgeted costs (Avots, 1983).

In construction projects, generally, there are two parties whose investments are involved: the project owner (or client) and the contractor. The client's investment starts with his decision to build the project and his expenses continue during design, execution and commissioning stages. In order to maintain both the scope and budget of the project it is necessary to manage the design to insure that all decisions will produce the best value possible for the owner (Jonathon, 2002). These methods pertain mainly to owners and designers, the responsible

parties up to the point where bids are solicited. Prior to bidding the project, contractors collect the bid documents, arrange site visits, and estimate the cost plus markup required to complete the project as designed. A contractor's estimate is based on completing the work and making a profit. Project cost management, therefore, involves balancing these competing needs without compromising the quality.

### **2.5.1 Project Cost Estimating and Control**

An estimate can be defined as the calculated prediction of the amount of money required to undertake a specific amount of work in the year in which it was prepared. For the project manager to effectively plan and control a project, accurate estimating is essential. Accurate estimates of project costs provide an essential part of the proper basis for management decisions and control. The most obvious reason for producing cost estimates is to assist in pricing decisions, but that is by no means the whole history. Cost estimates are usually needed for all types of projects, including in-house projects without fixed prices. Timescale planning, pre-allocation of project resources, the establishment of budgets for funding, manpower and cost control, and the measurement of achievement against expected performance all demand the provision of sound estimates.

Ahuja (1994) cited by Fetene (2008), stated that estimating is the primary function of the construction industry; the accuracy of cost estimates starting from early phases of a project through the tender estimate can affect the success or failure of a construction project. He also stated that many failures of construction projects are due to the result of inaccurate estimates. A study conducted in United States of America on cost estimating problems associated with pioneer energy projects and process plants revealed that 74% of cost growth was caused by underestimation, that is, improper estimation (Merrow, 1988).

Cost is a major factor in most decisions regarding construction; as construction cost estimate is prepared before the actual construction of the project, much study and thought must be put into the primary and subsequent estimating phases as they form the future construction documents. Estimates made in the early phase of a project are particularly important because they affect the most basic decisions about a project: whether it will be undertaken at all; how large it will be; how elaborate, sophisticated and durable it will be.

Estimating the cost of a given highway project is the responsibility of implementing agency (ERA) and/or that of the design consultant employed by the client. As a project is developed, so is its estimate (Figure 2.12). At the start of a project, a conceptual estimate is generated based on limited information in order to work the project into the agency’s 5 year construction plan. Once the project is set in the five year plan, design can begin. Frequently the engineers performing these conceptual estimates use only historical bidding data to develop their estimates.

<b>Project Stage</b>	<b>Concept Development</b>	<b>Design</b>	<b>Advertisement</b>	<b>Bid/ Award</b>	<b>Construction</b>
<b>Time</b>	→				
<b>Estimating Function</b>	Conceptual Estimate	Design Estimates	Prebid Estimates	Bid Analysis Collusion Detection	Cost Analysis

Figure 2.12; Estimate Development in Relation to Project Development (Source: Jonathon, 2002)

As a project progresses from concept to final design more of the unknown factors can be eliminated from the estimate and numbers that reflect the design can be produced (Figure 2.13). Estimates at final design, prior to bid, are often referred to as the engineer’s estimate, and are used to finalize project funding prior to bid solicitation and construction. Proper estimating and control of the project, especially at early design phase is crucial to the construction industry.

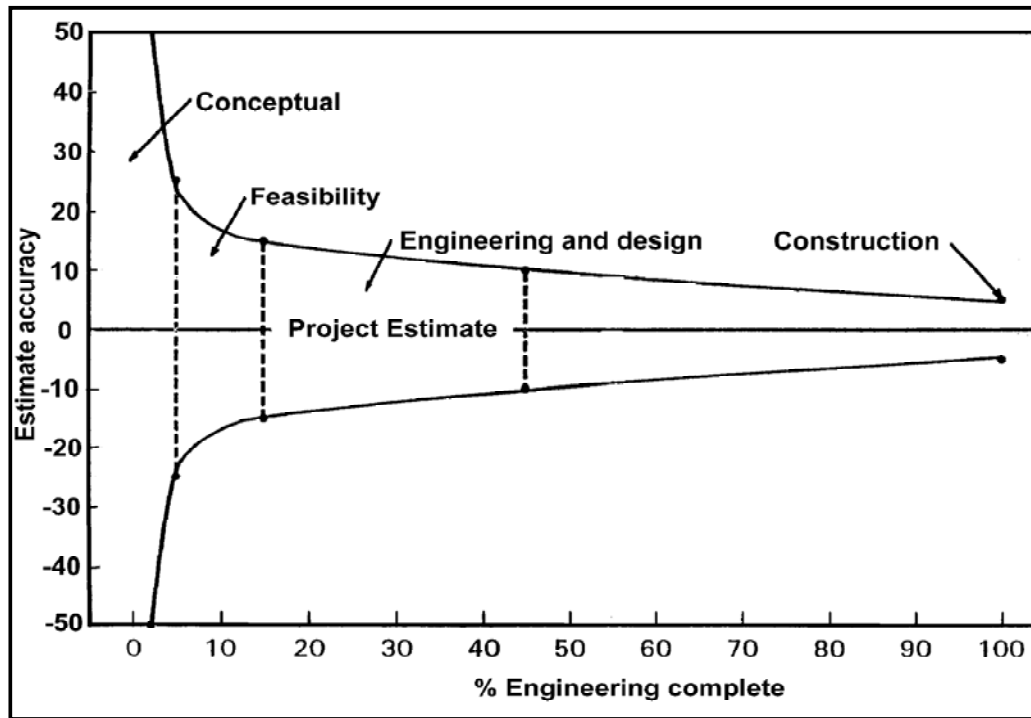


Figure 2.13; Estimate Accuracy vs. Project Development phase (Source: Jonathon, 2002)

Problems arise when contractors submit bid prices that are significantly higher than the engineer's estimate prepared by the client. At this point either more money must be allocated or the project scope must be reduced in order to lower project costs to budget limits. This frequently necessitates a significant amount of reengineering of the work which adds additional cost to the project while reducing its overall value.

The project cost estimate is primarily concerned with the cost of resources needed to complete the project activities and include all the processes which are employed to maintain financial control over a project. Common value auctions generally assume that a true cost exists but it can only be estimated (Friedman, 2005). Management theory, on the other hand, tends to assume that the forecast or budget cost is fixed and that production activities are sufficiently variable to be somehow manipulated to be kept within budget. In construction project, this fixing of budget costs is often done by the estimator based on previous experience on similar projects and thus assumed to provide a reasonable target cost.

The traditional approach to cost estimating is the derivation of a best estimate from the knowledge of existing conditions based on current rates and prices in similar situations, but

with adjustments to reflect anticipated differences in say ground conditions, site accessibility (location), availability of labor and other factors.

Many aspects in construction process remain uncertain and normal costing practices is to include an extra element to provide “insurance” against cost overruns. The word “contingency” is usually used to describe this traditional cost element. The contingency is typically based on a rule of thumb calculation, as a certain percentage of the estimated cost. The use of a better specified contingency will only be effective if suitable project control procedures are in place to control all aspects of project performance. However, it should be noted that improved contingency planning can never be a substitute for good project cost management.

### **2.5.2 Estimating Processes**

The Project Management Institute (PMI, 2000:47) identified various management tools and techniques that are used in project cost estimating as well as in cost control processes. The most popular areas are detailed as:

- analogous;
- parametric; and
- Detailed.

**Analogous estimating:** This is an approximate estimating method that compares costs with similar past projects and which often depends on expert judgment. It can be used in the preparation of the earliest price estimates for the client. In using this method, the estimator should have the relevant experience of estimating the cost of similar projects (Ashworth, 1994). Analogous estimating using the actual cost of a previous, similar project is the basis for estimating the cost of a current project and is frequently used to estimate the cost when there is a limited amount of detailed information about the project. Usually estimators retain their own database of historical project costs from which equivalent or similar cost information may be drawn (Loftus, 1999).

**Parametric estimating:** Parametric estimating uses project characteristics in a mathematical model to predict project cost. This method is considered fairly accurate when historical information used to develop the model is accurate. The parametric cost approach relates all costs of a project to just a few physical measures, or parameters that reflect the size or scope

of the project. For example, the gross floor area of a pre-stressed concrete deck surface over water would be a typical overall parameter for a structure such as a bridge over water. Some costs, say for road construction projects, can be expressed in lane/km. With good historical records on comparable structures and associated risks, parametric costing can give reasonable levels of accuracy for preliminary estimates (Barrie and Paulson, 1992). They pointed out that linear measure is the most widely used parameter for highway cost estimating, bearing in mind the quality (type), width, location and other pertinent factors.

**Detailed estimating (Bottom-up):** Unit price estimates can be compiled when quantities of work items may not be precisely determinable but the nature of the work is well defined (Clough, 1986). This is best suited for works which are relatively simple and repetitive in nature such as buildings. It involves estimating the cost of individual work items and the synthesis of cost estimates from resource estimates made at the lowest possible level of work-breakdown-structures (PMI, 2000). The addition of indirect cost: plant and equipment, office overheads, profit, escalation and contingency develops the total estimated project cost (Barrie and Paulson, 1992).

A study by Hester et al. (1991) indicates that the estimating method and the accuracy of project cost estimates could be a major reason for having cost changes. However, they found that most project owners assume that routine changes in the project will only affect the work in the change area. In reality, the effects can extend well beyond that specific change area Hester et al. (1991).

### **2.5.3 Early Project Estimates**

Various cost estimates are made at different stages of the process: project planning, decision to build, tendering, contracting, and later renegotiations. Cost estimates at each successive stage typically progresses toward a smaller number of options, greater detail of designs, greater accuracy of quantities, and better information about unit price. Thus, cost estimates become more accurate over time, and the cost estimate at the time of making the decision to build is far from final (Flyvbjerg et al., 2002).

Accordingly, as the project goes through various development phases (*i.e.*, conceptual design, preliminary engineering, final design, etc.) more information becomes available and project

scope becomes clearer. This new information allows the project team to be more precise with their estimates and narrow down the range of possible cost and duration of the project.

Figure 2.14 gives an overview of this process. It is evident that at earlier stages, the project estimate has a larger variance. As an example, during the conceptual design, there is a strong possibility that scope will be added or subtracted from the project. By the time the final design is completed and the project is put to bid, the only variance could be due to competition among bidders and the potential for change orders during construction.

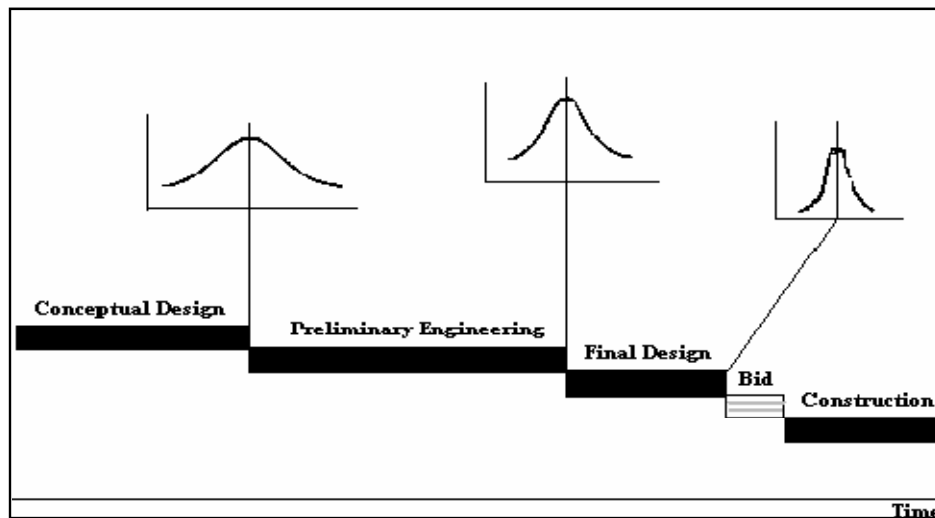


Figure 2.14; Effect of level of information on cost uncertainty (source: Molenaar, 2005)

Traditionally, project owners have accounted for the possible impacts of risks of cost or time overrun by establishing contingencies, or add-ons, to a base project cost and base project duration.

Accurate, early cost estimates for engineering and construction projects are extremely important to the sponsoring organization and the project team. For the sponsoring organization, early cost estimates are vital for business unit decisions that include strategies for asset development, potential project screening, and resource commitment for further project development. Inaccurate early estimates can lead to lost opportunities, wasted development effort, and lower than expected returns (Molenaar, 2005).

Early estimates are typically plagued by limited scope definition (and thus high potential for scope change) and are often prepared under tight time constraints. Furthermore, reliable cost

data are often difficult to obtain during the early stages of a project, particularly if basic design and geographic issues remain unresolved; which often materializes in road projects due to long foot print of the project. Early estimates, even when grossly inaccurate, often become the basis upon which all future estimates are judged (with future estimates sometimes being ‘corrected’ to be consistent with early estimates). However, final cost often exceeds the initial estimate (Hackney, 1998). He also stated that the accuracy of early cost estimates for capital projects has been a major concern and a subject of much scrutiny over the last 35 years.

#### **2.5.4 Project Cost Contingency**

In order to cope with project uncertainties, the planner should include a reserve budget or contingency in the project budget. Contingencies typically are single-value allowances established using simple rules of thumb: e.g., 10 percent of the base cost when setting a budget (Fetene, 2008). In contrast, risk analysis attempts to find the effect of project uncertainties and estimate their cost and schedule impact to a project; this way the allowances reflect justifiable estimates of likely risk costs and durations. It leads to a likely range of costs or durations that bracket potential risk cost or schedule impacts (Allen and Touran, 2005).

The cost performance of construction projects is a key criterion for project owners. Construction and development is fraught with difficulty and the basic principle of risk analysis is that an attempt should be made to at least identify these risky project items and attach some financial value to them. These amounts can then be added to a project budget as items of possible expenditure. The intention of this notion is that the project budget becomes a more realistic representation of the client’s likely outlay. Some of the project uncertainties will be eliminated or clarified as the planning of the project matures, however some uncertainties will be carried forward to project tender stage. The use of risk premium money is regarded as standard practice in construction. Despite the fact that most project construction owners transfer most risks to other parties in different forms, in many construction projects the owner adds a contingency allowance to the estimated cost in order to avoid project overrun arising from some risk factors (Thompson and Perry, 1992).

In terms of managing risk on a project, contingency can take many forms. It may be a time allowance in the program of work for delay such as wet weather, a cost allowance in the

project cost estimate to account for the residual risk accepted by the project manager or a contingency process in case an event happens. Cost contingency is included within a budget to represent the total financial commitment for a project client and the amount of such contingency is of critical importance to projects.

There appears to be no standard definition of contingency. Patrascu (1988) observed that:

“Contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution. Contingency can and does mean different things to different people.”

The Association for the Advancement of Cost Engineering (AACE, 2000) defines contingency as:

“An amount of money or time (or other resources) added to the base estimated amount to achieve a specific confidence level, or to allow for changes that experience shows will likely be required.”

Project Management Institute (PMI, 2000:199), defines contingency as:

“The amount of money or time needed above the estimate to reduce the risk of overrun of project objectives to a level acceptable to the organization.”

The key attributes of the concept of project cost contingency are:

- reserve — cost contingency is a reserve of money (AACE, 2000),
- Risk — the need and amount for contingency reflects the existence of risk in projects (Thompson and Perry, 1992; Allen and Touran, 2005).

Contingency can be divided into two categories of risk — known unknowns and unknown unknowns (PMI, 2000; Hillson, 2002) and can be invoked for events within the defined project scope that are:

- unforeseen (Yeo, 1990);
- unexpected (Mak et al., 2000);
- unidentified (Levine, 1995);
- Undefined (Thompson and Perry, 1992).

Traditionally cost estimates are treated as deterministic, having point estimates for each cost element that are based on their most likely value i.e. a single value estimate. These single values may or may not accurately indicate the possible value (Mak et al., 1998).

Nevertheless, cost performance of construction projects is a key success criterion for project sponsors and clients. Construction projects are notorious for running over budget (Hester et al., 1991; Zeitoun and Oberlender, 1993). When cost estimates are being prepared for feasibility, planning and then design stages, the cost of risk is reflected by the inclusion of a contingency sum. Also a contingency sum is traditionally added as a certain random percentage of base cost estimate, it is necessary to undertake the project specific risk assessment to be realistic on the amount of the contingency sum.

## **2.6 Literature Summary**

In order to develop conceptual and contextual basis for the research objectives, in depth literature review has been conducted on identification and management of risk factors leading to cost overrun and its consequential effects. Accordingly, this chapter has presented some of the crucial findings in the existing theoretical and empirical literature on risks associated with the construction projects, particularly associated with highways and on project cost overrun.

Therefore, the first part of this literature review introduces some general ideas about risks in construction projects, definitions and nature of risks. After having a clear and general idea of risks, its classifications, management and control, identification and mitigation measures has been discussed in detail. The second part of the literature review has concentrated on identifying factors which contributes to cost overrun, its causes and consequences (effects). Through this review and desk study on some selected projects 54 potential risk factors leading to cost overrun (Project Cost Overrun Variables) and 16 possible effects were identified and forms the bases on which the questionnaire has been developed.

The literature survey has revealed several research studies on highway construction projects which attempt to predict the amount a construction contract might increase while taking into account various factors that could be used in such predictions. The literature supports the notion that accurate, early cost estimates for engineering and construction projects are extremely important to the sponsoring organization. Accurate cost estimates are vital for business unit decisions that include strategies for asset development, potential project

screening, and resource commitments for further project development. Several research studies have demonstrated that changes initiated during construction projects have a large effect on their financial performance. It was also found that estimating methodology and accuracy of cost estimates can be major reasons for cost increases.

Regardless of the efforts made by different scholars on risk management and project cost overruns, the literature review process revealed that cost overrun is an inevitable phenomenon in construction projects. It was stated that the accuracy of construction cost estimating on major transport infrastructure projects has not increased over the past 70 years (Flyvbjerg et al., 2002; Molenaar, 2005). Recognizing this fact the fifth sub chapters of the literature review was devoted to project cost estimation, control and management in construction projects.

It has been reported that, also cost overrun is a global problem its extent and the importance of variables (risk factors) causing cost overrun differs based on the project specifics and development status of the construction industry of the concerned country. This gives clear justification for the current research on cost overrun risk factors as one possible way to decrease the problem in the Ethiopian construction industry, with emphasis on federal road construction projects.

Chapter 3 follows and describes the methodology adopted in the research to assess risk factors leading to cost overruns in highway projects, effects of cost overrun and cost management practices in Ethiopia; which are the main objectives of the research.

## **CHAPTER THREE**

### **3. RESEARCH DESIGN AND METHODOLOGY**

#### **3.1 Introduction**

Cost overrun in road construction projects are caused by many risk factors (project cost overrun variables). Each cost overrun causes have different rates of occurrences and impact on the project cost at completion. Some causes happen frequently and their impacts on cost are less. Whereas other causes happen rarely but their impact is severe. Therefore, it is necessary to identify key risk factors based on both occurrences and their impact, in order to rank their overall effects on cost overrun. This helps to prioritize the factors and, hence to determine the mitigation actions to be taken.

In this chapter, the research design and methodology followed to achieve the ultimate goal of the research which is specified at the beginning will be discussed. In addition data and information sources, research instruments, sample size and method of analysis were presented.

The following section provides a general description of the research strategy adopted for this thesis, as well as justification of the methodology.

#### **3.2 Research Design**

The strategy followed in this research was first started with problem identification which has been done through unstructured literature review, archival study and informal discussion with colleagues and professionals in the sector; and then the research design was formulated.

Then data and information sources were determined based on the formulated research design. On the basis of the data and information sources the research instruments were decided; and available documentary sources relevant to the research were reviewed. The review includes books, journal and articles, internet sources and archival document search such as progress and completion reports within Ethiopian Roads Authority– the implementing agency of the road sector development program in Ethiopia. The document search was mainly intended to collect values of cost overrun and their causes from some upgrading and rehabilitation projects which was completed/ substantially completed during RSDP I, II and III through

random selection and focusing on projects with higher cost overrun values for further investigation—to identify important cost overrun variables.

Finally, after an in-depth review of literature and desk study, a questionnaire was designed and distributed to contractors, consultants, the employers (ERA—regulatory department staffs) and reputed construction professionals to get their professional opinion based on their experience. Upon obtaining the desired data, checking and sorting of data has been done. The data were then analyzed for cross-checking the validity and conformity of the information obtained through the overall research work. This was followed by thorough discussions in order to draw a conclusion and to forward recommendations based on the findings of the study.

A descriptive and exploratory survey design was used in this study. It was attempted to collect data from the relevant population (implementing agency—ERA, consulting firms, contractors, and experts) to evaluate the perception of different stakeholders on the issues of cost overrun, ranking of project cost overrun variables—risk factors leading to cost overrun, its consequences, and the current practice of cost management in federal road construction projects.

This survey-based research design has been selected as it is useful in demonstrating the prevalence of the problem throughout the population (Dagneu, 2003). Once the distribution of the problem has been determined and major factors identified, it may be possible to get hints on how to prevent the problem. It also helps to identify differences among groups and to recommend possible remedies to be taken by respective stakeholders.

### **3.3 Sources of Data and Research Instruments**

Two research instruments were used for the collection of relevant information. To identify and rank the major risk factors leading to cost overrun and consequential effects of cost overrun in Federal Road construction projects in Ethiopia, a desk study approach and questionnaire survey were carried out.

The desk study was mainly carried out to obtain actual data from the source documents which included the contract documents, supplementary agreements, variation orders and progress as well as completion reports to have contextual bases on cost overrun in road sector

development program and assess the extent of the problem. The other instrument employed was to solicit professional opinion and relevant data through questionnaires.

Besides this a literature review to develop conceptual basis for the study was also conducted. Through the literature review, potential risk factors leading to cost overrun, effects of cost overrun and methods of controlling and managing project risks and cost were identified. The review provided the basis to design the questionnaire which was distributed to professionals involved in the road sector program.

For the questionnaire survey the respondents were randomly selected from the employer's organization (ERA), contractors, consultants and construction professionals who have been involved in the road sector development program. The questionnaire which consists of both open and closed ended question was distributed among these professionals.

First respondents were asked about their agreement on whether cost overrun in Ethiopian construction industry is a problem or not, based on the following scale of measurements.

- ✓ Agree
- ✓ Strongly agree
- ✓ Disagree
- ✓ Strongly disagree

After this they were asked the amount of cost overrun expressed as the percentage of original contract amount based on their experience, if they agree or strongly agree. Respondents were also asked to specify risk factors (project variables) that most contribute to cost overrun.

Once these basic questions are answered by the respondents then they were asked to rate the potential of each factor in causing cost overrun according to the frequency of occurrence and their impact on cost overrun based on the following scale of measurements.

For frequencies of occurrence

- 0- not at all = 0% probability to happen
- 1- Unlikely = 25% probability to happen
- 2- Likely = 50% probability to happen
- 3- Almost certain = 75% probability to happen
- 4- Certain =100% probability to happen.

For impact on cost overrun

0-No impact

1-Minor impact

2-Average impact

3-High impact

4-Very high (Extreme) impact

A 5-point Likert's scale (from 0-4) was used for the structured questionnaire to gauge the potential factors and the respondents' agreement on each contributing factors. This was intended to identify and rank potential factors leading to cost overrun based on their rate of occurrences and impact on cost overrun. Moreover, respondents were asked to identify the responsible party (parties) for initiating the factors and the most affected party (parties) out of the consequences.

For the effect part respondents were requested to indicate the most recurrent effects of cost overrun in Ethiopian road construction sector as ranked from 1-5 (when 5 represents very high frequent effects while 1 is least frequent), based on their experience. Respondents were also requested to propose possible measures which minimize cost overrun, and hence its consequential effects on the construction industry, and their response were analyzed using descriptive statistics including percentages and means.

Finally, open and closed ended questions which were intended for the assessment of the estimating methods and practices were directed to respondents; this is aimed to evaluate whether the estimating process itself contribute to the problem.

### **3.4 Sample Size/Research Population**

The research population was drawn from three agencies which are participating in federal road construction projects– owner (ERA), contractors, and consulting firms as well as other professionals who have been involved in road sector development program and working out of the three organizations. As much as possible attempts have been made so that the samples drawn from the population are representatives. Professionals include those reputed experts engaged in the construction industry and were involved in road construction projects in the near past and are currently working out of the three agencies. The contractors included were all Category 1 and were either General Contractors (GC) or Road Contractors (RC). The list

of contractors and consultants currently involved in road construction projects were obtained from Ethiopian Roads Authority (ERA), and some of the respondents are listed in appendix D.

The respondents included in the survey comprised of a total of 67 professionals: 15 from owner, 20 from contractors, 16 from consulting offices, and another 16 from reputed professionals. The numbers were determined on the basis of the time available for conducting the research work, available fund for the study (project), and the reliability of the respondents so that the overall research work would indicate the reality-purposive sampling was used.

### **3.5 Method of Data analysis**

Both descriptive and inferential statistics were employed in the analysis of data collected from various sources. In the analysis, the ‘mean score’ method was adopted for the structured part of the questionnaire, to establish the relative importance of the cost overrun factors based on frequencies of occurrence and their impact on cost overrun. The five point Likert scale (0, 1, 2, 3, and 4) is used to calculate the mean score for each factor and which was then used to determine the relative ranking among 54 factors. The mean score for 16 identified potential consequential effects of cost overrun were also ranked on five point scale (1 to 5).

The mean score (MS) for each potential risk factor of cost overrun is computed using the following expressions.

$$MS = \frac{\sum (fxS)}{N} \dots\dots\dots \text{Eq. (2)}$$

Where:

MS = Mean score

f = frequency of response for each score

S= score given to each factor (0 to 4)

N= Total number of responses for each factor

Sturk et al. (1996) defines risk as "expected consequence" or "expected loss of utility".

Based on this definition, they evaluate risks as:

$$\text{Risk} = \text{Probability} \times \text{Consequence} \dots\dots\dots \text{Eq. (3)}$$

Similar to Sturk et al., Jaafari (2001) defines risk as "the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude". For project cost overrun risk factors, this can be interpreted as the product of the mean score for rate of occurrence of the factor and the mean score of the impact of the factor on cost overrun. These formula and definition are used to articulate the most accepted principle that risk has two components: likelihood and impact.

Hence, the cumulative of the mean score of these two (i.e. frequency of occurrence and impact on cost overrun) was calculated to determine the overall ranking based on the two criteria. Accordingly, for overall ranking of the factors for the purpose of this research equation (3) becomes:

$$CMS = MS_R \times MS_I \dots\dots\dots \text{Eq. (4)}$$

Where:

CMS= Cumulative Mean score

MS<sub>R</sub>= Mean score of rate of occurrence

MS<sub>I</sub>= Mean score of the impact

Ranks of cost overrun factors based on cumulative mean score, as perceived by different parties are tested for correlation. The purpose of a correlation test is to see if there is difference in ranking between two groups of respondents and to avoid being deceived by chance of occurrences and impact as ranked by single part. The tests also helped to evaluate whether consensus of opinions exist among respondents

Spearman's-rank correlation coefficient for measuring the agreement/or difference in ranking between two groups of respondents scoring each factor is applied; because of its advantages of not requiring the assumption of normality and or homogeneity of variances (Chapman, 2002). In this research it is used to show the degree of agreement between the different parties involved in the survey: contractors, clients, consultants and construction professionals.

The ranking correlation coefficient ranges from -1 to +1. A correlation coefficient of 1 indicates a perfect linear correlation i.e. good or strong correlations while -1 indicates negative correlation implying high ranking in one group is associated with low ranking on the other. Correlation coefficient value near to zero indicates little or no correlation. This correlation coefficient is used to measure and compare the association between the rankings of two parties, while ignoring the ranking of the third one.

The Spearman's- rank correlation coefficient ( $r_s$ ) for agreement in ranking between the two parties is given by the following formula (Chapman, 2002).

$$r_s = \left\{ 1 - \left[ \frac{6\sum d^2}{n(n^2-1)} \right] \right\} \dots\dots\dots \text{Eq. (5)}$$

Where:

d = difference between ranks given by two parties or respondents for each factor.

n = number of pairs of values in the data set.

The rank correlation coefficient is used for measuring the differences or agreement in ranking between two groups of respondents scoring the various factors (i.e. clients versus consultants, clients versus contractors, client versus construction professionals, consultants versus construction professional, construction professionals versus contractor, and consultants versus contractors).

## **CHAPTER FOUR**

### **4. ANALYSIS OF FINDINGS AND DISCUSSION**

#### **4.1 General Overview**

This Chapter deals with the analysis of the information gathered from both the desk study and the questionnaire survey; which includes analysis of cost overrun for randomly selected projects, tendency of cost overrun versus contract amount, its extent, identification and analysis of rate of occurrences and impacts of risk factors leading to cost overrun in federal road construction projects, identification of responsible party/parties, most affected party/parties out of the consequences, effects of cost overrun, and current estimating practices by stakeholders in Ethiopian federal road construction projects.

A desk study was also conducted within the road sector implementing agency –(ERA). The documents referred during the desk study include progress and completion reports, contract documents and claim submittal, variation orders, correspondences and other important documents of the projects selected randomly. The purposes of the desk study were to investigate the amount of cost overrun as compared to the original contract amount and to identify the reasons for the overrun.

In the questionnaire survey respondents were presented with a range of questions designed to assess their perception on cost overrun in Ethiopian construction industry—they were asked to express their opinion on the existence of cost overrun by choosing any of the options ranging from “strongly agree” to “strongly disagree”. They were also asked to give the average extent of cost overrun if their answer to the existence of cost overrun is agree or strongly agree. Moreover, respondents were asked to specify risk factors (project cost overrun variables) that most contribute to cost overrun. This was specifically intended to get their understanding and observation.

Once they indicated this, respondents were then asked to gauge the risk factors leading to cost overrun based on their rate of occurrence and impact on cost, to prioritize which problems are more critical in contract administration and which activity brings most of the cost increase in local road construction projects. In addition respondents were asked to identify the initiators

for the factors and most affected parties out of the consequences. Finally, they were requested to rank the consequences of cost overrun and to enumerate possible measures to be taken to minimize the problem; and the closed and open ended questions to assess the estimating practices were directed to the respondents.

Analysis of results from both desk study and questionnaire survey is discussed in detail in the following sections, on the basis of which recommendations to construction industry of Ethiopia were made.

## **4.2 Results of Desk Study**

The main purpose of this section is to contextually investigate the extent of cost overrun and identify the major factors leading to cost overrun in Federal road construction projects. To analyze the amount of cost overrun, projects that were undertaken during the past road sector development programs (RSDP I, II& III) were randomly selected and investigated, and those projects with higher cost overrun were critically analyzed to identify the main factors leading to cost overrun. The results of the analysis from the desk study are given below.

### **4.2.1 Investigation of Extent of Cost overrun**

Before identifying key risk factors leading to Cost overrun its existence and extent must be confirmed first. Hence, the first step in this research is to check whether cost overrun is a problem or not in Ethiopian Federal road construction projects. This was done during the problem identification and further investigation was undertaken to evaluate its extent from randomly selected projects, which is the 1<sup>st</sup> specific objectives of the research.

During the desk study, investigation of the extent of cost overrun was done by comparing the final cost of the project with the initial contract value for randomly selected Federal road construction projects. 24 out of 30 i.e. (80%) of road projects investigated in the research suffered cost overrun in their execution. Moreover, data received from the 30 upgrading and rehabilitation road construction projects surveyed indicated that the average initial contract amount was 370.56 million birr, while the average final costs of those projects reached 470.43 million birr leaving an average cost overrun of **99.87** million birr or **26.95** % of the initial

average cost. The cost overruns of projects surveyed (listed in Appendix B) are represented in Figure 4.1.

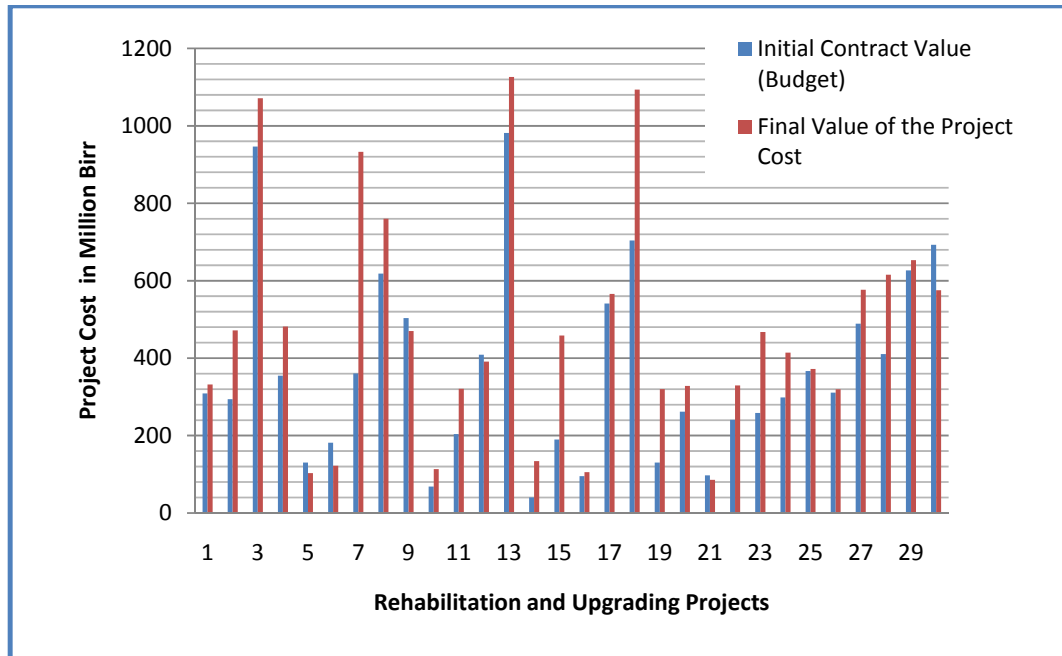


Figure 4.1; Cost overruns in projects surveyed

On the basis of data obtained from the randomly selected projects—Figure 4.1, out of 30 road construction projects executed in the years between 1997 and 2010, 24 projects (80%) suffered cost overrun at completion with the value ranging from -32.80% to 230.54% of the initial contract value.

These results show that the average cost overrun in Ethiopian federal road construction projects is less than the values found by other researchers in different parts of the world. For example, Flyvbjerg et al. (2004) found that Transportation infrastructure projects are particularly prone to cost overrun with actual costs on average being 28% higher than the original contract amount.

Taking into account the Ethiopian practice and expectations, the above scenario can be considered near-optimal, as traditionally cost overruns in public projects due to variation normally reach the maximum permitted by construction laws i.e. 25% of the initial contract value (MoFED, 2010).

However, some caution must be taken when analyzing these results, as the reasons behind this low rate of cost overruns for some projects can be due to scope changes (omissions), especially for those projects experiencing final cost reduction. This was observed from the contextual literature review made during the problem identification stage. For instance, during the implementation of RSDP III, the total expenditure (financial disbursement) is about 101% against the plan; while the corresponding physical accomplishment in km is 93% of the plan (ERA,2011), showing considerable scope change (omissions). Hence, had all the projects surveyed been completed without any omission, one can certainly expect higher average cost overrun value than observed.

#### 4.2.2 Relationship between Rate of Cost overrun and Contract Amount in Projects Surveyed

The result of the desk study shows that cost overrun ratio decreases as project size (budget) increases. This can be noted from the graph shown in fig.4.2 below, which indicates the relationship between contract amount and percentage of cost overrun for the surveyed projects (Appendix B) –reflecting the current tendency of cost overruns for projects depending upon the size of projects (contract amount).

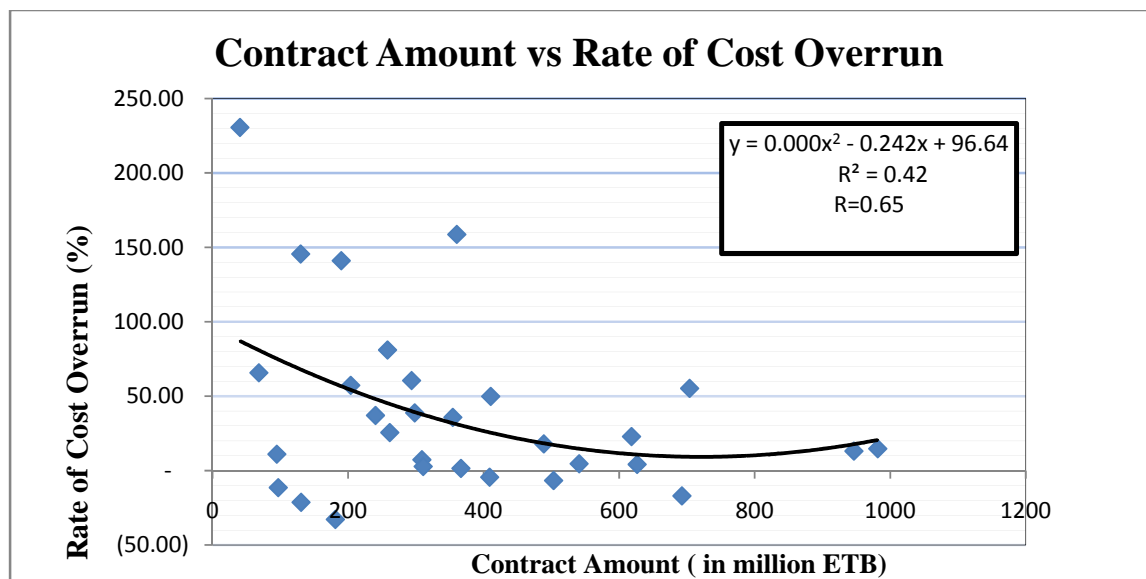


Figure 4.2; Contract amount versus rate of cost overrun for surveyed projects

It can be seen from figure that projects with relatively smaller volume of work are observed to suffer from higher overruns as compared to large projects. This might be due to the fact that

small projects having low allocated budgets are handled by professionals and firms having low management skills who have weak cost and budget control mechanism in their projects. Moreover, less emphasis might be given to those projects during planning by the client and handled by less experienced supervisors during construction.

### **4.2.3 Identification of Cost Overrun Variables**

The 2<sup>nd</sup> specific objective of the research was identification of main risks factors leading to cost overrun in Ethiopian federal road construction projects. In order to achieve this objective, desk study of completed and substantially completed projects was chosen as one of the tools in addition to the literature review which was then become the bases for the questionnaire/survey. The approach used to select sample projects for the desk study was Non probability sampling (purposive sampling), in which a sample that serves the real purpose and objectives of the research is selected. Thus, 10 projects which experienced relatively higher cost overruns were selected to identify the recurrent risk factors contributory to the problem.

In Ethiopia, road construction projects demanding huge capital investment are undertaken by funds borrowed from international financial institutions like World Bank, African Development Bank (ADB), grants and loans from bilateral and multilateral agreements, international organizations like European Union (EU), etc. and savings of the federal government as well as road fund.

Currently, the Contractors taking part in road projects implementations are National and international companies. Most of the local Contractors are of limited capacity and rarely do meet the requirements to participate in donor financed projects. Hence, international Contractors, who meet the requirements, have been participating in donor financed projects. International Consultants have also been participating in donor financed projects. Moreover, the projects studied in this research are upgrading and rehabilitation projects most of which are located at the central part of the country; while new road construction projects are located in remote areas where international contractors are not willing to work due to security problems. Hence, some local and majority of own force projects are located in these areas.

The other reason that most of the Upgrading and Rehabilitation works were handled by foreign construction firms was that the strict specification and requirements demanded by the

foreign financiers and assistance donors which limit the locals firms' ability of competing for these types of works.

Therefore, out of the selected 10 federal road construction projects (upgrading & rehabilitation) for the desk study, 3 executed by local contractors and the other 7 delivered by the international Consultants and Contractors in the years between 1997 and 2010 were selected.

The procurement of services and works were made on international competitive bidding, and the projects were delivered with design-bid- build project delivery method for those projects undertaken by international contractors; while for one project undertaken by domestic contractor the procurement was made on national competitive bidding and the remaining are awarded based on direct negotiation (ownforce).

On the basis of data obtained from the desk study, the result obtained which shows the amount of cost overrun and the risk factors leading to this overrun (reasons) is summarized in Table 4.1 below. The result indicated the amount of cost overrun as compared with original contract amount for 10 selected road construction projects and the major reasons leading to these overruns.

It is observed from the table that, material price escalation, claims due to: late removal of obstructions, failure to give possession of site, late issue of drawings (design related claim), widening of road section at some towns and change in alignment (scope change), changing the pavement from double surface treatment into asphalt concrete (scope change), changes in quantity (inaccurate quantities), unforeseen ground condition, construction of additional length and additions (variations) were some of the major factors that causes cost overrun in Ethiopian Federal road construction projects considered in the desk study.

Table 4.1: Cost Overrun in sample road Construction Projects selected for the desk study

Projects	Financier	Description of Works	Origin of Contractor	Programmed Cost in million ETB	Actual Cost in million ETB	Cost overrun (%)	Status
1. Addis - Gohastion	Japan	Rehabilitation/A C	Foreign	354.8	481.8	35.79	Completed
<b>Reason:</b> Increase due to removal and replacement of unsuitable subgrade material, Widening of road section at major towns, ROW problem, service relocations and additional drainage							
2. Kulubi - Harar	IDA	Upgrading Project /AC	Foreign	162.18	226.5	39.66	Completed
<b>Reason:</b> variation orders amounting ETB 15.92 million and additional 48 million due to price adjustment and claims related to design and employer's failure to remove obstruction.							
3. Kombolcha - Woldiya	GOE	Rehabilitation/A C	Local	360.64	932.92	158.68	98% Completed
<b>Reason:</b> Revised unit rate due to inflation, variation orders & Right of way problems							
4. Tarmaber - Kombolcha	EU	Rehabilitation/AC	Foreign	469.50	661.0	40.94	Completed
<b>Reason:</b> Design update owing to alignment changes to ensure that the center line of the road coincided with the centerline of bridges and large culvert structures, Presence of black cotton soil (unforeseen ground condition).							
5. Addis - Giyon-Jimma	EU	Rehabilitation/A C	Foreign	981.7	1572.3	60.16	Completed
<b>Reason:</b> Widening of road section at major towns, Lack of cross sections and the constructability of the design, inaccurate quantities, particularly in relation to black cotton soil sections, related claims and excessive delay.							
6. Gewane - Mille (Alternative Route)	GOE	Rehabilitation/A C	Foreign	40.6	134.2	230.54	Completed
<b>Reason:</b> Variation orders (construction of additional 4km), additional drainage, scope change from DBST to AC and changes in quantity, design change and associated delays.							
7. Alamata - Korem-B/Mera	GOE	Upgrading Project /AC	Local	190.1	458.2	141	Completed
<b>Reason:</b> Right of way problems (late removal of obstructions–houses, electric poles & water supply lines), Variation works due to additional lane @ B/Mera and other new towns, price escalation –Cement, fuel and bitumen, improper planning & inadequate site investigation.							
8. Debre - Markos – Gondar	IDA	Upgrading Project /AC	Foreign	704.1	1093.5	55.30	Completed
<b>Reason:</b> Claim for delayed possession of site, for unavailability of sub base material, and associated costs and price variations, for late issue of drawings and ROW problems.							
9. Awash - Kulubi	IDA	Upgrading Project /AC	Foreign	444.62	1093.8	146	Completed
<b>Reason:</b> Variation orders (ETB 33.75 million), price escalation, claim for employer's failure to remove obstruction from works and claim for failure to give possession of site.							
10. Jijiga - Degehabor	Japan	Upgrading Project /DBST	Local	258.4	467.8	81.03	Completed
<b>Reason:</b> Increase of carriage way width to 10m in town sections, material price escalation.							

The result in Table 4.1 was analyzed further to identify the most recurrent factors leading to cost overrun based on the selected projects for the desk study. Accordingly, the frequency and percentage of each factor leading to cost overrun is shown in Table 4.2 below.

Table 4.2: Frequency of observed factors in selected sample road projects

No	Project Cost overrun variables/Risk factors	Frequency/ rate of occurrence	Percentage (%)	Rank
1	Variations	6	18.18	1
2	Scope Change	3	9.09	6
3	Price escalation /price adjustment	6	18.18	1
4	Right of way (ROW) problem	6	18.18	1
5	Claims	4	12.12	4
6	Unforeseen ground condition	2	6.06	7
7	Failure to give possession of site	2	6.06	7
8	Design problems (design risk)	4	12.12	4

*Note: The specific factor may occur more than once in a single project, but it has been counted only once per project irrespective of its number of occurrences.*

From the result of the analysis in Table 4.2 Price escalation /price adjustment, Variations, Right of way, Claims, Design problems (design risk) and scope change are identified as major factors leading to cost overrun among the 8 potential factors which has been identified from the desk study. It was also noted that consequential delays related to design modification has contributed to excessive cost overrun, the costs being quantified as time extension cost.

The desk study revealed that most of the factors such as variations, scope changes, design problems and unforeseen ground conditions are related to lack of clarity and comprehensiveness of documents (survey, design, tender and contract documents) used in the process and poor planning. While it needs detail analysis, Zerfu (2009) also stated that poor design and technical specifications were among the major factors for the challenges faced by the Ethiopian Roads Authority (ERA) in road construction projects.

The other factors such price escalation; claims, Right of way problem and Failure to give possession of site are related to economic factor and improper planning respectively. Hence it

is essential to address the issues related to right of way before mobilization of the contractor to the site and taking into account factors such as price escalation, location of the project, material and labor availability during the engineering estimate and properly forecast the escalation trend.

As compared to the literature review the above variables (Table 4.2), are additional variables identified and used in the survey; although almost all are similar to those identified from literature.

### **4.3 Analysis of Survey Results**

This section presents the results of the questionnaire survey. After identifying cost overrun as the major problem in Ethiopian Federal Road construction projects and indicating its extent, the following areas of interest have been identified and investigated for discussion based on the results of the responses to the questionnaires in accordance with the research objectives.

These include:

- Investigating the extent and prevalence of the problem throughout the industry ;
- identification of the important factors most contribute to cost overrun;
- party/parties initiating the most significant factors leading to cost overrun;
- party/ parties which is/are most affected from the consequences;
- the consequential effects of cost overrun; and
- The estimating practice currently in place in the construction industry has been reviewed briefly for its reliability.

Taking this into consideration, this sub chapter will present the result of the analysis from questionnaire survey on major risk factors, initiators, parties which are more affected as a result of cost overrun, consequential effects of the problem and weather the estimating methods are contributory to the problem or not.

The study has identified that opinions vary greatly on the relative occurrence and impact of each factors leading to cost overrun as well as other issues outlined above. The results of questionnaires are presented and analyzed in the subsequent sections.

### 4.3.1 Questionnaires Response Rate

As stated in section 3.4 questionnaires were distributed to the major parties that play dominant role in day to day construction activities. These are contractors, consultants, clients and other construction professionals.

For the preparation of comprehensive analysis on cost overrun, a total of 67 questionnaires were distributed out of which 45 are collected from volunteer respondents. This yields a response rate of 67.16%. Before starting the analysis, the returned questionnaire was checked for their reliability and out of the 45 questionnaires 43 were found to be suitable for data analysis with a valid response rate of 64.18%, while two responses were cast off on the basis of insufficient information. Table 4.3 shows number and rate of responses by major stakeholders.

Table 4 .3: Distribution of Questionnaires and response rate by respondents.

Respondents Category	Questionnaires Distributed	Questionnaires Collected	Percentage	Valid responses	Valid Response Rate (%)
Contractors	20	14	70.00	13	65.00
Consultants	16	8	50.00	8	50.00
Clients	15	12	80.00	11	73.33
Other Professionals	16	11	68.75	11	68.75
Total	67	45	67.16	43	64.18

The survey was conducted between October and December, 2010. It took 3 to 8 weeks to collect the questionnaires from potential respondents. Distribution is done mainly through personal networking for construction professionals and in some cases for other stakeholders too. Moreover, respondents were contacted both in person and via email for the distribution and frequently contacted through phone afterwards for collection of the same.

Responses were only obtained after several diligences. The researcher had to resort to persisting phone calls, resending emails, resending personal contacts with key personnel of consultants, contractors, clients and construction professionals. According to my perception

of the respondents' reluctance, various reasons were behind the lack of responses from the industry: conservative behaviour of the industry, fear of some of the respondents to give cost related information, fear that data would be misused in some way against respondents, professionals being too busy due to involvement in different routine activities, and lack of proper database on the past projects to recognize and respond for the factors. This last reason, e.g., the absence of quantitative and qualitative data about past projects can be taken as the reason for the lack of competitiveness of Ethiopian construction industry, as due to lack of knowledge transfer the same risk can affect the projects performance repeatedly, as it was observed during the archival study.

However, I have to be sincere to admit that some of the questionnaire (particularly open ended questions) is somewhat demanding and time taking; whereas questionnaire should be easy to respond and consumes less time as much as possible. Therefore, I am very grateful to my respondents who completed this demanding questionnaire by taking their valuable time.

#### **4.3.2 Amount of Cost overrun from Survey Results**

The second research instrument used to assess whether cost overrun is a problem in Ethiopian construction industry and that of road construction projects in particular is a questionnaire survey. This was intended to reinforce the results of the initial contextual literature review and the results of the desk study to observe whether the problem is understood by all stakeholders as well as to identify the extent of the problem throughout the research population.

As it is indicated in Figure 4.3 below, 100 % of the respondents for this research have recognized cost overrun as a problem in Ethiopian construction industry particularly in federal road construction projects, out of which 41.46% strongly agreed while the remaining 58.54% simply agree on cost overrun as a major problem in Federal road construction projects.

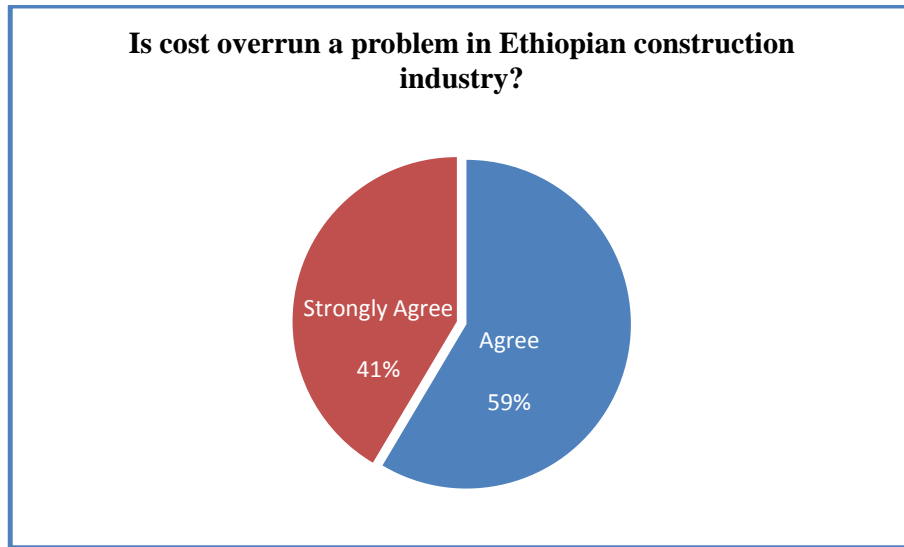


Figure 4.3; Respondents perception on whether cost overrun is a problem or not in Ethiopian Federal road construction projects

To identify the extent of the problem, informants were also asked to specify the average amount of cost overrun in federal road construction projects, expressed as the percentage of original contract amount based on their experience, if they agree or strongly agree. The survey result indicates that the average cost overrun, as perceived by the respondents was **34.18%** of the initial average cost. Figure 4.4 shows the average cost overrun as perceived by respondents.

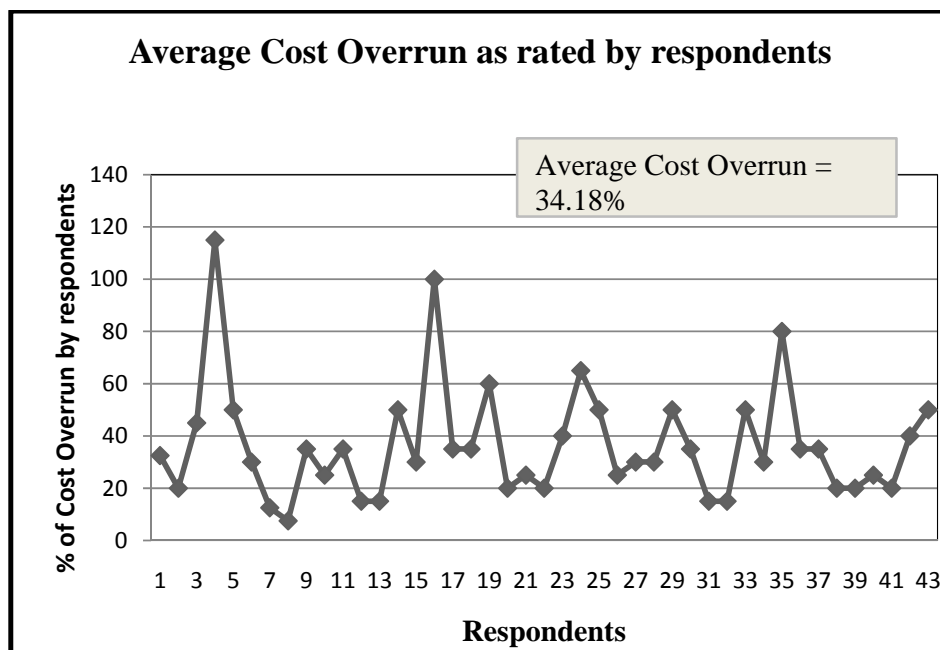


Figure 4.4; Distribution of Respondents responses for average cost overrun

According to this Figure majority of the respondents, more than 80% indicated that the average amount of cost overrun in federal road construction projects ranges between 20-115%. Moreover, the average cost overrun as perceived by the respondents was found to be greater than the average value obtained in the desk study (26.95%). This could be due to the reasons mentioned in section 4.2.1 such as scope changes owing to omissions in projects experiencing final cost reduction. Nevertheless, both of the sources indicated that the amount of cost overrun is considerable and requires some attention.

### **4.3.3 Cost Overrun Risk Factor Analysis from Survey Results**

This section deals with the analysis of the information gathered from the questionnaire survey including identification of rate of occurrences and impacts of risk factors leading to cost overrun, identification of responsible party/parties, consequences of cost overrun, most affected party/parties out of the consequences and briefly the estimating practices.

Before providing the list of factors, respondents were asked to enumerate five major cost overrun risk factors according to their perspective. It was found that the consequently identified factors were already in the list and were not providing any additional input to the comprehensive list– except some factors which are listed in different way. These factors are:

- Supplementary agreement
- Land slide
- Problems occurring in the process of tender document preparation (error in specification and tender document)
- Security of the country
- Time extension caused by right of way problems (EOT cost due to justifiable delay)
- Financial claims, prolongation costs– specially by international contractors
- Incapacity of consultants
- Late removal of obstructions & poor planning
- Poor contract administration by clients
- Lack of ethical work behavior (bribe)
- Insufficient & incapable professionals in designing
- Absence of detail in TOR of design itself
- Error in quantity

- Cash flow problem
- Force majeure (sometimes)
- Poorly drafted design (spec, drawing, Eng. Report)
- Lack of Expertise in the employer’s organization for administrating the contract (lack of experienced professionals) arising out of high professional turnovers
- Ambiguities
- Change in legislation

In conjunction to this, a list of 54 factors were presented to the respondents to rank and score them according to rate of occurrence and impact on cost overrun , on the scale of 0 to 4. The mean scores (MS) for each potential risk factor of cost overrun based on both rate of occurrence and impact on cost overrun were calculated using equation (2)– section 3.5 of this thesis; and the cumulative effect on cost overrun computed using equation (4) to rank the factors based on overall impact i.e. product of impact and probability will be used to rate the risk factor as discussed in section 2.3.3. For the purpose of this research Fig. 2.8(pp 37) is slightly modified and presented as indicated in Figure 4.5; this is intended to give respondents a chance to ignore (give score of zero), for risk factors they considered not contributory to cost overrun in local road construction sector as described in literatures reviewed.

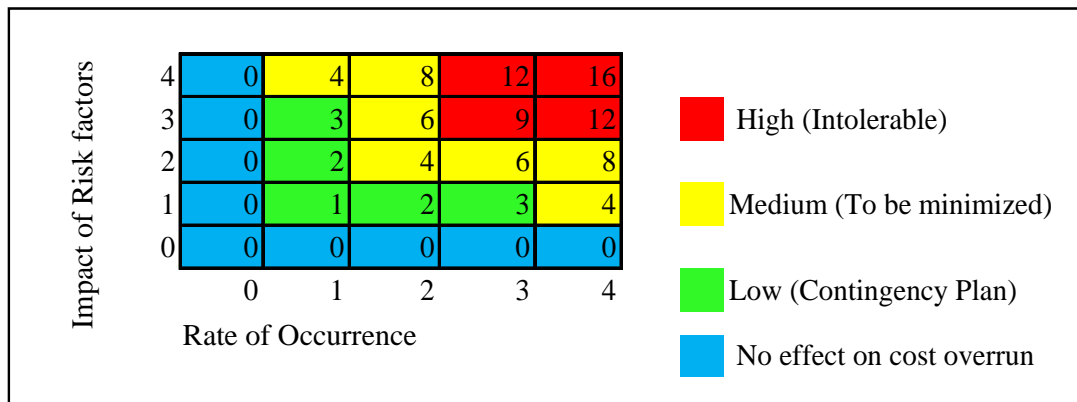


Figure 4.5; Probability Impact Grid for Ranking Cost Overrun risk factors

The rating of the factors were made as low (contingency plan), medium (to be minimized) and high (most significant/intolerable) on the scale of 0 to 16. Where cumulative mean score of 0 indicates the factor is not contributing to cost overrun and score of 16 shows that the factor is regarded as most significant towards generating project cost overrun.

Figure 4.6 gives the severity ranking of the cost overrun risk factors as depicted by the survey analysis. The Figure is based on the cumulative result, i.e. frequency of occurrence and impact of each factor, computed using equation (4) and values listed in Table 4.4 column seven for each factor versus the rank listed in column one.

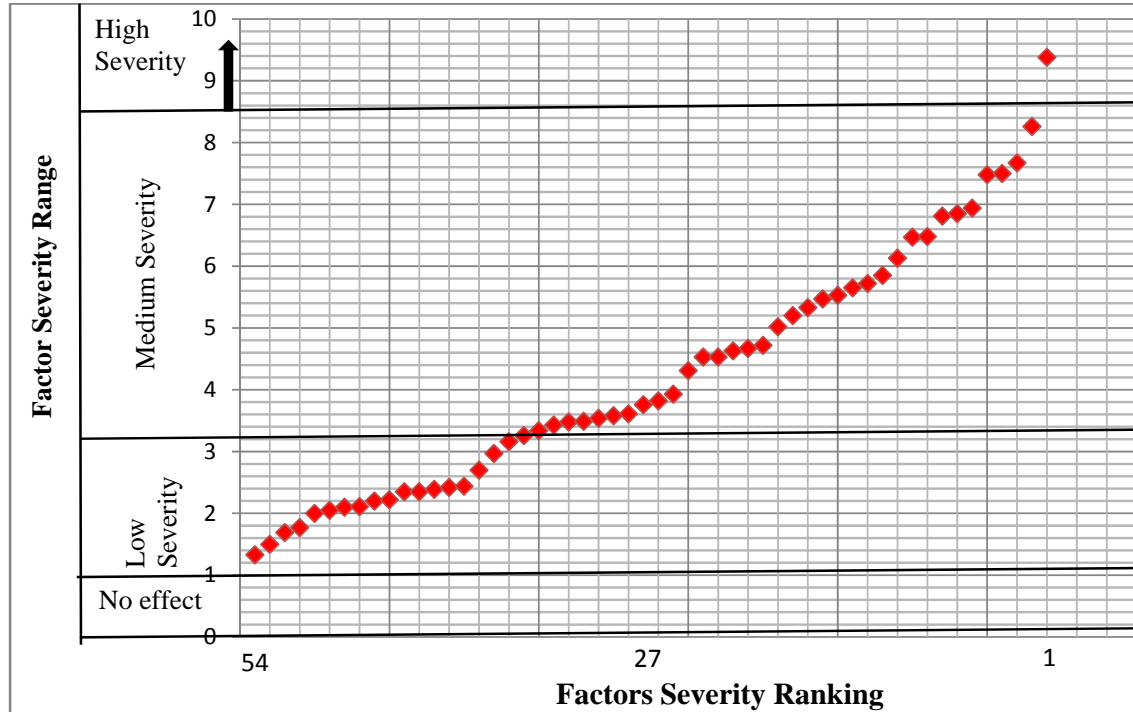


Figure 4.6; Severity Ranking of Cost Overrun Risk Factors

Table 4.4: Summary of the project cost overrun variables (risk factors) as ranked by respondents to questionnaire survey

Rank	Potential risk factors leading to Cost overrun	CMS Contr.	CMS Consul.	CMS Client	CMS Const. Profe.	WA CMS
1	Unexpected Inflation/ material Price escalation	8.77	11.27	9.33	8.86	9.38
2	Delays on completion time/Change of schedule	8.54	6.2	8.99	8.72	8.26
3	Scope changes occasioned by inadequate pre-contract study	6.22	9.92	7.67	8.16	7.67
4	Unstable cost of manufactured materials	6.44	8.14	8.02	7.99	7.5
5	Inadequate site investigation/unexpected ground conditions	6.88	8.44	7.67	7.46	7.48
6	Right of way problems (access to site and quarry)	7.15	6.67	6.79	6.98	6.94
7	Inaccurate cost estimation/underestimation					

		6.79	6.60	7.06	6.85	6.85
8	Design risk/ Frequent design changes	7.62	4.33	5.98	8.02	6.81
9	Inadequate production of raw materials in the country	6.76	4.00	6.81	6.85	6.48
10	Shortage of construction materials	7.40	4.57	6.22	6.81	6.47
11	Scope changes arising from redesign and extensive variation occasioned by change in brief	5.64	7.35	5.86	6.06	6.13
12	Poor project (site) management/ Poor cost control	6.56	6.59	4.20	5.98	5.85
13	Wrong method of cost estimation	5.23	5.83	6.10	5.97	5.72
14	Additional work/Direct change orders by client	5.02	4.25	6.56	6.76	5.65
15	Lack of prompt decision making (quick response) by client	5.95	3.60	5.70	5.84	5.53
16	Improper planning	5.84	4.28	5.44	5.79	5.47
17	Long period between design and time of bidding/tendering	5.38	3.60	5.96	5.49	5.33
18	Inadequate preconstruction study	4.17	5.83	5.56	5.79	5.20
19	Lowest bidding procurement method	4.15	5.76	5.07	5.78	5.02
20	Poor Contract administration	5.02	3.57	4.94	4.91	4.72
21	Absence of construction cost data	3.38	2.80	6.53	5.98	4.67
22	High cost of machineries	5.45	2.00	4.22	5.21	4.63
23	Fraudulent practices, kickbacks, corruption	4.97	4.77	3.38	4.81	4.53
=23	Inadequate duration of contract period	4.73	3.06	4.69	4.75	4.53
25	Inadequate quality/ Ambiguity of contract documents	3.82	1.94	5.40	5.47	4.31
26	Lack of proper communication and coordination	3.98	2.29	4.62	4.37	3.93
27	Contractors poor procurement processes	4.04	3.00	3.70	3.98	3.82
28	Disputes on site	2.33	3.14	5.44	4.47	3.76
29	Poor financial control on site	3.78	2.88	3.52	3.87	3.61
30	Lack of contractors proper evaluation (review) of tender documents at tendering phase	2.29	5.06	4.00	3.98	3.58
31	Lack of specialized Construction manager	4.67	3.33	2.67	2.98	3.54
32	Poor relationship between management and labor	2.08	4.00	5.19	3.57	3.49
33	Acceleration Costs	3.36	3.00	3.72	3.64	3.48
34	Adverse effect of weather	3.19	2.50	4.93	2.85	3.43
35	High machineries maintenance costs	2.96	1.60	4.22	3.98	3.34
36	High Service relocation costs	2.31	3.33	4.93	2.89	3.26
37	Stealing and waste on site	3.09	1.92	3.98	3.19	3.16
38	Inadequate labor/ skill availability	2.26	2.52	3.78	3.42	2.97
39	Work suspensions owing to conflicts	3.79	2.44	1.67	2.36	2.70
40	Bureaucracy in bidding/ tendering method	2.68	3.96	1.93	1.78	2.44
41	Environmental issues	2.19	1.00	3.18	3.05	2.42
42	Lack of knowledge of available resources	3.10	1.67	1.97	2.02	2.39
43	Inappropriate government policies	2.97	0.20	2.25	2.68	2.35
=43	Litigation	2.39	3.00	2.10	2.25	2.35
45	Inappropriate contractual procedure / Provision of contract clauses	1.61	3.22	3.19	2.24	2.22
46	Domination of construction industry by foreign firms and aids	1.73	1.13	3.11	2.43	2.20
47	Inappropriate contractor policies	1.74	1.92	2.77	2.05	2.11

48	High transportation costs	2.56	1.44	1.90	2.02	2.10
49	High cost of skilled labor	2.19	0.53	2.41	2.43	2.05
50	Lack of coordination between general contractor and subcontractors	1.81	2.24	2.04	2.09	2.00
51	Change in government regulation	1.62	0.40	2.25	2.19	1.77
52	Mode of financing and payment for completed work	2.13	2.25	1.36	1.15	1.69
53	High interest rates charged by bankers on loans received by contractors	1.15	1.50	1.93	1.54	1.50
54	Technology changes	1.54	0.67	1.33	1.43	1.33

CMS=Cumulative mean score of probability of occurrence and impact on cost

WA= Weighted average of the CMS of four parties

Results indicated that out of the identified 54 risk factors 18 (33%) factors were rated as low severe, majority of the scores lie in the medium severity range and 1 (2%) factor was highlighted as having high severity on causing the cost overrun.

It is to be noted from the above figure that all of the identified 54 factors are contributory to the cost overrun problem in local road construction projects. Hence, appropriate mitigation measures are mandatory to counteract the agonizing effects of cost overrun.

In general, the analysis result revealed that more than half of the factors (65%) are in the medium severity range– contributing to cost overruns of projects; and hence needs to be minimized through appropriate risk management system by the concerned stakeholders.

Therefore, the need to re-examine the existing practice of risk management is essential to enhance cost performance of road construction projects. Although, according to the findings of Getachew (2009) neither formal risk management system is in place to manage risks that may occur in Federal road projects nor formal risk management plan for road projects is required from consultants; indicating that the risk management performed in Federal road projects has traditionally been that of gut feel or a series of rules-of-thumb similar to some other countries construction industry (Al-Bahar and Crandall, 1990).

The next step in the research process was to distill down the high number of cost overrun variables recorded into a smaller number of high level risk factors i.e. those causing considerable cost overrun. To this end as discussed in section 2.3.7 (pp42) only the first 15 factors were selected for further analysis. This is based on Pareto’s Law: i.e., 20% of risk

items are responsible for 80% of cost increase, so those are the risks that need to be considered (Parsons *et al.*, 2004). However, the first 15 factors were selected for further analysis based on the explanations given on the preceding pages as more factors need to be minimized, although only the top 11(20%) need to be considered as suggested in literature.

Respondents were also asked to indicate the initiators/ responsible party/parties and the most affected parties as a result of the consequences of cost overrun.

Accordingly, the analysis result of the respondents' response on ranking of the factors, initiators and most affected parties out of the consequences for the selected top 15 risk factors is summarized in Table 4.5 below. The ranking of the overall risk factors is presented in Table 4.4 above. Note: the initiators and most affected parties are analyzed only for the top 15 factors and are listed together with the factors.

Table 4.5: Summary of the top 15 Perceived project cost overrun variables (risk factors)

Rank	Potential risk factors leading to Cost overrun	CMS Contr.	CMS Consul.	CMS Client	CMS Const. Profe.	WA CMS	Responsible Party(parties) Or Initiators	most affected party/parties
1	Unexpected Inflation/ material Price escalation	8.77	11.27	9.33	8.86	9.38	GV, OR– Economic Factors	CR, OW, PS, OR-end users
2	Delays on completion time/Change of schedule	8.54	6.2	8.99	8.72	8.26	OW & CR	CR, OR, OW
3	Scope changes occasioned by inadequate pre-contract study	6.22	9.92	7.67	8.16	7.67	CS & OW	OW & CR
4	Unstable cost of manufactured materials	6.44	8.14	8.02	7.99	7.5	GV& OR	OW , CR & OR
5	Inadequate site investigation/unexpected ground conditions	6.88	8.44	7.67	7.46	7.48	CS&OW	CR , OW & end users
6	Right of way problems (access to site and quarry)	7.15	6.67	6.79	6.98	6.94	CS&OW	CR ,OW & end users
7	Inaccurate cost estimation/underestimation	6.79	6.60	7.06	6.85	6.85	CS, CR & OW	CR & OW
8	Design risk/ Frequent design changes	7.62	4.33	5.98	8.02	6.81	CS&OW	CR, CS & OW
9	Inadequate production of raw materials in the country	6.76	4.00	6.81	6.85	6.48	OR	CR , OW & end users
10	Shortage of	7.40	4.57	6.22	6.81	6.47	GV& OR	CR , OW &

	construction materials							end users
11	Scope changes arising from redesign and extensive variation occasioned by change in brief	5.64	7.35	5.86	6.06	6.13	CS&OW	CR, SH & CS
12	Poor project (site) management/ Poor cost control	6.56	6.59	4.20	5.98	5.85	CR& CS	CR , OW & OR
13	Wrong method of cost estimation	5.23	5.83	6.10	5.97	5.72	CS , OW & CR	SH
14	Additional work/Direct change orders by client	5.02	4.25	6.56	6.76	5.65	CS&OW	CR & OR
15	Lack of prompt decision making (quick response) by client	5.95	3.60	5.70	5.84	5.53	OW	CR , CS, OW& OR

CMS=Cumulative mean score of probability of occurrence and impact on cost

WA= Weighted average of the CMS of four parties

CR= Contractor

OW= Owner/Client

PS=Project Sponsor

CS=Consultant

GV-Government

OR= Others

SH=Shared

#### **4.3.4 Test for Agreements on Cost Overrun Risk factors Among Respondents**

One of the specific objectives of this research is to investigate agreements of project participants on ranking of the risk factors. The rank of risk factors based on cumulative value for their occurrences and impacts on cost as identified by each party are listed in Table 4.6 below. The ranking based on the cumulative mean score weighted average (illustrated above in table 4.4) cannot indicate the agreement in perception of the parties on risk factors; rather it indicates the overall ranking by all parties. Therefore, the agreement in ranking of the factors between respondents in each category: contractors, consultants, clients and construction professionals need to be tested.

As discussed in section 3.5 of this research, Spearman rank correlation coefficient is applied to test the agreements.

Table 4.6: Summary of the Potential project cost overrun risk factors as ranked by parties involved in the survey

No.	Potential risk factors leading to Cost overrun	Contractor		Consultant		Client		Construction Professionals	
		CMS	Rank	CMS	Rank	CMS	Rank	CMS	Rank
1	Lowest bidding procurement method	4.15	24	5.76	12	5.07	22	5.78	19
2	Wrong method of cost estimation	5.23	17	5.83	10	6.10	12	5.97	15
3	Adverse effect of weather	3.19	32	2.50	35	4.93	24	2.85	39
4	Inaccurate cost estimation/underestimation	6.79	7	6.60	7	7.06	6	6.85	8
5	Poor relationship between management and labor	2.08	47	4.00	19	5.19	21	3.57	33
6	Inadequate labor/ skill availability	2.26	43	2.52	34	3.78	33	3.42	34
7	Disputes on site	2.33	40	3.14	27	5.44	18	4.47	26
8	Bureaucracy in bidding/ tendering method	2.68	37	3.96	21	1.93	49	1.78	51
9	Litigation	2.39	39	3.00	29	2.10	46	2.55	44
10	Scope changes occasioned by inadequate pre-contract study	6.22	11	9.92	2	7.60	5	8.16	3
11	Inadequate site investigation/unexpected ground conditions	6.88	6	8.44	3	7.67	4	7.46	6
12	Scope changes arising from redesign and extensive variation occasioned by change in brief	5.64	14	7.35	5	5.86	15	6.06	12
13	Inadequate preconstruction study	4.17	23	5.83	10	5.56	17	5.79	17
14	Work suspensions owing to conflicts	3.79	28	2.44	36	1.67	52	2.36	43
15	Inadequate quality/ Ambiguity of contract documents	3.82	27	1.94	42	5.40	20	5.47	21
16	Inappropriate contractor policies	1.74	49	1.92	43	2.77	41	2.05	48
17	Lack of contractors proper evaluation (review) of tender documents at tendering phase	2.29	42	5.06	13	4.00	31	2.98	28
18	Poor project (site) management/ Poor cost control	6.56	9	6.59	8	4.20	30	5.98	13
19	Technology changes	1.54	53	0.67	51	1.33	54	1.43	54
20	Improper planning	5.84	13	4.28	17	5.44	18	5.79	17
21	Unexpected Inflation/ material Price escalation	8.77	1	11.27	1	9.33	1	8.86	1
22	Fraudulent practices, kickbacks, corruption	4.97	20	4.77	14	3.38	37	4.81	24
23	Mode of financing and payment for completed work	2.13	46	2.25	38	1.36	53	1.15	54
24	Delays on completion time/Change of schedule	8.54	2	6.20	9	8.99	2	8.72	2
25	Unstable cost of manufactured materials	6.44	10	8.14	4	8.02	3	7.99	5
26	Acceleration Costs	3.36	31	3.00	29	3.72	34	3.64	32
27	High cost of machineries	5.45	15	2.00	41	4.22	28	5.21	22
28	Contractors poor procurement processes	4.04	25	3.00	29	3.70	35	3.98	28
29	High interest rates charged by bankers on loans received by contractors	1.15	54	1.50	47	1.93	49	1.52	52
30	Lack of proper communication and	3.98	26	2.29	37	4.62	27	4.37	27

	coordination								
31	Design risk/ Frequent design changes	7.62	3	4.33	16	5.98	13	8.02	4
32	Right of way problems (access to site and quarry)	7.15	5	6.67	6	6.79	8	6.98	7
33	Long period between design and time of bidding/tendering	5.38	16	3.60	22	5.96	14	5.49	20
34	High Service relocation costs	2.31	41	3.33	25	4.93	24	2.89	38
35	High machineries maintenance costs	2.96	36	1.60	46	4.22	28	3.98	28
36	Environmental issues	2.19	44	1.00	50	3.18	39	3.05	36
37	Change in government regulation	1.62	51	0.40	53	2.25	44	2.19	46
38	Lack of knowledge of available resources	3.10	33	1.67	45	1.97	48	2.02	49
39	High cost of skilled labor	2.19	44	0.53	52	2.41	43	2.43	41
40	Shortage of construction materials	7.40	4	4.57	15	6.22	11	6.81	10
41	Poor Contract administration	5.02	18	3.57	24	4.94	23	4.91	23
42	Lack of prompt decision making (quick response) by client	5.95	12	3.60	22	5.70	16	5.84	16
43	Lack of specialized Construction manager	4.67	22	3.33	25	2.67	42	2.98	37
44	High transportation costs	2.56	38	1.44	48	1.90	51	2.02	49
45	Lack of coordination between general contractor and subcontractors	1.81	48	2.24	39	2.04	47	2.09	47
46	Domination of construction industry by foreign firms and aids	1.73	50	1.13	49	3.11	40	2.43	41
47	Inadequate duration of contract period	4.73	21	3.06	28	4.69	26	4.75	25
48	Inappropriate government policies	2.97	35	0.20	54	2.25	44	2.68	40
49	Inadequate production of raw materials in the country	6.76	8	4.00	19	6.81	7	6.85	8
50	Poor financial control on site	3.78	29	2.88	32	3.52	36	3.87	31
51	Stealing and waste on site	3.09	34	1.92	43	3.98	32	3.19	35
52	Absence of construction cost data	3.38	30	2.80	33	6.53	10	5.98	13
53	Inappropriate contractual procedure / Provision of contract clauses	1.61	52	2.22	40	3.19	38	2.24	45
54	Additional work/Direct change orders by client	5.02	18	4.25	18	6.56	9	6.76	11

Using results in Table 4.6 and equation (5), given in section 3.5 (pp82) of this thesis, Spearman correlation coefficients ( $r_s$ ) are calculated and tabulated as shown in Table 4.7.

A significance association between the sets of ranks from calculated Spearman's rank correlation coefficients ( $r_s$ ) is assessed, in order to see whether there is agreement between two groups of respondents in ranking the factors; the level of significance 95% ( $\rho = 0.05$ ) is used. This allows verifying whether there is "agreement" between respondents' response.

Table 4.7: Summary of spearman's rank correlation coefficients for risk factors leading to cost overrun

<b>Respondents Category</b>	<b>Contractor</b>	<b>Consultant</b>	<b>Client</b>	<b>Other-Construction Professionals</b>
<b>Contractor</b>	1			
<b>Consultant</b>	0.76	1		
<b>Client</b>	0.77	0.75	1	
<b>Other-Construction Professionals</b>	0.89	0.79	0.94	1
<b>Number of pairs of values</b>	<b>in the data set</b>			<b>n=54</b>

In this case, with a level of significance of 95% ( $\rho = 0.05$ ), the calculated values of  $r_s$  for all the six groups are greater than the critical values of  $r_s$  ( $S_L = 0.364$ ), indicating that there is a significant agreement between the respondents in each group.

Where:

$r_s$  = Spearman's rank correlation coefficient

$S_L$  = Critical value of  $r_s$  (appendix C)

$\rho$  = Probability that rejects the null assumption wrongly (usually =0.05)

From Table 4.7 above, it can be concluded that there is a good correlation between the attitudes of the respondents in all the six groups. This means that most of the respondents have similar perception on risk factors leading to cost overrun.

Results also indicated that there is a strong agreement between clients and construction professionals ( $r_s = 0.94$ ) in ranking the factors among the six groups; this could be due to the fact that most of the professionals who responded to the survey were past employees of the clients' organization.

#### **4.3.5 Analysis of Effects of Cost Overrun from Survey Results**

In addition to identification of risk factors leading to cost overrun, a section of the questionnaire containing 16 potential effects identified from literature was presented to respondents. Respondents were requested to indicate the most recurrent effects of cost overrun from the listed 16 potential effects on a 5-point Likert's scale as ranked from 1-5 (when 5 represents very high frequent effects while 1 is least frequent), based on their experience to evaluate the frequencies of the effects in Federal road construction projects.

From each of these responses to identify the consequential effects of cost overrun, results were analyzed in order to identify the major ones among the 16 potential effects. The result of this analysis is tabulated in Table 4.8 based on weighted average of the mean score values of the parties involved in the survey and the frequency of the top 10 effects are shown in Fig 4.7.

Table 4.8: Summary of the Potential Effects of cost overrun as ranked by all parties involved in the survey

Rank	Hypothesized Potential Effects of Cost Overrun	MS of Contr.	MS of Consul.	MS of Client	MS of Construction Professionals	WA MS
1	Prevent planned increase in road network	3.23	3.86	3.22	3.54	3.42
2	Damage professional relations	3.69	3.14	3.11	3.42	3.39
=2	Dispute among parties	3.46	3.43	3.22	3.45	3.39
4	Inability to secure project finance/securing it at higher costs	3.46	3.43	3.00	3.24	3.30
5	Loss of clients' confidence in consultants	3.15	3.57	3.11	3.45	3.29
6	For professionals -inability to deliver value to clients	2.92	3.43	3.44	3.36	3.24
7	Added investment risks/Funding risk	2.92	3.14	3.33	3.01	3.08
8	Decreased rate of national growth	3.23	3.14	2.89	2.96	3.07
9	Discourages sponsors to invest in construction industry	3.31	2.86	2.89	2.97	3.05
10	Less returns on investment for client	3.38	3.71	3.22	3.25	3.03
11	Loss of profit to the contractor	2.92	3.29	2.78	3.10	3.00
12	Suspension of work	3.54	3.29	2.11	2.70	2.95
13	Delay in payment	3.15	2.71	2.78	2.69	2.87
14	Loses of credibility to highway organization/bad reputation	2.69	3.43	2.44	2.58	2.74
15	Abandonment of future projects	2.54	2.86	2.44	2.65	2.60
16	Drop in construction activities	2.62	2.57	2.44	2.53	2.55

From the survey results it can be seen that almost all effects of cost overrun are recurrent in local road construction industry with a frequency of 51% for least frequent effect. It was found that contractors and end users are affected next to project owner (Table 4.5 pp102) as a result of effects of cost overrun. Although the degree of effects of cost overrun varies on the stakeholders in the construction industry, all the parties involved are affected by cost overrun as shown in Table 4.5, section 4.5.2.

The obvious victim of cost overrun would be the project owner since he has envisaged his construction project to be realized within an allocated cost and time frame. Anything outside these stated frames are cost overrun and time overrun to the client. Cost overrun does not

affect only those parties that are involved directly in the construction of a project, but its effects pass to the construction industry as a whole and consequently to the national economy of the country—leading to decreased rate of national growth; which is ranked to be the 8<sup>th</sup> potential effects of cost overrun by respondents in Ethiopian road construction sector.

It is observed from Table 4.8 that, reduction in planned road network, damage of professional relations, dispute among parties, inability to secure project finance, loss of clients' confidence in consultants, professionals' inability to deliver value to clients, and added investment risks were some of the major effects of cost overrun in Ethiopian Federal road construction projects..

Although it is not common in the Ethiopian federal road construction industry to abandon future projects due to cost overrun—ranked 15<sup>th</sup> in Table 4.8 above, when cost overrun is due to financial constraints of clients, the construction projects suffer lots of problems which further aggravate the problems of cost overrun and bring the said effect to happen .

For road projects cost overrun will lead to delay as the clients do not have enough financial reserves which are ready to be allocated, hence they require either to divert budget from other projects or new approval for these additional costs from higher public officials such as road fund or Ministry of Finance and Economic Development (MoFED), in doing so time will go on and consequent delay on the project lead to further cost overrun due to inflationary pressure and accumulated interests.

In addition to Table 4.8, Fig 4.7 below indicated the relative importance of these major effects identified through this research processes. From this Figure, it can be realized that more than 62% of the effects are the most recurrent effects in Ethiopian Federal road projects with the frequency of more than 60%.

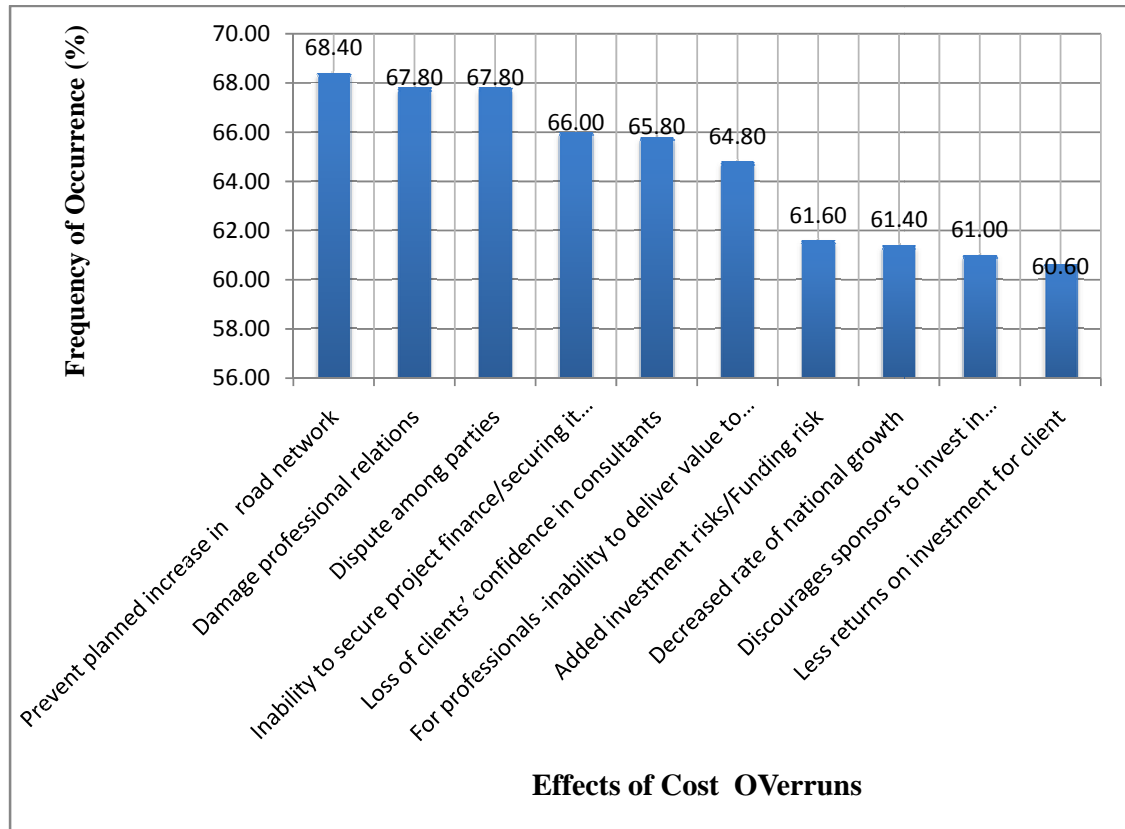


Figure 4.7; Frequency of the Top 10 Effects of cost overrun

#### 4.3.5.1 Test for Agreements on Effects of Cost Overrun among Respondents

Similar to that of the risk factors leading to cost overrun, the ranking by all parties for effects were tested to check the agreement between respondents using spearman's rank correlations for the 16 potential effects listed above. Therefore, the ranks given for each effect by the respondents are summarized in Table 4.9 to calculate the correlation coefficients.

Table 4.9: Summary of the Potential effects of cost overrun as ranked by respondents

No.	Potential Effects of Cost overrun	Contractor		Consultant		Client		Construction Professionals	
		MS	Rank	MS	Rank	MS	Rank	MS	Rank
1	Loses of credibility to highway organization/bad reputation	2.69	13	3.43	4	2.44	12	2.58	15
2	Loss of clients' confidence in consultants	3.15	8	3.57	3	3.11	5	3.45	2
3	Added investment risks/Funding risk	2.92	10	3.14	10	3.33	2	3.01	9
4	For professionals -inability to deliver value to clients	2.92	10	3.43	4	3.44	1	3.36	5
5	Discourages sponsors to invest in construction industry	3.31	5	2.86	13	2.89	9	2.97	10
6	Less returns on investment for client	2.38	16	3.71	2	3.22	3	3.25	6
7	Delay in payment	3.15	8	2.71	15	2.78	11	2.69	13
8	Loss of profit to the contractor	2.92	10	3.29	8	2.78	11	3.10	8
9	Abandonment of future projects	2.54	15	2.86	13	2.44	13	2.65	14
10	Drop in construction activities	2.62	14	2.57	16	2.44	13	2.53	16
11	Inability to secure project finance/securing it at higher costs	3.46	3	3.43	4	3.00	8	3.24	7
12	Prevent planned increase in road network	3.23	6	3.86	1	3.22	3	3.54	1
13	Damage professional relations	3.69	1	3.14	10	3.11	6	3.42	4
14	Suspension of work	3.54	2	3.29	8	2.11	16	2.70	12
15	Dispute among parties	3.46	3	3.43	4	3.22	3	3.45	2
16	Decreased rate of national growth	3.23	6	3.14	10	2.89	9	2.96	11

Using the data in table 4.9 and equation (5) given in section 3.5 (pp82), the results of the spearman's rank correlation coefficients are calculated and summarized in Table 4.10 below to test the agreement among parties.

Table 4.10: Summary of spearman's rank correlation coefficients for effects of cost overrun

Respondents Category	Contractor	Consultant	Client	Others-Construction Professionals
<b>Contractor</b>	1			
<b>Consultant</b>	0.084	1		
<b>Client</b>	0.09	0.57	1	
<b>Others-Construction Professionals</b>	0.41	0.68	0.79	1
<b>Number of pairs of values in the data set</b>			<b>n=16</b>	

For n=16 & significance level of 95% ( $\rho = 0.05$ ); Critical value of  $r_s = 0.506$  (appendix C)

The overall results of Spearman's rank correlations revealed that unlike that of the factors leading to cost overrun, the perception of stakeholders (parties) vary greatly on the potential effects of cost overrun in Ethiopian Federal road construction projects. The result in general indicated that there is a weak correlation among parties as compared with risk factors causing cost overrun. This could be due to difference in exposure to the threats of cost overrun by different parties in construction projects.

In this result it is indicated that there is a strong correlation between employer (client) and construction professionals as well as between consultant and construction professionals. There is also a good correlation between client and consultant with  $r_s$  value of 0.57. The reason behind this is as mentioned for the risk factors leading to cost overrun i.e. most of the construction professionals responded were previous employee of the client and the consultants are employed by the client and obviously share the opinion of the client in most cases.

From the correlation result in Table 4.10 it can be seen that there was a very weak correlation between consultants' and contractor's response as well as between contractors' and clients' responses. One of the reasons could be resentment as a result of miscommunication and the general feeling of apprehension that exists between contractors and consultants. The other reason may be due to resulting effects, which are directly related with who is affected.

Contractors and construction professional also do not agree on the effects of cost overrun but the disagreement is neither as high as the disagreement between contractor and consultant nor that of contractor and client.

The agreements among parties can easily be noticed in Figure 4.8. From the profile shown, one can see more or less similar scatter pattern but there is highest difference between mean scores of contractors and consultants implying their relative disagreement on their perception towards effects of cost overrun. As shown in Figure 4.8 the mean frequencies of effects of cost overrun are higher as gauged by consultants in comparison to the perception of contractors.

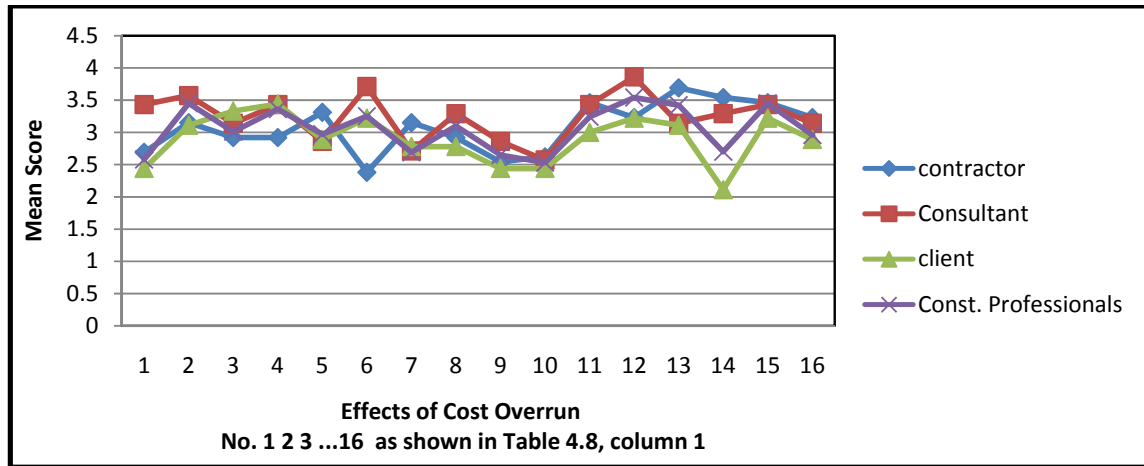


Figure 4.8; Mean Scores for effects of cost overrun rated by respondents based on frequency of occurrences

Besides addressing the main objectives of identifying the major factors leading to cost overrun, initiators of the factors, most affected parties and their consequences, respondent were also requested to forward their opinions on how to minimize cost overrun so as to alleviate its effects.

The proposed solutions forwarded by the respondent to the questionnaire survey are summarized as follows;

1. Making accurate design so as to avoid variations and design modifications
2. Estimating the work load accurately
3. Clearing ROW obstructions before mobilization of contractors to the site (before commencement of the works)
4. Producing and manufacturing of construction materials locally
5. Awarding contract to capable contractors at reasonable cost rather than the least bidder procurement procedures
6. Establish accountability in design consultants'
7. Keep experienced professional staff in the client's organization (by more than half of respondents from client)
8. Continued training has to be given for the professionals in the industry
9. Institutional & industry linkage (knowhow of fresh graduate on cost control)
10. Equal risk allocation in the contract document
11. Minimize change orders
12. Allocation of Sufficient time for design by client
13. Proper follow-up from the client

14. Establish rate data/ updating
15. Design capacity improvement within the consultant
16. Improve contract management skill in the client's organization
17. Establish formal risk management system at least for large projects
18. Improve the construction management skill within own force projects
19. Create awareness among road users to resolve cost related with ROW (right of way) removal
20. Work in manageable time and less work than can be handled
21. Focus on detailed engineering design and review before tendering to contractors
22. Use advanced planning software to focus on critical activities of projects
23. Use standard progress monitoring and unit rate system over the country
24. The design consultant shall make detailed extensive site investigation
25. Transparent and legitimate bidding procedures and tender document preparations
26. Timely removal of Right-of- way problems & setting proper project planning schemes
27. Creating good project management by organizing relevant professionals & allocating resources
28. Bidding shall be based on the least responsive bidder with respect to the Engineers estimate
29. Develop a mechanism to monitor the contractor proper utilization of his finance coming from the project under construction (cash flow) during the construction phase
30. Build the capacity of local consultants & contractors
31. Minimize Corruption
32. More contingency for Price escalation should be provided & the amount be predicted based previous increment/ data, and project particulars
33. Project scope should be well known and decided initially
34. Clients' representatives (counterpart engineers) should be well qualified to evaluate designs and estimates submitted by consultants, instead of accepting what is given to them by the consultant without further evaluation.
35. Accurate prediction of occurrence of risk events and taking proactive measures

#### **4.4 Cost Estimating Practices in Federal Road Construction**

This section attempts to briefly examine the cost estimating practices currently in use by the stakeholders in the Ethiopian federal road construction projects. Based on fifth section of the questionnaire survey results, the Ethiopian context has been briefly dealt with to check whether there is an experience on the detailed estimating methods in the local construction industry. This was intended to examine whether the estimating practices itself is contributory to the problem or not. In depth analysis of the Ethiopian context is beyond the scope of the current thesis work.

It is convincing that the owner's primary goal in estimating project cost should be to ensure that the estimating methods will lead to finish the project within budget. The market conditions, anticipated time before execution, geographic area of the project, material availability etc. should be considered while preparing the total project cost estimate. The bid preparation process should also based on the actual site conditions to avoid the unnecessary financial and time extension claims, as these are observed to be the source of claim particularly by international contractors during the desk study. The process should also consider the required project quality, safety, and stakeholders involvement during both design and construction periods.

The practice in Ethiopia, however, does not seem that these aspects are considered. Consultants' capacity to discharge the contractual responsibility should also be one of the criteria to be considered in estimating processes as the results of questionnaires response revealed that the cost estimation is solely the duty of the consultant on behalf of the client.

Throughout a project's development, estimates are completed to ensure that sufficient funds have been allocated to complete the proposed work. This section is primarily concerned with total project cost estimates, which is usually prepared at the design stage of a project; this was intended to determine the extent of estimating procedure standardization within stakeholders in local construction industry. The chronological development of a project estimate begins with the conceptual estimate and evolves through project development until the final pre-bid estimate is produced.

The following areas of interest have been identified and investigated for discussion based on the results of the responses to the questionnaires. These include: personnel preparing estimates, training and design phase cost control, detailed estimating, estimate items, and contingency.

### **1. Personnel Preparing Estimates**

Estimating experience of all stakeholders' personnel engaged in developing estimates ranged from less than five years to more than 10 years across the surveyed stakeholders. All most all respondents reported that personnel who also perform other duties prepare the estimates. Only one respondent from the contractors answered that they have a dedicated estimating section.

All of the respondents from the implementing agency (ERA) answered that currently there is no such a dedicated estimating unit, but two of the respondents who are at the top management level answered that the organization has started the study to establish a system to address this problem. This shows that the current estimating trend itself is contributory to the problem of recurrent cost overrun in highway construction projects.

Several respondents from the clients' organization that reported having estimators with required experience in past, when the involvement of consultants was less, stated that they had in recent years lost their most experienced personnel due to high manpower turnover and the entire estimation of the project cost is outsourced to consultants.

The experienced and qualified professional turnover was one of the serious and costly problems facing Ethiopia Roads Authority (Solomon, 2007; Zerfu, 2009). Similar to the survey finding, these scholars argue that currently the Ethiopian Roads Authority is facing a frequent turnover of staff, and as such the high turnover is costing the authority in terms of productivity, money and time.

Design consultants are used by clients to produce project documents. This situation is caused either by a lack of client's manpower or a need for specialized design knowledge. When consultants are used to prepare project documents they are usually required to submit a project estimate to the clients for use in project budgeting. In all of the five regions (after the current morph of ERA into regulatory and operation divisions) this consultants' estimate is used without modification or with only minor checking.

## **2. Training**

To ensure all estimators have current estimating knowledge, a training program is vital. This can be either a formal set of classes for all estimators, mentoring among the estimators in the section, or support for estimators to attend off-site conferences, seminars, workshops or classes pertinent to their work. Training related to cost management and standardization were identified by many respondents as essential in Ethiopian road construction sector as they answered the question “Your over all suggestions on the cost management practices in Ethiopian road construction projects”. 100% of the respondents to the question “Is there a formal training program for new personnel in estimating?” revealed that there are no such training all over the industry.

Additionally most respondents reported that the personnel preparing estimates shall have experience in design, management or construction prior to becoming estimators in their response to “What is your ideal profile of an expert project design estimator?” But the response to the question asking the experience level of personnel performing estimates indicates that the estimating in most of the surveyed stakeholders is done by personnel with experience of less than 5 years, most of them between 2 to 3 years.

Whichever method is used, it is necessary for the personnel preparing estimates to understand how and why the system works. This is done either by having an estimating manual, or through training and familiarization with office policy. Many of the respondents from all parties share this idea and answered that the expert project estimator must have good knowledge of road designs, must be one who has participated in road construction especially as office engineer, construction engineer, knowledge of standard codes and he/she should have a good exposure in soil engineering relevant to road construction. It is also reported that the project estimator should have to get training to build his capacity and to be familiar with estimation technologies.

Without a manual of practice or formal training program it is difficult for stakeholders in the construction industry to produce consistent, accurate estimates, or unless they are able to attract and retain personnel who have been trained elsewhere.

Generally, providing the personnel performing estimating duties with the right training and information as early in the estimating process as possible was determined to be the most influential factor in producing consistently accurate estimates.

### **3. Design Phase Cost Control**

While it is mandatory to track the programmed (or budgeted) cost of the project against the estimated construction cost of the final design during the design phase of a project, the respondents answer to the question “Does the organization, during the design phase of a project, impose a strict methodology to control the cost of construction?” revealed that there is no such a methodology in all of the parties contacted during this survey. Respondents have also reported that there is no written protocol or code of practice in place to monitor the cost of the project.

Had this been in place, it enables the client to better manage their construction programs by giving supervisors and directors an accurate overview of the costs associated with projects under design. As design progresses it may become clear that insufficient funds have been allocated based upon an unknown site condition, a change in project scope, or changes in the construction market. When this is discovered it must be reported to clients and either a cost increase approved or design changes made to bring the cost inline with the budget.

Approval authority for small cost/scope changes in projects is delegated to the engineer responsible for the project with due consultation with the employer and this will vary depending the contract, and is usually 10% of the contract price. Large cost/scope changes however, must be approved by the ERA’s directors or the road fund or respective financiers incase of donor financed projects, however there are limitation for these variations according to the guidelines of the financiers; this is currently 25% for projects financed by Federal Government of Ethiopia (MoFED, 2010). These cost constraints have paramount advantages as they encourage designers and supervisors to find ways to stay within the project budget. And when that is not possible, it ensures that the changes are necessary and make sense within the client’s overall construction program.

#### **4. Detailed Estimating**

Among the various management tools and techniques that are used in project estimating as well as in cost control processes—analogue, parametric and detailed estimating discussed in section 2.5.2 of this thesis the detailed estimating tool is used by most of the consultants and contractors in Ethiopian construction industry. While the analogue estimating method that compares costs with similar past projects also called historic bid price estimating is used by the client for the preparation of the earliest budget estimates and checking the consultants estimates with minor modification of such historic prices to account for current market conditions.

Detailed estimating requires a great deal of knowledge about construction methods, supply systems, labor markets, material availability, and crew productivity specific to the area where the work is being performed. It also requires more time to prepare a detailed estimate, than methods that simply apply historic bid averages to work items. This is because the estimator must conceptualize the construction process in order to prepare an accurate estimate. Both consultants and contractors response to the survey questions indicated that factors such as geographic area of the project, market condition and anticipated time before execution of the project are considered when preparing estimates of the project, although there is no a definite technique mentioned to take these factors into account. Whereas more than 90% of the respondents from the client organization indicated that the estimates are usually prepared by design consultants, hence relevant personnel only do the checking.

All of the contractors answered that they perform detailed estimates for major work items, using historic databases to track costs based on crews, equipment, and production, as well as to provide work item costs for minor items in the estimate. The consultants also reported that they perform the detailed estimating.

The basic information that is necessary to perform a detailed estimate such as crew sizes, equipment types, production rates, and labor and material costs can be derived from a variety of sources. One of the information source to at least get the basic crew size, equipment types and performance rate is the ERA Construction Management System (CMS), which is established about 26 years ago and needs some revisions; currently the performance standard established at that time is multiplied by 1.15 (15% addition) and used to monitor projects

progress and overproduction calculation in ERA own force projects. It is important that the estimator be familiar with available resources, how to get the resources, and most importantly has a competent knowledge of construction processes. All of these elements are necessary in order to develop an accurate cost estimate.

## **5. Estimate Items**

The participants in the survey were requested to respond weather attempts are made to account for overhead costs—those project related costs that cannot be attributed to specific work items such as: head office overhead, required safety staffing, temporary facilities etc., mobilization and traffic control costs, demolition and detours among others. The responses for these questions are analyzed and discussed as follow:

### **a) Overhead Costs/Indirect costs**

Indirect construction costs are all costs, which cannot be directly booked under a specific activity in a construction project but rather required to keep the whole project operational. These costs are mainly categorized as the Head office overhead costs and the site overhead costs.

Construction firms usually have their head offices at the capital cities of different regional states where contractors consider appropriate to manage their projects. Head office overhead costs are all costs required to run the whole operation of the construction company which usually administers different projects at a time. These costs are not usually associated with specific project but rather shared proportionally by all projects under the company. As a result, in estimating the construction unit costs of an activity, head office overhead costs are expressed as a percentage of the direct unit cost of each activity.

The following are some of the head office overhead cost components:

- Head office staff costs
- Small vehicle transportation expenses
- Travel expenses
- Building costs
- Bidding expenses
- Office furniture and equipment expenses
- Office running expenses and Sundry expenses

Site overhead costs are all costs required to run the whole operation of a specific construction project at site level. These costs are not associated with specific activity in a project but rather shared proportionally by all activities within the project.

The following are some the site overhead cost components:

- Project site staff costs
- Project transportation facilities
- Project camps
- Power and water supply costs
- Office furniture and equipment expenses
- Miscellaneous expenses

As in head office overhead, in estimating the construction unit costs of an activity, site overhead costs are expressed as a percentage of the direct unit cost of each activity.

Since contractors and consultants perform the detailed estimates, unit prices are adjusted to account for overhead (usually 35% of unit prices). All respondents reported that estimating overhead and profit directly based on individual line items, enabling them to more accurately account for special project requirements that vary from job to job.

#### **b) Contractor Mobilization**

Respondents from the industry have different opinion on this item, 28 respondents (65.12%) reported that mobilization rate for equipments such as high-bed, low-bed, truck trailers is established as well as fuel consumption rate is established. While 20.93% reported that usually lump sum amount is established. The other 13.95% answered that mobilization costs are included as overhead cost: as specified % of the direct cost. This indicates respondents perspective vary greatly regarding this item, that is its inclusion or non inclusion greatly affects the bid prices and, there should be some standard estimating guidelines for all of the stakeholders as indicated by some of the respondents to this survey.

**c) Demolition Work**

Respondents answer to the question requesting their idea on whether the cost of demolition is identified separately or not also differs. Three of the respondents (6.98%) answered that it completely varies from project to project and depends on condition of contract. Twenty respondents (46.51%) indicated that they estimate demolition work as an individual line item, while the rest 46.51% reported that it will be included in other pay items depending upon the specific type of demolition work.

Although, to perform demolition under a separate contract is usually not familiar in Ethiopian construction industry, it is better to think of this method as most of the right of way problems in urban areas through which most of the highway projects cross related to demolition of facilities. The decision to perform demolition under separate contract should also be based upon schedule constraints for the alignment and/or right of way, and whether there is sufficient time to perform required demolition before construction begins in an area.

If it is not feasible or currently not applicable to have a separate contract for major demolition work prior to the construction contract, it is indispensable to estimate demolition as a separate pay item in order to avoid claims related to demolition when the construction work begins, as this is what is observed in some of the projects considered during the desk study since these projects are upgrading and rehabilitation projects which involve demolition of existing structures such as houses, culverts, bridges and other facilities in urban areas. Whereas, more than half of the respondents indicated that it is included in other pay items or as some percentage of contract price i.e. included in overhead cost.

**d) Detour &Traffic Control**

Traffic control is a difficult item to estimate as it requires a great deal of effort to properly conceptualize how the project work will be sequenced. One method used by client and consultants for estimating traffic control cost is to use a predetermined percentage of the project's total cost. A variation on this method is to analyze the type of work, location, and schedule limitations first, and then to adjust the percentage based upon those considerations.

The other predominant method for estimating traffic control is to analyze the project documents in detail and calculate total signage, flagging personnel, barriers, and other

necessary items based on the geographic location and terrain of the project area, each of which is multiplied by the appropriate number of project days to complete the work.

Although, traffic control cost itself is not easy to estimate, 12 respondents (27.91%) indicated that the costs of detours are included within traffic control costs. While the remaining 72.09% answered that the detour is a pay item i.e. costs related to detour is identified separately. It is essential to estimate the cost of detours separately as it has been the source of dispute on site, due to the fact that clients and consultants need it to be done as day work while the contractor need to fix new unit price for detours and there is also other issues related to right of way as detours are usually constructed off-road in rural areas.

## **6. Contingency**

The level of project risk contingency in estimates has a major impact on their financial outcomes for clients. If contingency is too high it might encourage poor cost management, cause the project to be uneconomic and aborted, or lock up funds that is not available for other projects (Dey, 2001). On the other hand, if the contingency allocation is too low, then it may be too rigid and set an unrealistic financial environment, resulting in unsatisfactory performance outcomes (Touran et al., 2004). In some areas of the public sector, there is a tendency to remove contingency provisions in budget submission, as contingencies are often seen as fats — leaving no allowance to express anticipation of any project risk (Yeo, 1990). This situation is also observed in some of road projects considered during the desk study; which is an indication of the presence of the public owners' attitude reported by Yeo in Ethiopian context.

Nevertheless, contingency budgeting is done in order to provide funds for minor change orders, without forcing the client to request additional funds or reallocate funds from other projects. A contingency amount can be planned for and budgeted at project award. The reported amount for contingency set asides by almost all of the respondents to this survey in Ethiopian road construction sector is 10% of the contract amount less day works (before VAT). These additional funds are reserved within the clients' budget in a contingency fund to pay for minor project changes that arise during construction. These changes may be additional cost to the client in payment for contractor work or to others (e.g. requirement to purchase additional right of way). This amount is not part of the estimate, and is generally not

publicized outside of the client, and even might not be utilized at all for instance in case of final project cost reduction.

Some of the respondents from the contractors firm expressed in their response that it is the client who usually determine the contingency budget and that they don't know how clients put this figure. While some respondents from the consultants' and client's organizations reported that also the normal trend is to put 10% of the estimated project cost, they do not have the idea of the background as to why the 10% is selected, and others answered that 10% is used arbitrarily.

The practice of presenting project cost estimates as a deterministic figure comprising a base estimate and the addition of a single contingency amount (usually as a percentage addition) has been adopted in the construction industry for a long time for budgeting purposes. Usual practice is for this amount to be a single lump sum with no attempt made to identify, describe, and value various categories and possible areas of uncertainty and risk (Touran et al., 2004). Cost contingency is included within a budget to represent the total financial commitment for the project owner. Therefore the estimation of cost contingency and its ultimate adequacy is of critical importance to project owners.

Project specific factors should be taken into account while calculating the contingency budget and other percentage value than 10% shall be adopted for different projects accordingly. For instance, in most of USA state Departments of Transportations (DOTs), the reported range for contingency was 5 - 45% depending on the type of project and amount of uncertainty prior to design i.e. at conceptual stage; and 3 - 19% contingency amount planned for and budgeted at project award (Jonathon, 2002).

With regard to the project type, the survey result indicated that the estimating accuracy for bridge projects are better compared to costs of road and other road related items with a confidence level of 90-95% for the former and 80-90% for the later (roads and Miscellaneous –road related). Therefore, high percentage of contingency budget is required for road projects compared to bridges in local construction sector.

Florice et al. (2001) point out that it may be important to require different contingencies for different elements of a project. However, the establishment of a range of contingencies can require a considerable amount of work by estimators, so they simply add on a 10%

contingency across the board for example in order to acknowledge the difficulty of pinning down project uncertainty.

This contingency is often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data. This approach is considered arbitrary, as Thompson and Perry (1992:121) observe:

“All too often risk is either ignored or dealt with in an arbitrary way: simply adding a 10% contingency onto the estimated cost of a project is typical.”

Moreover, Thompson and Perry (1992) outline several weaknesses of using a random contingency amount as follows:

- ✓ The percentage figure is most likely arbitrarily arrived at and not appropriate for the specific project
- ✓ There is a tendency to double count risk because some estimators are inclined to include contingencies in their best estimate
- ✓ A percentage addition still results in a single-figure prediction of estimated cost, implying a degree of certainty that is simply not justified
- ✓ The percentage added indicates the potential for detrimental or downside risk; it does not indicate any potential for cost reduction and may therefore hide poor management of the execution of the project
- ✓ Because the percentage allows for all risks in terms of a cost contingency, it tends to direct attention away from time, performance and quality risks such as design risks
- ✓ It does not encourage creativity in estimating practice, allowing it to become routine and mundane, which can propagate oversights.

Baccarini (2004) analyzed project cost data of 48 road construction projects from an Australian government road authority for the estimation of construction contingency. He reports that the organization uses a traditional percentage approach for estimating contingency. The main findings of his analysis include:

- ✓ Construction contingency is on average 5% of award contract value, whilst variations were 10% of award contract value. This shows a shortfall in contingency of 4.6%
- ✓ The amount of estimated contingency is significantly inadequate to cater for the total value of contact variations, by an average shortfall of 47%

- ✓ There are no significant correlations between cost contingency and project variables that might be used to predict cost contingency.

The overall analysis of the survey results and the literature indicates that the contingency allowances used in construction projects cost estimation involves an arbitrarily percentage of contract amount; whereas, the contingencies need to be calculated based on the actual project circumstances taking into account risks and uncertainties as well as opportunities.

#### **4.7 Best Practices and Lessons Learned**

Best Practice in risk management and cost estimation from project identification phase through to project delivery and implementation leads to efficient use of scarce public resources and mitigates the risk of cost overruns. Better cost estimation also provides higher levels of certainty for highway organizations, governments and the public to whom government agencies are accountable.

At the moment the main problems are that, the knowledge of the risk management processes is weak –mainly depending on provision of contract, and its benefits are unclear. Learning from project to project is almost non-existent; there are no ways for tacit knowledge to be transferred due to poor database of historic projects. Therefore, it is important to have proper project and service database for appropriate maintenance and management of future similar projects.

Currently the hiring of consultants by ERA for software development for bridge projects and old bridge data management was a good start towards addressing this problem. Hence, this needs to be encouraged for other areas of highway constructions too.

Moreover, as observed from the survey results the industry has been driven to extreme price competition. This was observed from the responses to the question requesting the respondents to outline steps taken when contractors offer are not close to estimates and at what percent difference are these steps taken. Respondents from the client procurement department to this question indicated that in earlier bidding procedures 20% less or more is considered as compared to the estimate. That is if the bid price difference is greater or less than 20% of the engineer's estimate, retender would be the alternative as per the government procurement

procedure, but currently this procedure is replaced by procedure that has no limit i.e. the least bidding price is used.

On the other hand there is significant difference between the estimating practices of individual contractors and consultants without any consistency based on program size or regional location as might be expected. It appears that the estimating practices of any contractor and/or consultant are determined solely by the experience of the personnel in charge of estimating, either the head of the estimating section (if any) or chief of design. This exacerbates the situation where stakeholders do not talk to others, who most likely deal with similar projects, about pricing information.

A great deal of knowledge could be gained and transferred if stakeholders in the construction industry would discuss estimating practices. This would also make collaboration on and discussion of large project estimates easier, especially between consultants and enhance knowledge transfer if the good practices are documented.

The start of study by implementing agency (ERA) to establish a dedicated estimating unit, to address the problem with current estimating practice is a good beginning. This needs to be practiced further, in other stakeholders too.

#### **4.7.1 Estimating Manual**

Highway organization would benefit greatly by producing a manual of standard estimating practices and performance standards to be used by both clients estimators and design consultants retained for estimating purposes. The availability of an easy to use guide, that prescribes the standard estimate format for the client, will greatly aid client estimators. With this guide estimators will be able to perform estimates in less time, as many of their questions can be addressed simply by reading the manual. The benefits would outweigh the cost of initial production and periodic updates to the manual. Currently the construction performance standard used is produced about 26 years ago and without any update, while the usual practice in developed world is to produce national and regional construction performance standards continually on yearly basis. Moreover, this standard has another shortfall as the rates of performances of some activities are based on equipment which is not in use in the industry.

Therefore, ERA together with other concerned government and non government bodies shall produce a standard estimating manual.

## **CHAPTER FIVE**

### **5. CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Conclusions**

Literatures revealed that Cost overrun is a very frequent phenomenon and is almost associated with nearly all projects in the construction industry; stating that the trend is more severe in developing countries where these overruns sometimes exceed 100% of the anticipated cost of the project. The review of the accomplishment of the 12 years Road Sector Development Program (RSDP I, RSDP II and part of RSDP III) strengthens this. It was found that, in Ethiopia cost overrun of more than 230% is observed in road construction projects.

Therefore, identification of risk factors leading to cost overrun and analyzing its ultimate impact is a prerequisite to minimize or avoid cost overrun so as to reduce its consequential effects. Hence, the main objectives of this thesis are to identify and analyze the major risk factors leading to cost overrun and its impacts on Ethiopian federal road construction projects and forward the way to deal with it in the future. To achieve these objectives, the study used desk study and questionnaire survey as a research instruments. The information gathered from the survey was analyzed using the mean score method and correlated using Spearman's rank correlation coefficients for structured part of the questionnaires. The analysis of results from the desk study and non-structured part of the questionnaires was carried out using descriptive statistics including percentages and means.

The results obtained in this processes have been discussed and presented in the previous chapter. Therefore, based on the results from the analysis, the following major conclusions have been derived and summarized in accordance with the objectives of the research:

1. The result of the desk study indicated that out of the 30 upgrading and rehabilitation road projects investigated, 24 projects (80%) suffered cost overrun in their execution. For these road construction projects, the average cost overrun was found to be 26.95% of the contract amount, the actual cost overrun ranging from -32.8% to 230.54%.  
The result of the questionnaire survey also strengthen this finding, it indicated that the perceived average cost overrun was found to be 34.18% of the contract amount.
2. Projects with small size (budget-wise) were found to be more prone to cost overruns in comparison with large projects.

3. The second objective of this research was identification and analysis of risk factors leading to cost overrun. To achieve this, a questionnaire survey containing 54 potential risk factors (variables) leading to cost overrun which were identified from literatures and desk study were ranked by respondents based on the cumulative value of frequency of occurrence and impact. The result showed that:
  - ☞ Unexpected inflation/ material price escalation, delays on completion time, scope changes, unstable cost of manufactured materials, inadequate site investigation and right of way problems (access to site and quarry) are identified as major factors leading to cost overrun in Ethiopian Federal road construction projects.
  - ☞ Findings revealed that both internal and external aspects of risk factors contribute to cost overruns in local road construction projects;
  - ☞ Among all factors leading to cost overruns, design problems and management related factors such as failure to give possession of site which are related to improper planning can be controlled and prevented most easily as they are the in-house factors;
4. The survey results indicated that the majority of cost overrun factors (65%) lie in the medium severity impact range. Hence, more attention should be paid to these factors as they cause considerable increase in the cost of the project initially estimated.
5. It was found that clients and consultants are most of the time found to be responsible for the problems of cost overrun in the construction industry.
6. Based on the survey result, it was found that all stakeholders and the national economy as the whole are affected by cost overrun. But, clients are those who are severely affected by cost overrun followed by contractors.
7. There is strong correlation between the perceptions of the respondents in all the six groups in ranking the factors leading to cost overrun.
8. The major effects identified in this research are reduction in planned increase of road network, Damage professional relations, Inability to secure project finance/securing it at higher costs, Loss of clients' confidence in consultants, For professionals -inability to deliver value to clients and Decreased rate of national growth .
9. It was found that the cost estimating and management in local road construction industry varies greatly among stakeholders and needs standardization and proper database.

## **5.2 Recommendations and Future Research**

### **5.2.1 Recommendations**

Based on the findings of the research, the following improvements were recommended to the estimating and management of project cost and handling of project risk factors leading to cost overrun, to alleviate the problem by parties in federal road construction projects:

1. All parties should develop a more definitive policy and approach to calculation of price escalation i.e. establish a consistent guidelines and approach to the monitoring, forecasting and calculation of escalation based on the key project components;
2. Stakeholders shall consider all project parameters such as traffic control costs, demolition costs as well as other overhead costs during the estimating process as the method of costing these items are found to vary greatly among the parties in Ethiopian road construction sector.
3. It is essential to address the issues related to right of way before mobilization of the contractor to the site. Hence, the design of any projects needs to include a detailed analysis of rights of way problems (obstruction clearance) and clearly specify the steps to be taken — as it was found to increase project costs substantially, particularly for projects executed by international contractors considered in the desk study.
4. All parties should improve the understanding of risk and contingency allowances to cover risks that should be included in outset cost estimates:
  - ✓ Promote the understanding that risk is assessed in two components; likelihood and impact;
  - ✓ Provide appropriate contingency allowances for each project based on the assessed and expected level of risk: taking into account anticipated differences in say ground conditions, level of certainty in estimating, site accessibility and other factors instead of arbitrarily allocation;
5. Stakeholders need to build proper database of past projects to enhance knowledge transfer. Because, healthy and sound company cost database not only helps to have competent project cost estimates but it is also the sole basis to evaluate the performance of project execution during construction.
6. The inherent cost overrun can be reduced by adopting best value contractor selection instead of pure price competition:

- ✓ One type of competitive bid can be the average-bid method, in which the winner is the contractor whose bid satisfies a certain relationship with the average of all bid prices. The basic advantage of the average-bid method, from an owner's perspective, is that it safeguards against signing a construction contract for an unrealistically low bid price that almost certainly will lead to adversarial relationships during construction (Friedman, 2005). On the other hand it also safeguards contractors to fall for their mistaken low amount bids.
- 7. The literature suggests the informal means to govern project risk management might be more efficient than traditional ones concentrating on formal contract management and authority. At the moment these informal means are mostly unknown or rarely used in local road construction projects, hence it needs to be exercised;
- 8. An adequate risk sharing system where all actors share both the benefits and damages of all risks, for example shared financial safety reserves for mitigating risks when they happen would increase a motivation to care about the whole project by all stakeholders;
- 9. Providing the personnel performing estimating duties with the right training and information as early in the estimating process as possible by stakeholders;
- 10. Ensure adequate and realistic project duration allowing for potential project delays;
- 11. ERA together with other concerned government and non government bodies shall produce a common standard estimating manual to be used by all stakeholders;
- 12. All parties should have appropriate cost estimate review and approval processes, including what and how to review, and the level and types of review;
- 13. Attempt to better define the scope of the project for cost estimates at early project phase;
- 14. Capacity building programs for professionals and for firms on the construction industry. There must be programs for institutional strengthening and manpower development in the areas of construction project management. The start by ERA to cover tuition fee for Masters Program for professionals in road sector was a good beginning. This needs to be pursued further by other concerned parties such as professional associations.
- 15. Building the capacity of clients, consulting firms and construction companies as well as investing in good pre tendering work planning are essential to enhance the project cost management.

16. Proper Review of the Terms of References (TOR) for design services in such a way that it will be more comprehensive, demanding sufficient key personnel inputs, with reasonable service period and with consideration of use of specialized expert services (e.g. for surveying work).

### **5.2.2 Future Research**

Current research has highlighted many risk factors that are leading to cost overruns based on the aggregate value of frequency of occurrence and impact on cost overrun. Based on the findings of the research the following areas need further investigation.

1. Remedial measures to cope up with these factors and to bring them down to some acceptable limits if they cannot be eradicated completely.
2. The performance of the least bidder procurement procedure needs to be evaluated.
3. It was observed that data on historic projects are not well documented. The reluctance of the respondents from the industry also denotes the absence of quantitative data about past projects adequately treated and filed. This obviously contributes to the problem of cost overrun, because knowledge acquired with past projects cannot be used efficiently.

☞ There is a need for studies into the storage and retrieval of historical project data. Historical data of finished projects have to be made more accessible. In view of the nature of construction projects with data being stored in different formats such as site diaries, calculation sheets, payment systems etc., the use of sophisticated information technology is very desirable.

4. Contingency estimation guideline for Ethiopian Federal Road construction projects based on project type, anticipated risk and geographical location of projects

## REFERENCES

- Abebe, D. (2003). *Construction Management and Finance*, Addis Ababa University Printing Press.
- Abebe, D., and Girmay, K. (2003). Claims in International Construction Projects in Ethiopia, ZEDE, Journal of EEA, Vol. 20, pp 1-24.
- Adametiz, M. (2003). Short Report on Risk Management.  
[http://members.ozemail.com.au/~sqain/meeting\\_reports/Risk\\_report.htm](http://members.ozemail.com.au/~sqain/meeting_reports/Risk_report.htm) (accessed March, 2010).
- African Development Bank (ADB/OECD, 2007). *African Economic Outlook: www.afdb.org/fileadmin/.../afdb/.../30727900-EN-ETHIOPIA-AEO2008.PDF* (accessed on May 26, 2010).
- Ahmed, S.M., Ahmed R. and Saran, D.E. (1999). Risk management trends in the Hong Kong construction industry: a comparison of contractor and owners perceptions, Journal of Engineering, Construction and Architectural Management 6/3: 225-234.
- Akinci, B. and Fischer, M. (1998). Factors affecting contractors' risk of cost overburden, Journal of Management in Engineering, 14(1): 67-76.
- Akintoye, S. & MacLeod B. (1997). Risk analysis and management in construction, International Journal of Project Management Vol. 15, No. 1, pp. 31-42,
- Akintoye, A., Beck, M., Hardcastle, C., Chinyio, E. & Assenova, D. (2001). "Framework for risk assessment and management of private finance initiative projects," Glasgow Caledonian University, United Kingdom.
- Akpan, P. and Igwe, O. (2001). Methodology for determining price variation in project execution, Journal of Construction Engineering and Management, 127(5):367-73.
- Al-Bahar, J.F. and Crandall, K.C. (1990). Systematic risk management approach for construction projects, Journal of Construction Engineering and Management, 116(3): 533-546
- Allen, J. and Touran A. (2005). "Risk Analysis in Transit Projects," Proceedings, 49<sup>th</sup> Annual Meeting of AACE International, New Orleans, LA.
- Andi, M. (2006). The importance and allocation of risks in Indonesian construction Projects. Construction Management and Economics, 24, 69-80.
- Anderson, S., Fischer D. & Rahman S. (1999). Constructability issues for highway projects, Journal of Management Engineering, 15 (3): 60-68.
- Angelo, W., & Reina, P. (2002). Megaprojects Need More Study Up Front to Avoid Cost Overruns.

Angelo, W., and Rubin, D. (2001). "School Officials Learn Lesson in Managing Booming Work," *Engineering News Record*, 27 (7), 47-48.

Artto, K., Kähkönen, K., Pitkänen, P.J. (2000) .*Unknown Soldier Revisited: A Story of risk Management*. Project Management Association Finland, Helsinki, p .114.

Artto, K., Kujala, J., Martinsuo, M. (2005). The risk ranking of projects: a methodology, *International Journal of Project Management*, Vol. 19, pp.139-145.

Ashworth, A. (1994). *Cost Studies of Building*. London: Longman Scientific and Technical.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria, *International Journal of Project Management*, Vol. 17, No. 6, pp. 337-342.

APM, Project Management Body of Knowledge, Fourth Edition, Edited by Dixon, M, Association for Project Management, UK, 2000.

Avots, I. (1983). Cost-Relevance Analysis for Overrun Control, *International Journal of Project Management*, Vol.1 No.3, 142-148.

Avots, I. (1984). Information systems for matrix organizations. In *Matrix Management Systems Handbook*, ed. D. I.Cleland (ed.). New York. Van Nostrand Reinhold.

Ayyub, B. (2003). *Risk Analysis in Engineering and Economics*, Chapman & Hall/CRC.

Baccarini, D., Archer, R. (2001). The risk ranking of projects: a methodology, *International Journal of Project Management*, Vol. 19, pp.139-145

Baker, S., Ponniah, D. and Smith, S. (1999). Survey of risk management in major U.K. companies, *Journal of Professional Issues in Engineering Education and Practice*, 125(3):94-102.

Baloi, D., Price, A. (2003). Modeling global risk factors affecting construction cost performance, *International Journal of Project Management*, Vol. 21, pp. 261-269.

Barrie, D.S. and Paulson, B.C. (1992). *Professional Construction Management*. New York: McGraw-Hill, Inc.

Becker, H. J. and Behailu, D.D. (2006). Public Private Partnership in Road Projects in Ethiopia. Fachgebiet Integrierte Verkehrsplanung, Technische Universität Berlin Institut für Land- und Seeverkehr, Berlin

Bramble, B.B. and Cipollini, M.D. (2004). Resolution of disputes to avoid construction claims. In *National Cooperative Highway Research Program Synthesis of Highway Practice: 287*. Washington D.C: Transportation Research Board, National Research Council (accessed March, 2010).

- Brandon, P. S. (1990). Quantity surveying techniques: New directions the challenge and the response, Blackwell Scientific Publications, Oxford, pp.1-20.
- Caltrans, (2007). *Project Risk Management Handbook: Threats and Opportunities*. 2<sup>nd</sup> ed. Ed, OSPMI, Sacramento, USA.
- Chan, A. (2004). Key performance indicators for measuring construction success, Benchmarking: International Journal, 11 (2), pp. 203-21.
- Chang, A.S. (2002). Reasons for cost and schedule increases for engineering design projects, Journal of Management and Engineering, 2002: 29-36 (accessed February, 2010).
- Chapman, C. and Ward, S. (1997). *Project Risk Management: Processes, Techniques, and Insights*. Chichester: Wiley N.Y.
- Chapman, C. (2002). Project risk analysis and management- PRAM the generic process, International Journal of Project Management, Vol. 15, No. 5, pp. 273-281.
- Chapman, C. (2001).The controlling influences on effective risk identification and assessment for construction design management, International Journal of Project Management, Vol. 19, No. 3, pp. 147-160.
- Chitkara, K.K. (2004). *Construction Project Management, Planning, Scheduling and Controlling*. Tata McGraw Hill.
- Clough, R. (1986). *Construction Contracting*. New York: John Wiley & Sons, Inc
- Cvethovich, G. and Earle, T. C. (1992). Environmental hazards and the public, Journal of Social Issues, 48 (4): pp.1-20.
- Dagnew, E. (2003). *Differential Impact Assessment of Disasters and Coping Strategies: A Methodology Experienced in Ethiopia*, Berhanena Selam Printing Press.
- Dake,K. (1992). Myths of nature and the public. Journal of Social Issues, 48 (4): pp. 21-38.
- de Cano, A. and de le Cruz, P. E.(2002). Integrated Methodology for Project Risk Management, Journal of Construction and Engineering Management, 128 (6): pp. 473-484.
- Dey, P. K. (2001). Decision support system for risk management: a case study. Management Decisions, 39 (8): 634-49.
- Dias, A., and Ioannou, P.G. (1995). A desirability model for the development of privately-promoted infrastructure projects. UMCEE Report No.95-09. Ann Arbor, Mich: Civil Engineering Dept., University of Michigan.
- Elchaig, T., Boussabinaine, A., and Ballal T. (2005). “Critical determinants of construction tendering costs: Quantity surveyors’ standpoint”, International Journal of Project Management.

Emhjellen, M., K. Emhjellen and Osmundsen, P. (2003). *Cost estimation overruns in the North Sea*, Project Management Journal, March: 23-31. (accessed March, 2010).

ERA (2005). *DCI: How Is It Performing Over the RSDP Period? Paper Prepared for Mid-Term review of RSDP*. ERA, Planning and Programming Division.

Ethiopian Roads Authority, (2007). *Road Sector Development Program III (2007-2010)*.

Ethiopian Roads Authority, (2008). *RSDPs Performance 11 years' assessment*, Addis Ababa, Ethiopia.

Ethiopian Roads Authority, (2011). *Thirteen Years Assessment of RSDP Performance and Phase IV*. January 2011, Addis Ababa, Ethiopia.

Federal Democratic Republic of Ethiopia Government (FDRE), *Rural Development Policies & Strategies*, 1994, Addis Ababa.

Fetene Nega (2008). *Cause and effects of cost overrun in public building construction projects in Ethiopia*. MSc Thesis. Addis Ababa University, Ethiopia.

Fishburn, P.C. (1984). *Foundations of risk measurement: Risk as probable loss*. Management Science Journal, 30(4): pp. 396-406.

Fisk, R. E. (1997). *Construction Project Administration*. 5ed, Prentice-Hall Inc, Upper Saddle River, New Jersey.

Flanagan, R., & Norman, G. (1993). *Risk Management and construction*. Oxford: Blackwell Scientific Publications.

Florice, S., Miller, R. (2001). *Strategizing for anticipated risks and turbulence in large scale engineering projects*, International Journal of Project Management, Vol. 19, pp. 445-455.

Flyvbjerg, B.M.S. Holm and Buhl, S. (2002). *Understanding Costs in Public Works Projects: Error or Lie?* Journal of the American Planning Association, 68 (3): 279-95 (accessed March, 2010).

Flyvbjerg, B.M. S. (2003). *Megaprojects and Risks: An Anatomy of Ambition*, Cambridge.

Flyvbjerg, B.M. S. Skamris H. and Soren, L. (2004). *What Causes Cost Overrun in Transport Infrastructure Projects?* Journal of American Planning Association, 69(4): 346-358 (accessed March, 2010).

Ford, D.N., Lander, D.M., Voyer, J.J. (2002). *A real options approach to valuing strategic flexibility in uncertain construction projects*, Construction Management and Economics, Vol. 20, pp. 343-351.

Frame, J. D. (2003). *Managing Risk in Organizations: A guide for managers*. Jossey-Bass.

- Friedman, L. (2005). A competitive bidding strategy, *Journal of Operations Research*, 1 (4): 104-12.
- Getachew Tsegaye (2009). *Design Risk Management in Ethiopian Federal Road Projects*. MSc Thesis. Addis Ababa University, Ethiopia.
- Hackney, J. (1998). Contingency allowances and overrun probabilities for Capital Projects: Paper B4. In Proceedings of the 19th International Cost Engineering Congress. Oslo, Norway.
- Hartman, F. and Soelgrove, P. (1996). Risk Allocation in Lump-Sum Contracts: Concept of Latent Dispute, *Journal of Construction Engineering and Management*, Vol. 122, No. 3, pp. 291-296.
- Hartman, F.T. (2000). *Ten Commandments of Better Contracting; A practical Guide to Adding Value to an Enterprise through More Effective SMART Contracting*, ASCE press, pp. 207-234.
- Hester, W.T., J.A. Kuprenas and Chang, T.C. (1991). *Construction Changes and Change Orders: Their Magnitude and Impacts*. Berkeley: University of California.
- Hillson, D. (2002). Extending the risk process to manage opportunities, *International Journal of Project Management*, 20 (3): pp 225-40.
- Hillson, D. (2003). Using a Risk Breakdown Structure in project management, *Journal of Facilities Management*, Vol. 2, No. 1, pp.85-97
- Hopkinson, M. (2006). "Top Down Techniques for Project Risk Management," *Proceedings, PMI Global Congress*, Madrid.
- Ibbs et al. (2007). Quantified Impact of Project Change, *Journal of Professional Issues in Engineering Educations & Practices*, Vol. 133.No 1, January 1, 2007.
- Jaafari, A. and Schub, A. (1990). Surviving failure: Lessons from field study. *Journal of Construction and Engineering Management*, 116(1): pp. 68-86.
- Jaafari, A. (2001). Management of risks, uncertainties and opportunities on projects: time for a fundamental shift, *International Journal of Project Management* 19 (1), pp. 89-101.
- Jonathon, E. (2002). *Best Practices for Highway Project Cost Estimating*. MSc Thesis, Arizona State University, USA.
- Kartam, K., Nabil, A. & Saied, A. (2001). Risk and its Management in the Kuwait Construction Industry: a Contractor's Perspective, *International Journal of Project Management*, vol.19, pp. 325-335.
- Kayode, M. (1979). *The Art of Project Evaluation*. Ibadan, Nigeria: University Press.

- Kerzner, H. (2003). *Project Management: A Systems Approach to Planning, Scheduling and Controlling*. Wiley
- Kumamoto, H. and Henley, E. J. (1996). *Probabilistic Risk Assessment and Management for Engineers and Scientists*. 2nd Edition ed. New York, NY: IEEE Press.
- Latham M. (1994). *Constructing the Team*, SO, London.
- Lema, M. (2006). *Alternative Project Delivery Methods for Public Constructions: Cases in Oromia Region*. MSc Thesis. Addis Ababa University, Ethiopia.
- Leu, S. S., Chen A. T. and Yang, C. H. (2001). A GA-based optimal model for construction time-cost trade-off, *International Journal of Project Management*, 19:pp. 47-58.
- Levine, H. (1995). Risk management for dummies: managing schedule cost and technical risks and contingencies. *PM Network*, October: 30-32.
- Loftus, J. (1999). *Project Management of Multiple Projects and Contracts*. London: Thomas Telford Ltd.
- Macdonald, C. (2001). Allocation of Risk in Major Infrastructure Projects – Why do we get it so wrong? *The International Construction Law Review*, Vol. 18, Part 2, pp. 345-352.
- Mak, S. and Picken, D. (2000). Using risk analysis to determine construction project contingencies. *Journal of Construction Engineering and Management*, 126(2): 130-36.
- McCoy, F.A. (1986). Measuring Success: Establishing and maintaining a baseline. In *Proceedings of the 18<sup>th</sup> Annual Seminar/symposium of the Project Management Institute*, pp. 47-52. Montreal, Canada.
- Merrow, E.W. (1988). *Understanding the Outcomes of Megaprojects: A Quantitative Analysis of Very Large Civilian Projects*. Library of Congress, RAND.
- Mills, A. (2001). A systematic approach to risk management for construction, *Structural Survey*, Vol. 19, No. 5, pp. 245-252.
- Ministry of Finance and Economic Development (MoFED, 2006), *Building on Progress: A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2005/06-2009/10)*. Volume II, Addis Ababa, Ethiopia.
- MoFED (2010). “*The federal Government Public Procurement Directive.*” June, 2010.
- Ministry of Works and Urban Development (MoWUD, 2006). *Plan for Accelerated and Sustainable Development to end Poverty (PASDEP), (2005/2006-2009/2010): Urban development and construction industry components of PASDEP*. Addis Ababa, Ethiopia.
- Molenaar, K. (2005). Programmatic Cost Risk Analysis for Highway Megaprojects, *Journal of Construction Engineering and Management*, 131(3):345-57(accessed April, 2010)

- Naoum, S.G. (2001). *Dissertation Research and Writing for Construction Students*, Reed Educational and Professional publishing, Britain.
- Nijkamp, P. and B. Ubbels. (1999). How Reliable are Estimates of Infrastructure Costs: A Comparative analysis? *International Journal of Transport Economics*, 26(1): 23-53 (accessed March, 2010).
- O'Brien, J.J. (1998). *Construction Change Order*. McGraw Hill, New York, NY Oxford
- Odeh, A.M., Battaineh, H.T. (2002). Causes of construction delay: traditional contracts, *International Journal of Project Management*, 2002 Vol. 20, No. 1, pp. 67-73.
- Orji, H. (1988). Construction Financing in Nigeria: A banking perspective. *Financial review*, 1 (4): 12-13.
- Pakkala P. (2002). *Innovative Project Delivery Methods for Infrastructure: An International Perspective*. Helsinki: Finnish Road Enterprise. (Accessed in March, 2010)
- Parsons, Inc., A. Touran, and Golder Assoc. (2004). "Risk Assessment Methodologies and Procedures," a white paper prepared for the Federal Transportation Administration, May.
- Patrascu, A. (1988). *Construction Cost Engineering Handbook*. New York: Dekker.
- Pipattanapiwong, J. (2004). *Multi-party Risk Management Process (MRMP) for a Construction Project Financed by an International Lender*. Master Thesis, Asian Institute of Technology.
- Potter, S. (1987). *On the right lines? The limits of technological innovation*. London: Frances Pinter.
- Pouliquen, L.Y. (1970). *Risk Analysis in Project Appraisal*. World Bank Staff Occasional Papers Number Eleven, John Hopkins Press.
- Project Management Institute, (2000). *A Guide to the Project Management Body of Knowledge*. 2<sup>nd</sup> ed. North Carolina, USA: PMI Communications Publishing.
- Raftery, J. (1994). *Risk Analysis in Project Management*. London: E & FN Spoon.
- Richards, D. P. (1999). "Perspectives on Risk Assessment in Tunneling," *Proceedings, Geo engineering for Underground Facilities*, 1185-1203.
- Royer, P.S. (2000). Risk Management: The Undiscovered Dimension of Project Management, *Project Management Journal*, Vol.31, No.1, pp. 6-13
- Rutgers, A. and Haley, D. H. (1997). Project risk and risk allocation, *Cost Engineering*, 39 (9): pp.27-29.
- Salapatras, J.N. and Sawle, W.S.(1986). Measuring success of utility projects past, present and future. In *Proceedings of the 18<sup>th</sup> Annual Seminar/symposium of the Project Management Institute*. Montreal,.

- Shehu.Z and Sommerville, J. (2006). *Real time risk management approach to construction Projects*. Glasgow Calonian University, Glasgow, United Kingdom.
- Sidwell, A.C., Kennedy, R .J. and Chan, A.P.C. (2002). *Re-engineering the Construction Delivery Process*. Brisbane: Construction Industry Institute, Australia.
- Simon, P., Hillson, D. and Newland, K.(1997), *Project Risk Analysis and Management (PRAM) Guide*. Association for Project Management, The APM Group Ltd., 140 Whitehall Road, Norwich, Norfolk, NR2 3EW, ISBN 0-9531590-0-0.
- Simu K. (2006). *Risk Management in small construction projects*. Department of Civil, Mining and Environmental Engineering. Lulea, Lulea University of Technology, Sweden.
- Smith, N.J.(1999). *Managing Risk in Construction Projects*, Blackwell Science, UK.
- Smith, N. J., Tony, M. & Jobling, P. (2006). *Managing risk in construction Projects*. Blackwell Publishing.
- Skitmore, M., Lyons, T. (2004) .Project risk management in the Queensland engineering construction industry: a survey, *International journal of Project Management*, Vol. 22, No. 1, pp. 51-61.
- Solomon Aberra (2007). *Skilled Manpower Turnover and Its Management: The Case of Ethiopian Roads Authority*. MBA Thesis, Addis Ababa University Faculty of Business & Economics, Addis Ababa, Ethiopia.
- Statman, M. and Tyebjee, T.T. (1984). The risk of investment in technological innovation. *IEEE Transactions on Engineering Management*, 31 (4): 165-71.
- Steiner, G.A. (1969). Top management planning. In *Project Management Handbooks*,eds. D. I. Cleland and W.R. King. New York: Van Nostrand Reinhold (accessed June, 2010).
- Sykes, A. (1982). *Reducing Neglected Risks on Giant Projects: in New Dimensions of Project Management*, ed. A.J. Kelley (ed). Lexington, MA: Lexington Books.
- Tadesse Ayalew (2009). *Causes and Effects of Variations in Ethiopian Federal Road Projects*. MSc Thesis, Addis Ababa University Faculty of Technology, Addis Ababa, Ethiopia.
- Tah, J. H. M. and Carr, V. (2001).Towards a framework for project risk knowledge management in the construction supply chain. *Advances in Engineering Software*, 32:835- 46.
- Tang, W., Qiang, M., Duffield, C., Young, D.M. & Lu, Y. (2007). Risk management in the Chinese construction industry, *Journal of construction engineering and management*, 133 (12).

- Tasmania, D. (2002). PM007 Project Risk Register, Template and Guide.
- Thomas, H. R. (1985). *Comparative analysis of time and schedule performance on highway construction projects involving project claims*. Washington, DC: Federal Highway Administration Report No. FHWA-TS-85-217.
- Thompson, P.A. and Perry, J.G. (1992). *Engineering Construction Risks: A guide to project risk analysis and risk management*. SERC Project Report. London: Thomas Telford Ltd. (accessed March, 2010).
- Touran, A., Bolster, P. and Thayer, S. (2004). “*Risk Assessment in Fixed Guideway Construction*,” Report No. FTA-MA-26-0022, U.S. Dept. of Transportation, Washington, D.C.
- Turner, J.R. (1999). *The Handbook of Project-Based Management: Improving the processes for achieving strategic objectives*. 2nd edition, McGraw-Hill, London.
- Uher, T. (1994). *A general risk classification model for construction*, Australian Institute of Building Papers, 5:pp. 25-33.
- Uher, T., Toakley, A.R. (1999). Risk management in the conceptual phase of a project, *International Journal of Project Management*, Vol. 17, No. 3, pp.161-169
- U.S. General Services Administration (1992). *Value Engineering Program Guide for Design and Construction: Volume 1, Internal Operations and Management*, USA.
- Ward, S. (1999). Requirements for an Effective Project Risk Management Process, *Project Management Journal*, 30(3). pp. 232-246.
- Ward, S. and Chapman, C. (2003). Transforming project risk management into project uncertainty management, *International Journal of Project Management*, 21 (2): pp.97-105.
- Wideman, R. Max. (1992). *Project and Program Risk Management*, Project Management Institute, Drexel Hill, PA.
- Williams (a), T. M. (1993). Risk management infrastructures, *International Journal of Project Management*, 11 (1): 5-10.
- Williams (b), T. M. (1993). Using the risk register to integrate risk management in project Definition, *International Journal of Project Management*, 12: 17-22.
- Williams, T.M. (1999). The need for new paradigms for complex projects, *International Journal of Project Management*, 17(5): 269-73, (accessed March, 2010).
- Williams, T. M., Akermann, F. R. and Eden, C. L. (1997). *Project risk: systemicity, cause mapping and a scenario approach*. Edited by K. Kahkonen and K. A. Arto, *Managing Risks in Projects*. London: E & F.N. Spoon.

- Wood, G.D. & Ellis, R.S.T. (2003). Risk management practices of leading UK cost consultants, *Journal of Engineering, construction, and architectural management*, 10 (4), 254-62.
- World Bank, (1994). *World Development Report 1994: Infrastructure for development*. Oxford, UK: Oxford University Press.
- Wubishet, J. Mengesha. (2004). *Performances for Public Construction Projects in Developing Countries: Federal Road and Educational Building Projects in Ethiopia*. Doctoral Dissertation, NTNU, Norway.
- Wubishet, J. Mengesha. (2006). Stakeholders and Their Relationships for Public Construction Projects: The case in Developing Countries, *EACE Bulletin*, Vol. 7, No 1, pp 13-20.
- Yeo, K. (1990). Risks, classification of estimates, and contingency management, *Journal of Management in Engineering*, 6 (4): 458-70.
- Young, T.L. (1996). *The Handbook of Project Management: A Practical Guide to Effective Policies and Procedures*. London: Kogan Page.
- Zaghloul, R., Hartman, F. (2003). Construction contracts: the cost of mistrust, *International Journal of Project Management*, Vol. 21, No. 6, pp. 419-424.
- Zeitoun, A.A. and Oberlender, D.O. (2003). *Early Warning Signs of Project Changes: Document 121*. Edited by C.I. Institute. Austin, Texas: construction Industry Institute.
- Zerfu, T. (2009). *Challenges in ERA Road Construction Projects*. ERA, Addis Ababa, Ethiopia.

## **Appendix A**

### **Questionnaire**

ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES  
FACULTY OF TECHNOLOGY  
CIVIL ENGINEERING DEPARTMENT



Questionnaire

On

**Risk Factors Leading to Cost Overrun in Ethiopian Federal Road  
Construction Projects & its Consequences**

BY

TURKEY WAKJIRA

ADVISOR: ABEBE DINKU, *Prof. (Dr.-Ing)*

FOR THE PARTIAL FULFILLMENT OF MSc. DEGREE IN CIVIL ENGINEERING  
(MAJOR CONSTRUCTION TECHNOLOGY AND MANAGEMENT)

October, 2010

Date of Completion: .....

**Dear Sir,**

The aim of this questionnaire is to obtain professional opinion on issues of cost overrun, risk factors leading to cost overrun and on the process of preparing total project cost estimates at the time of design, ideally in road construction. This is to identify major cost overrun risk factors (variables) and their consequential effects on Federal Road Construction Projects in Ethiopia and recommend possible remedial measures that minimize the problem (cost overrun).

## **Introduction**

1. The purpose of this survey is to obtain data for the specified research conducted as a partial fulfillment of MSc. Degree in Construction Technology and Management at Addis Ababa University.
2. For the purpose of this questionnaire and research, the total project cost estimate includes the estimated costs of all component activities from the initiation of the project proposal to finalization. This total project cost estimate is usually prepared at the design stage of a project and can often include the costs of the following:
  - conducting investigations and developing the design;
  - detailing the design;
  - Environmental impact assessment, tender document preparation;
  - acquiring land & settling Right of Way (ROW) issues;
  - altering public utility plant;
  - construction;
  - Project administration and handover.
3. For the purpose of this research, cost overrun is defined as the increase of the final actual cost of a construction project (usually expressed as a percentage of original contract amount) at a completion over the original contract amount– agreed by and between the client (the project owner) and the contractor during the signing of the contract.
4. The information supplied in this completed questionnaire will be used for broad research purposes only (for academic purpose.). All specific company and interviewee information will be kept confidential at all times. Only generalized analysis of the information contained within this completed questionnaire will be utilized in the research process.

Your response, in this regard, is highly valuable and contributory to the outcome of the research.

Regards,

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Addis Ababa

## Section 1: Company and respondent profile

- 1.1. Company Name (optional):-----
- 1.2. Type or origin of your organization (Please indicate with “√” when appropriate)
- Project Owner/Client----- Domestic Consultant-----Foreign Contractor---- Foreign Consultant- ----Domestic Contractor----- Financer-----

Others (please specify) -----

Year of establishment: < 5 years \_\_\_ 6-10 years \_\_\_ 10-15 years \_\_\_ >15years\_\_\_

Telephone: \_\_\_\_\_ E-mail\_\_\_\_\_

Some of the projects participated in: -----

- 1.3. If Foreign Consultant or Contractor, how long has your organization been involved in Ethiopian Construction Sector?

Less than 5 years ---- 6-10 years ---- More than 10 years-----

- 1.4. In your agency, which position in the organizational level you are?

Top management ---- Middle management ---- Expert ---- Others -----

- 1.5. How long have you been involved in the road sector projects?

Less than 5 years ---- 6-10 years ---- More than 10 years-----

- 1.6. How many road projects have you been involved in?

Less than 5 projects ---- 6-10 projects ---- More than 10 projects-----

Related experience: Estimating (-----years); Design (-----years); Construction (-----years) Management (-----years)

## Section 2: Basic information on Road Construction Project Cost Overrun

- 2.1. Cost Overrun is a problem in Ethiopian construction industry in general and that of road construction projects in particular?

Agree----- Strongly agree ----Disagree ----Strongly disagree-----

- 2.2.If your answer to the above question is agree or strongly agree? What is the average extent of project cost overrun occurred in projects you have participated in (your experience)? -----%

- 2.3. Please specify five project variables (risk factors) that most contribute to cost overrun? -----

-----  
-----  
-----  
-----

### **Section 3: Risk Factors which leads to project cost overrun**

3.1. The following tables consist of lists of possible risk factors (cost overrun variables) in construction projects identified from literatures and desk study. Based on your experience what is the likely contribution of these factors to cost overrun in federal road construction projects that you have involved in? Please rate your answer based on rate of occurrence (frequency of occurrence) & their impacts on cost by marking (√) under each preferences. In addition please indicate the responsible parties for the initiation of these factors and most affected party/parties out of the effects or consequences of cost overrun by marking (√).

<b>A. For frequencies of occurrence</b>	<b>B. For impact on cost overrun</b>
0- not at all = 0% probability to happen 1- Unlikely = 25% 2- Likely = 50% 3- Almost certain = 75% 4- Certain =100% probability to happen.	0-No impact 1-Minor impact 2-Average impact 3-High impact 4-Very high (Extreme) impact

C. Responsible Party  
For cost overrun

- CR- Contractor
- CS- Consultant (Design and/or Supervision Consultant)
- OW- Owner/Client
- GV-Government
- OR- Others
- SH- Shared
- PS- Project Sponsor

List of possible risk factors that causes Cost overrun in construction projects  (Please rate these factors based on their frequency of occurrence and impact on cost in the next two columns and indicate the responsible party/parties and most affected party/parties out of the effects in the third & fourth columns)	Rate of occurrence					Impact on cost overrun					Responsible Party(parties) or Initiator							most affected party/parties out of the consequences					
	0	1	2	3	4	0	1	2	3	4	C	C	P	O	G	O	SH	C	O	P	O	S	
											R	S	S	W	V	R		R	End users	W	S	R	H
1. Lowest bidding procurement method																							
2. Wrong method of cost estimation																							
3. Adverse effect of weather																							
4. Inaccurate cost estimation/underestimation																							
5. Poor relationship between management and labor																							
6. Inadequate labor/ skill availability																							
7. Disputes on site																							
8. Bureaucracy in bidding/ tendering method																							
9. Litigation																							
10. Scope changes occasioned by inadequate pre-contract study																							
11. Inadequate site investigation/unexpected ground conditions																							
12. Scope changes arising from redesign and extensive variation occasioned by change in brief																							
13. Inadequate preconstruction study																							
14. Work suspensions owing to conflicts																							
15. Inadequate quality/ Ambiguity of contract documents																							
16. Inappropriate contractor policies																							
17. Lack of contractors proper evaluation (review) of tender documents at tendering phase																							
18. Poor project (site) management/ Poor cost control																							
19. Technology changes																							
20. Improper planning																							

List of possible risk factors that causes Cost overrun in construction projects  (Please rate these factors based on their frequency of occurrence and impact on cost in the next two columns and indicate the responsible party/parties and most affected party/parties out of the effects in the third & fourth columns)	Rate of occurrence					Impact on cost overrun					Responsible Party(parties) or Initiator						most affected party/parties out of the consequences							
	0	1	2	3	4	0	1	2	3	4	C	C	P	O	G	O	S	H	C	O	P	O	S	H
											R	S	S	W	V	R			R	End users	W	S	R	H
21. Unexpected Inflation/ material Price escalation																								
22. Fraudulent practices, kickbacks, corruption																								
23. Mode of financing and payment for completed work																								
24. Delays on completion time/Change of schedule																								
25. Unstable cost of manufactured materials																								
26. Acceleration Costs																								
27. High cost of machineries																								
28. Contractors poor procurement processes																								
29. High interest rates charged by bankers on loans received by contractors																								
30. Lack of proper communication and coordination																								
31. Design risk/ Frequent design changes																								
32. Right of way problems (access to site and quarry)																								
33. Long period between design and time of bidding/tendering																								
34. High Service relocation costs																								
35. High machineries maintenance costs																								
36. Environmental issues																								
37. Change in government regulation																								
38. Lack of knowledge of available resources																								
39. High cost of skilled labor																								
40. Shortage of construction materials																								
41. Poor Contract administration																								

List of possible risk factors that causes Cost overrun in construction projects  (Please rate these factors based on their frequency of occurrence and impact on cost in the next two columns and indicate the responsible party/parties and most affected party/parties out of the effects in the third & fourth columns)	Rate of occurrence					Impact on cost overrun					Responsible Party(parties) or Initiator						most affected party/parties out of the consequences							
	0	1	2	3	4	0	1	2	3	4	C	C	P	O	G	O	S	H	C	O	P	O	S	H
											R	S	S	W	V	R			R	End users	W	S	R	H
42. Lack of prompt decision making (quick response) by client																								
43. Lack of specialized Construction manager																								
44. High transportation costs																								
45. Lack of coordination between general contractor and subcontractors																								
46. Domination of construction industry by foreign firms and aids																								
47. Inadequate duration of contract period																								
48. Inappropriate government policies																								
49. Inadequate production of raw materials in the country																								
50. Poor financial control on site																								
51. Stealing and waste on site																								
52. Absence of construction cost data																								
53. Inappropriate contractual procedure / Provision of contract clauses																								
54. Additional work/Direct change orders by client																								

**Section 4: Potential Effects of Cost Overrun**

4.1. The following table consists of list of the possible effects of cost overrun in construction projects identified from literatures. Based on your experience, among the following lists (1-16) of potential effects of cost overrun, please indicate the most recurrent effects in Ethiopian road construction sector as ranked from 1-5 (when 5 represents very high frequent effects while 1 is least frequent) by marking (√) under each preferences. Please also specify possible measures to be taken in order to minimize cost overrun in Ethiopian road construction projects.

Potential Effects of Cost Overrun	please indicate the most recurrent effects of cost overrun as ranked from 1-5 by marking (√) under each preferences					Please enumerate possible measures to be taken to minimize cost overrun, and hence its consequential effects on the construction industry.
	1	2	3	4	5	
1. Losses of credibility to highway organization/bad reputation						
2. Loss of clients' confidence in consultants						
3. Added investment risks/Funding risk						
4. For professionals -inability to deliver value to clients						
5. Discourages sponsors to invest in construction industry						
6. Less returns on investment for client						
7. Delay in payment						
8. Loss of profit to the contractor						
9. Abandonment of future projects						
10. Drop in construction activities						
11. Inability to secure project finance/securing it at higher costs						
12. Prevent planned increase in road network						
13. Damage professional relations						
14. Suspension of work						
15. Dispute among parties						
16. Decreased rate of national growth						

**Section 5: Total Project Cost Estimating & Estimating practices**

- 5.1. Does your organization have a dedicated estimating section or do personnel who also perform other duties prepare estimates? -----  
-----
- 5.2. What is the experience level of personnel performing estimates?  
Less than 5 years ---- 6-10 years ---- More than 10 years-----
- 5.3. Is there a formal training program for new personnel in estimating? Yes \_\_\_ No \_\_\_.

5.4. Does the organization, during the design phase of a project, impose a strict methodology to control the cost of construction? Yes \_\_\_\_ No \_\_\_\_.

If yes, would you describe? If there is a written Protocol would you provide a copy?

-----  
-----  
-----

5.5. In your opinion, what are the four most important factors/issues in project estimating?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5.6. In your experience, what role does value engineering and/or value management play in total project cost estimating and also in design?

\_\_\_\_\_  
\_\_\_\_\_.

5.7. Are contractors ever consulted about cost before a project estimate is prepared? Yes \_\_\_\_\_ No \_\_\_\_\_.

5.8. Are factors such as market conditions, anticipated time before execution, or geographic area of the project considered when preparing conceptual estimates? Yes \_\_\_\_ No \_\_\_\_.

5.9. Do you attempt to make a detailed estimate of project costs? (Detailed – means calculating production based on specific crews, equipment, and methods.) Yes \_\_\_\_ No \_\_\_\_.

5.10. Do you attempt to make a detailed estimate of major work items?

5.11. Do you attempt to make an estimate of project overhead costs (those project related costs that cannot be attributed to specific work items – head office overhead, required safety staffing, quality control staffing, temporary facilities, etc.) Yes \_\_\_\_ No \_\_\_\_.

5.12. How are mobilization and traffic control costs estimated? \_\_\_\_\_  
\_\_\_\_\_.

5.13. Is the cost of demolition identified separately? Yes \_\_\_\_ No \_\_\_\_.

5.14. Are the costs of detours identified separately or included with traffic control? \_\_\_\_\_.

5.15. Are all projects awarded to a single general contractor or will specialty portions, such as bridges, be awarded separately? \_\_\_\_\_

What is your comment on this issue? \_\_\_\_\_

5.16. Does your organization use alternative project delivery methods (are these allowed for use by the contract/business law)? \_\_\_\_\_. If so, how are these projects estimated differently than traditional design-bid-build projects? Additionally, what methods are you using and for what size and type of projects? (for clients only)\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5.17. How much time typically lapses between the engineer's estimate calculation and the bid opening? (for clients only)

\_\_\_\_\_.

5.18. What steps are taken when estimates are not close to bid prices? At what percent difference are these steps taken? (for clients only)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

5.19. Is there a contingency amount incorporated into each project estimate? Yes\_\_No\_\_\_. If so how is this amount determined? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_.

5.20. Are incentives used for early project completion, roadway smoothness or other items? Yes\_\_\_No\_\_\_. If so, where does this money come from and is it set aside and planned for during estimating? \_\_\_\_\_

\_\_\_\_\_

5.21. What is the time duration that contractors have for preparing their project estimates? \_\_\_\_\_. Does this change based on the size (budget) of the project? \_\_\_\_\_. Your comment on this issue \_\_\_\_\_

\_\_\_\_\_.

5.22. Please list four of the most frequent caused errors, mistakes, omissions in project design estimating. \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5.23. What are four main problems or constraints encountered in project design estimates?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_.

5.24. What is your percent confidence in the expected accuracy level of project design estimates for the following?

Roads \_\_\_\_\_

Bridges \_\_\_\_\_

Miscellaneous (road related) \_\_\_\_\_.

5.25. Do you have any comments on how to improve total project estimates and how to achieve this? \_\_\_\_\_

\_\_\_\_\_

5.26. What is your ideal profile of an expert project design estimator? (background, experience, skills, training, etc) \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5.27. What system changes are you considering and why?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5.28. Your over all suggestions on the cost management practices in Ethiopian road construction projects. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5.29. Any other comments you wish to provide: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

***I sincerely appreciate your timely response and cooperation.***

**Thank You!!**

## Appendix B

### Cost and Other data for Projects Surveyed

Item No.	Projects	Work/ Type of Surfacing	Budget in million ETB	Disbursement in million ETB	% cost overrun
1	Ziway - Butajira	Upgrading /DBST	309.1	331.9	7.38
2	Mille – Assab	Rehabilitation/AC	293.9	471.8	60.53
3	Modjo – Mille	Rehabilitation/AC	946.6	1071.2	13.16
4	Addis - Gohastion	Rehabilitation/AC	354.8	481.8	35.79
5	Dubti - Assaita	Upgrading /DBST	130.8	103	(21.25)
6	Kersaber-D/Damo-Bizet	Upgrading /Gravel	181.4	121.9	(32.80)
7	Kombolcha- Woldiya	Rehabilitation/AC	360.6	932.9	158.71
8	Gonder-Dansha-Humera	Upgrading /AC	618.4	760	22.90
9	Addis-Ambo	Rehabilitation/AC	503.4	470	(6.63)
10	Ambo - Gedo	Rehabilitation/AC	68.6	113.7	65.74
11	Nazareth-Assela	Rehabilitation/AC	204.1	321	57.28
12	Addis-Awassa	Rehabilitation/AC	409.1	391.1	(4.40)
13	Addis-Giyon-Jimma	Rehabilitation/AC	981.7	1126.2	14.72
14	Gewane-Millea (Alternative Route)	Rehabilitation/AC	40.6	134.2	230.54
15	Alamata-Korem-B/Mera	Upgrading /AC	190.1	458.2	141.03
16	Sodo – Arbaminch	Upgrading /DBST	95.1	105.6	11.04
17	Woldiya - Alamata/ Betemera – Wukro	Upgrading /AC	541.1	566	4.60
18	Debre Markos – Gondar	Upgrading /AC	704.1	1093.5	55.30
19	Awash – Kulubi	Upgrading /AC	130.3	319.9	145.51
20	Alemgena – Butajira	Upgrading /DBST	261.7	328.6	25.56
21	Harar - Jijiga – Degehabour	Upgrading /Gravel	97.2	86.1	(11.42)
22	Chida - Sodo	Upgrading /Gravel	240.6	329.8	37.07
23	Jijiga-Degehabor	Upgrading /DBST	258.4	467.8	81.04
24	Degehabur – K/Dehar	Upgrading /DBST	298.5	414.3	38.79
25	Woreta-GobGob	Upgrading /AC	366.7	372.2	1.50
26	Metu-Gore	Upgrading /AC	311	319.6	2.77
27	Nekempt-Mekenajo	Upgrading /AC	488.9	576.85	17.99
28	Mekenajo-Nejo–Mendi	Upgrading /DBST	410.6	615.3	49.85
29	Butajira-Hossaina-Sodo	Upgrading /DBST	626.7	653	4.20
30	Azezo-Metema	Upgrading /AC	692.8	575.5	(16.93)
	<b>Total</b>		<b>11,116.90</b>	<b>14,112.95</b>	<b>26.95</b>

## Appendix C

### Critical Values of Spearman's Rank Correlation Coefficients for Different Number of Data Set

Table: critical values of  $r_s$  (Spearman rank correlation coefficient), at various levels of probability. For any  $n$  observed value of data set,  $r_s$  is significant at a given level of significance if it is equal to or larger than the critical values shown in the table.

Number of Subjects (data set)	Level of significance for one-tailed test			
	0.05	0.025	0.01	0.005
	Level of significance for two-tailed test			
	0.1	0.05	0.02	0.01
5	0.9	1	1	-
6	0.829	0.886	0.943	1
7	0.714	0.786	0.893	0.929
8	0.643	0.738	0.833	0.881
9	0.6	0.683	0.783	0.833
10	0.564	0.648	0.746	0.794
12	0.506	0.591	0.712	0.777
14	0.456	0.544	0.645	0.715
16	0.425	0.506	0.601	0.665
18	0.399	0.475	0.564	0.625
20	0.377	0.45	0.534	0.591
22	0.359	0.428	0.508	0.562
24	0.343	0.409	0.485	0.537
26	0.329	0.392	0.465	0.515
28	0.317	0.377	0.448	0.496
30	0.306	0.364	0.432	0.478

*Note: when there is no exact number of subjects, use the next lowest number*

*Source: (Naoum, 2001).*

## **Appendix D**

List of Some of the Respondents (Name of Organizations Only)

### **Clients**

ERA— Southern Region, Eastern Region, Central Region, Western Region, Northern Region, Engineering Procurement Services and Planning Department

### **Contractors**

Sunshine Construction PLC

MIDROC Construction Ethiopia PLC

SUR Construction PLC

CRBC Addis Engineering PLC

Enyi General Business PLC

Alamayou Ketema General Contractor PLC

Berehe Hagos General Contractor PLC

Satcon Construction PLC

TERA Construction PLC

YENCOMAND PLC

Gemshu Beyene Construction PLC

Akir Construction PLC

Sinohydro Corp.

ERA Shashemene DRMC

DMC Construction PLC

ERA Nekemt DRMC

ERA Kombolcha DRMC

ERA Corporation (Previously Operation Department)

## **Consulting Firms**

Construction Design Share Company

Core Consulting Engineers PLC

Beza Consulting Engineers PLC

Classic Consulting Engineers PLC

HEC

Hamda Consulting Eng. &Tec.

Eng. Zewede Eskinder & Co. plc

Metaferia Consulting Engineers PLC

Bet Consulting Engineers PLC

Net Consulting Engineers PLC

Yerer Engineering PLC

Best Consulting Engineers PLC

**Other Construction Professionals:** are individuals that have ample experience in road construction projects during the RSDP period and currently working out side of the three organizations and their involvement in the survey was considered to make the study more comprehensive.

## **DECLARATION**

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

### **Candidate**

Name: Turkey Wakjira

Place: Addis Ababa, Ethiopia

Date of Submission: \_\_\_\_\_

Signature: \_\_\_\_\_

Title of the Thesis:

**“Risk Factors Leading to Cost Overrun in Ethiopian Federal Road  
Construction Projects & its Consequences”**

This thesis has been submitted for examination with my approval as university advisor.

### **Thesis Advisor**

Name: Professor Abebe Dinku (Dr.-Ing)

Signature: \_\_\_\_\_

Date: \_\_\_\_\_