ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE

DEPARTMENT OF PROJECT MANAGEMENT

FACTORS INFLUENCING COST OVERRUN: THE CASE OF WATER AND SANITATION CONSTRUCTION PROJECT IN ADDIS ABABA

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS DEGREE IN PROJECT MANAGEMENT

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DECLARATION

I undersigned, declare that this research report entitled **"factors influencing cost overrun in AAWSA projects"** is my original work. I have carried out it independently with the guidance and suggestions of the research advisor. And it has not been presented in Addis Ababa University or any other University.

Daniel Bekele (The researcher) ____

Signature

____

Date

APPROVAL SHEET

We, the undersigned, members of the Board of Examiners of the final open defense by Daniel Bekele have read and evaluated his research project entitled " **factors influencing cost overrun in AAWSA projects** " and examined the candidate. This is, therefore, to certify that the research project has been accepted as a partial fulfillment for the requirement of Master's Degree in project Management.

Approved by Board of examiners:

Advisor	Signature	Date
External Examiner	Signature	Date
Internal Examiner	Signature	Date

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Title **page**

List of figures

List of abbreviation

AAWSA	Addis Ababa water and sanitation Agency
FI	Frequency index
II	Important index
SI	Severity index
SPSS	Statistical package of social study
SOW	Statement of work
RFP	Request for proposal

Abstract

Among the many problems in construction projects, cost overrun is one of the prominent problem which has been broadly published in different literatures related to construction. In order to solve the problem one should identify the factors of cost overrun. Thus, this survey study was conducted aiming to sort out and rank the factors of cost overrun on water and sanitation construction projects in Addis Ababa Water and Sanitation Agency. This study was done using purposive sampling technique and 60 practitioners were selected. Based on a comprehensive literature review, 54 factors linked to project cost overrun in AAWSA projects were sorted out. Using these factors questionnaires were designed and distributed to 60 practitioners to evaluate the significant factors that affect project cost overrun. As a result 10 top rated factors were identified and ranked based on severity, frequency and important index. These are underestimating time requirements, Poor project control (cost, schedule and quality), Contractual claim (extension of time), Delay in construction, Inadequate supply of raw materials and equipment by contractors, Delays between design and procurement phases, Lowest bidding procurement procedures, inflation, Design error and omissions and Inadequate preconstruction study. The ten top factors were the highest impacts on the performance of project cost overrun from the client's, consultants' and contractors' perspective. In conclusion poor project and poor resource management were the significant factors for cost overrun in AAWSA projects.

Key Words: Cost, Overrun, Construction, water Projects

CHAPTER ONE
INTRODUCTION

1.1 **Background of the study**

The inability to complete projects within budget continues to be a chronic problem worldwide and is worsening from time to time. (Ahmed S, Azher S, Castillo M, Kappagantula P.2002). Azhar and Farouqui (2008) observe that the trend of cost overrun is common worldwide and that it is more severe in developing countries. The debate in the construction industry on how to minimize or eliminate delays and cost overruns has been discussed for some time among professionals, clients and/or end users, and the policy makers. The funding for construction industry activities in many countries, is used to regulate the economy. As the construction industry continues to grow in size, so do planning and budgeting problems. It is common for projects not to be completed on time and within the initial project budget. Because of construction delays and cost overruns, less and less work is performed despite the increase in construction budgets. The aim of this research is to assess factors influencing cost overrun on water and sanitation construction projects in Addis Ababa.

Cost and time have its proven importance as the prime factor for project success. Most of the significant factors influencing project cost overrun and delay are Changes in owner's needs, unexpected site conditions, Evolution in the design philosophy and Design or budget errors (Harold K.2009). A project otherwise completed may not be regarded as a successful endeavor reaching to the end of any project is not a kind of success for the project owner. For the client or owner of the project, success of a project depends on many factors; the most important factors are finishing the project within the budgeted cost and reaching to the closing date of project without delay with a good quality of work and creating no health and safety problems.

In Ethiopia, construction sector is an important sector. Although not working to its fullest potential, it is still 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. As many other developing countries are facing also cost and time related issues among which cost overrun is quite prominent. There are several causes that are responsible for cost overruns and delay. This paper will be attempts to identify the major causes of cost overrun in water and sanitation construction projects of Addis Ababa and can serve as the way forward for future work in coping with these overruns.

The major factors that cause project cost overrun in water and sanitation construction project in Addis Ababa are poorly understood. Thus, this study was undertaken to identify the causes that lead to cost overrun in water and sanitation construction projects in Addis Ababa.

1.2 Statement of the problem

The Construction Industry plays an important role in the development of a country through the delivery of projects and other related activities that generate income for individuals and firms. This contribution is deemed to be greatly enhanced when project delivery is on target in terms of stated performance parameters. However, this is generally considered not to be the case, either nationally or internationally (Monyane 2013). It is common to see a construction project failing to reach its objectives within the predicted cost. Cost overrun is a very common phenomenon that almost associated with nearly most of the projects in construction industry. So, reaching to the end of any project is not a kind of success for the project owner. For the client or owner of the project, success of a project depends on many factors; the most important factors are finishing the project within the budgeted cost and reaching to the closing date of project without delay with a good quality of work and creating no health and safety problems

Among the construction projects undertaken in recent year cost over is one of the major problems in Ethiopia. (Fetene 2008: Abubekir 2015: Zinabu and Getachew 2015)This problem in turn is causing difficulties in financing of upcoming projects, timely utilization of the facility by the public and the relationship among stakeholders (client, Contractor, consultant) involved in the construction process. In essence, the assumed problem statement for this study states that water and sanitation construction projects are prone to the cost overrun problem and most of the projects are not completed within a given budget and time. The main causes that are responsible for delay and cost overrun in water and sanitation construction projects are poorly understood and as George and Garfas (2010) state every projects are unique and there is no single cause for cost and schedule overrun. Thus, the assumed problem statement for this study states that "water and sanitation construction projects are prone to and experience cost overruns that propagate a mirage of problems in the water and sanitation construction projects organization in Addis Ababa.

1.3 Research question

In order to achieve a practical and credible conclusion the study try to answer the following questions:

- What are the factors that lead to cost overrun in water and sanitation construction projects in Addis Ababa?
- How the identified factors be analyzed and in what order should they come based on their frequency, level of severity and the important index of cost overrun on the AAWSA projects?

1.4 Objective of the study

The general objective of the study is to assess the factor that lead to cost overrun on AAWSA projects.

Specific objectives

- To identify various factors that influence cost overrun in water and sanitation projects in Addis Ababa.
- To analyze and rank the identified factors based on their frequency, level of severity and the important index of the causes of cost overrun.

1.5 Significance of the study

There has not been much research conducted to identify the cause of cost overrun factors. So, from this study can be enlighten and inspire people about the cause of cost overruns in the construction industry. The advantages of this research included produce the statistical result and it can be the guideline or reference to the project manager, consultants and client, to let them identify well important factors of cost overrun. So, the findings of this study would beneficial to the project manager, consultants and clients in construction project.

1.6 Scope and Limitation of the study

This study is limited to water and sanitation construction project in Addis Ababa and is conducted among client, consultant and contractors in order to identify the cost overrun factor, to analyze and rank in their order of significance, level of severity and the importance of the causes cost overruns perceptions of the three major parties in, namely; clients, contractors and consultants, and to analyze and rank the categories of the relevant responsible parties to the causes of cost overrun. 60 respondents of water and sanitation project clients, contractors and consultants were selected to carry out this study and the questionnaires were distributed.

1.7 Organization of the study

A thorough literature review follows the identification and approval of the research problem various documents and relevant information were collected. The collected information along with data retrieved from questionnaire respondents were discussed and analyzed. The results were interpreted and based on the results conclusions and recommendations were made. In general the study is organized into five major chapters:

Chapter 1: Introduction to the study. This provides a background to the study, statement of the Problem, research questions, objectives, and significance of the study and limitations.

Chapter 2: Literature Review. The chapter discusses theories relevant to the study and provides

Literature previously done by other authors on the factors influencing cost overrun in water construction projects.

Chapter 3: Research Methodology. This chapter discusses the research design, sampling Procedures, data collection methods and analyses that would have been used in the research.

Chapter 4: This chapter presents and discuss the results in relation to the research Questions.

Chapter 5: Conclusions Recommendations and. The findings will be summarized and Recommendations and conclusions given based on the results.

CHAPTER TWO
LITERATURE REWIEW

2.1 General concepts of cost overrun

A successful construction project is an integrated effort by people of different qualifications ensuring its completion within the scheduled time, without exceeding the allocated budget, and within the specified quality and standards. However, for various reasons, project successes are not common in the construction industry, especially in developing countries, caused by delays and cost overrun. There are many causes of delays and cost overruns in construction projects. Several studies have pointed out various factors based on the underlying condition that the specific study is concerned with, such as project type, specific location and project size.

The main purpose of this chapter is to identify the factors that cause construction project cost overruns as exhaustively as possible through an intensive and comprehensive review of past research carried out by various researchers in different construction environments. This review literature is particularly important as it provides a substantial part of the inputs for the lists of causes to be considered for the research and to develop a conceptual framework for the research method design.

In the following sections, a brief discussion of the cost overrun of construction projects are given, some basic terminologies/phrases used in the study are described and a comprehensive review of literature presented.

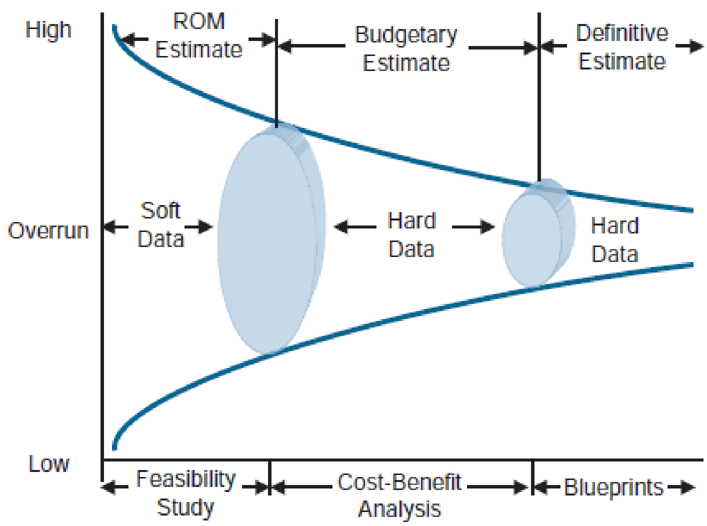
2.1 Cost overrun

Cost overruns occur when "the final cost of the project exceeds the initial estimate or budget" (Avotos, 1983). Nevertheless, the estimate or initial budget is constantly changing during the execution of the project. For this reason, it is important to be careful with the budget that is going to be taken into account to calculate the overrun of the project (Avotos, 1983). Some authors consider that the initial budget is created when the decision of commencing building is made (Flyvbjerg, *et al.*, 2002; Odeck, 2004). On the other hand, some other authors uphold the idea that cost overrun should be found comparing the original contract value with the final cost of the project

at the time of completion. The difference between cost overrun definitions may cause a difference in the magnitude of cost overruns that have been reported over the years (Love, *et al.*, 2012).
Le-Hoai, et al. (2008) also considered that the magnitude of cost overruns may or may not vary depending on the size of the project, the location of the project and the type of project. For example, (Eden et al 2005) pointed out that although there is more information about cost overruns in public projects, this does not mean that there are no cost overruns in the private industry. In fact, the authors uphold the idea that projects of private sector tend to have larger cost overruns. On the other hand, (Koushki, et al 2005) expressed that cost and time overruns are common not only in large projects, but also in small and simple projects. This issue was also discussed by (Frimpong, et al. 2003) who stated that overruns are more frequent and significant in large projects than small projects. (Gkritza and Labi 2008) supported this idea and they also added that cost overruns are also more common in long duration projects. Nevertheless, (Odeck 2004) contradicted this statement. He considered that large projects have fewer cost overruns because managers pay more attention to the management of these types of projects than the attention they usually pay to small projects.

2.2 The cost overrun dilemma

According to (Kerzner H.2009) the lifeblood of most organizations is a continuous stream of new products or services. Because of the word “new,” historical data may be at a minimum and cost overruns are expected. Figure 1 shows a typical range of overruns. Rough order-of-magnitude (ROM) estimates are often made from “soft” data, which can result in a wide range of overruns, and are used in the initiation phase of a project. As we go from soft data to hard data and enter the planning phase of a project, the accuracy of the estimates improves and the range of the overruns narrows. When overruns occur, the project manager looks for ways of reducing costs. The simplest way is to reduce scope. This begins with a search for items that are easy to cut. The items that are easiest to cut are those items that were poorly understood during the estimating process and were therefore underestimated. Typical items that are cut or reduced in magnitude include: Project management supervision, Line management supervision, Process controls, Quality assurance and testing.



Figer 2.1 Range of cost overrun

Source: (Kerzner H.2009)

Cost overruns can occur in any phase of project development. The most common causes for cost overruns are Proposal phase Failure to understand customer requirements, Unrealistic appraisal of in-house capabilities and underestimating time requirements. Planning phase Omissions, Inaccuracy of the work breakdown structure, Misinterpretation of information, Use of wrong estimating techniques, Failure to identify and concentrate on major cost elements and Failure to assess and provide for risks. Negotiation phase Forcing a speedy compromise, Procurement ceiling costs and Negotiation team that must "win this one". Contractual phase Contractual discrepancies SOW different from RFP requirements and Proposal team different from project team. Design phase Accepting customer requests without management approval, Problems in customer communications channels and data items, Problems in design review meetings. Production phase Excessive material costs, Specifications that are not acceptable and manufacturing and engineering disagreement (Kerzner H.2009)

2.3 Project development phase

Proposal phase

A project proposal is a detailed description of a series of activities aimed at solving a certain problem. The proposal should contain a detailed explanation of the: Justification of the project; Activities and implementation timeline; Methodology; and Human, material and financial resources required. The project proposal should be a detailed and directed manifestation of the project design. It is a means of presenting the project to the outside world in a format that is immediately recognized and accepted. (Besim 2002)

Planning Phase

This is a critical stage in the cost management process; an inaccurate planning can doom a project to continual stress and compromise, neither the client, end-user nor design team being completely satisfied at the end. A common mistake at this stage is to apply those historical data without making adjustments for the myriad factors which affect construction costs such as size of the project, location, price increases, delivery system, overall quality of the project envisioned, etc (Bill, et al, 2006).

Early cost estimates are employed in the early planning phases of a proposed project to match an owner's needs, expressed as written programmatic requirements, with budget constraints in order to establish its overall scope and quality expectations. Value Engineering should also be considered at this stage. Any changes to the program at this early phase have very little, if any, impact on schedule and redesign costs, but the benefits in terms of solidifying the program and establishing project goals can be huge. Most owner and designer cost control problems are created at the planning stage of a project. At this time, client needs sometimes are understated in order to justify a project. More often than not, client needs are not fully known and thus are oversimplified (Donald E. Parker, 1984)

Negotiation phase

The main purpose of the negotiation phase is to finalize the details of the work to be carried out under the grant agreement within the associated budget, as well as to establish the legal and financial information needed to establish the grant agreement. Two main elements comprise the project negotiation process: Technical (scientific) negotiations and Financial and legal negotiations.

Technical (scientific) negotiations

The underlining aim here is to agree on the final content of the work to be performed during the life of the project. During this part of the negotiation process the proposal may need to be adapted to meet the recommendations of the evaluation, as described in the negotiation mandate. The full work plan of the project as well as work to be carried out by each of the beneficiaries and any potential future expansion of the consortium will need to be defined in sufficient detail. Agreement will need to be reached on the list of deliverables and their content, timing and dissemination level, as well as on the project milestones and their assessment criteria. Finally, an indicative time schedule needs to be established for the project reviews (if not predefined in the special conditions of the grant agreement) – which ideally should be synchronized with the reporting periods.

Financial and legal negotiations

Here the focus is on reaching agreement on budgetary matters such as the budget for the full duration of the project and the budget breakdown for the different project periods, as well as issues related to subcontracting and third parties. In addition, this is where issues are dealt related to the establishment of the amount of the initial pre-financing, timing of project periods and reviews. As far as legal negotiations are concerned, these include the analysis and review of the final composition of the consortium, any special clauses required for the project, and other aspects such as the project start date. During this part of the negotiation process the total costs, total eligible costs and maximum Community financial contribution will be determined, and a table of the estimated breakdown of budget and Community financial contribution per activity to be carried out by each of the beneficiaries will be established. Furthermore, the amount of pre-financing, the start date and the duration of the project, the timing of the reporting periods, and the management capacity of the coordinator, are all established and verified.

Contractual phase

While construction contracts serve as a means of pricing construction, they also structure the allocation of risk to the various parties involved. The owner of the project has the sole power to decide what type of contract should be used for a specific facility to be constructed and to set forth the terms in a contractual agreement. It is important to understand the risks of the contractors associated with different types of construction contracts.

Lump Sum Contract In a lump sum contract, the owner has essentially assigned all the risk to the contractor, who in turn can be expected to ask for a higher markup in order to take care of unforeseen contingencies. Beside the fixed lump sum price, other commitments are often made by the contractor in the form of submittals such as a specific schedule, the management reporting system or a quality control program.

Unit Price Contract In a unit price contract, the risk of inaccurate estimation of uncertain quantities for some key tasks has been removed from the contractor. However, some contractors may submit an "unbalanced bid" when it discovers large discrepancies between its estimates and the owner's estimates of these quantities. Depending on the confidence of the contractor on its own estimates and its propensity on risk, a contractor can slightly raise the unit prices on the underestimated tasks while lowering the unit prices on other tasks. If the contractor is correct in its assessment, it can increase its profit substantially since the payments is made on the actual quantities of tasks; and if the reverse is true, it can lose on this basis.

Cost plus Fixed Percentage Contract For certain types of construction involving new technology or extremely pressing needs, the owner is sometimes forced to assume all risks of cost overruns. The contractor will receive the actual direct job cost plus a fixed percentage and have little incentive to reduce job cost. Furthermore, if there are pressing needs to complete the project, overtime payments to workers are common and will further increase the job cost. Unless there are compelling reasons, such as the urgency in the construction of military installations, the owner should not use this type of contract.

Cost plus Fixed Fee Contract Under this type of contract, the contractor will receive the actual direct job cost plus a fixed fee, and will have some incentive to complete the job quickly since its fee is fixed regardless of the duration of the project. However, the owner still assumes the risks of direct job cost overrun while the contractor may risk the erosion of its profits if the project is dragged on beyond the expected time.

Cost Plus variable Percentage Contract For this type of contract, the contractor agrees to a penalty if the actual cost exceeds the estimated job cost, or a reward if the actual cost is below the estimated job cost. In return for taking the risk on its own estimate, the contractor is allowed a variable percentage of the direct job-cost for its fee. Furthermore, the project duration is usually specified and the contractor must abide by the deadline for completion. This type of contract allocates considerable risk for cost overruns to the owner, but also provides incentives to contractors to reduce costs as much as possible.

Target Estimate Contract. This is another form of contract, which specifies a penalty or reward to a contractor, depending on whether the actual cost is greater than or less than the contractor's estimated direct job cost. Usually, the percentages of savings or overruns to be shared by the owner and the contractor are predetermined and the project duration is specified in the contract. Bonuses or penalties may be stipulated for different project completion dates.

Guaranteed Maximum Cost Contract. When the project scope is well defined, an owner may choose to ask the contractor to take all the risks, both in terms of actual project cost and project time. Any work change orders from the owner must be extremely minor if at all, since performance specifications are provided to the owner at the outset of construction. The owner and the contractor agree to a project cost guaranteed by the contractor as maximum. There may be or may not be additional provisions to share any savings if any in the contract. This type of contract is particularly suitable for turnkey operation.

Design Phase

Once an initial budget has been established, the scope set and the quality expectations documented, it is important to monitor the estimated cost of the project by employing a series of increasingly precise cost estimating techniques that coincide with further development of design and construction details. Estimates are employed at various stages of project design development as part of ongoing cost management, and as a means of evaluating competing alternatives. The drawings and specifications should also go through a constructability review, wherein the construction documents are analyzed for completeness, coordination between activities, cost effective designs, and general code compliance. The specifications should also be reviewed to ensure that the general requirements included are not overly restrictive (e.g. working hours, noise restrictions and so forth).

Construction Phase

At the bid stage, drawings should be nearly 100% complete; however, in many instances this does not happen, leading to addenda being issued to clarify details, resolve conflicts or to complete the design. The preparation of the bidding documents is also crucial in an overall cost management strategy. Consideration should be given to contract clauses that govern changes in the work and how they will be valued; allowable mark ups on changes by the various levels of contractors and sub-contractors; notice requirements for delays; the use of unit prices for changes and any other clauses that may affect the final cost of the project. During construction, usually, the focus shifts from predictive cost estimating to reactive cost control of any changes in the work. Changes arise from a number of different sources; unforeseen conditions, owner generated changes, drawing errors and omissions, code issues or contractual claims, etc. In addition, changes can arise from ongoing proactive cost management, generated either by the consultant,

The client or by the contractor, where one of the parties proposes a better value substitution.

2.4 Causes of Cost overrun in construction project

This section aims to understand the main causes of cost overrun. For this reason, it presents some results of different studies over the years of cost overruns in different types of construction projects in many different countries. Generally, the factors that influence cost overruns are present from the estimating stage to the completion stage of the project (Baloi and Price, 2003). Therefore, understanding the main factors that cause cost overruns is important due to the fact that it helps to minimize the impact and create a strategic plan to face uncertainties in all stages of the project (Reichelt and Lyneis, 1999).

2.5 Existing Studies of Cost Overrun in Construction Projects

In the past, (Subramani, et al. 2014) carried out Desk study along with questionnaire survey to identify the causes of cost overrun. A total of 30 filled questionnaires were collected from clients, consultants and contractors In Indian. The main idea of the authors was to understand the main reasons for cost overruns. They concluded that the main reason for cost overruns was *slow decision making, poor schedule management, increase in material/machine prices, poor contract management, poor design/ delay in providing design, rework due to wrong work, problems in land acquisition, wrong estimation/ estimation method, and long period between design and time of bidding/tendering are the major causes of cost overrun*. Therefore, the summary of the main causes of cost overruns found by (Subramani, et al. 2014) can be seen in Table 1.

Table 2.1. Main causes of cost overruns in construction projects in Indian

Main causes of cost overruns in construction projects in Indian
slow decision making
poor schedule management
increase in material/machine prices
poor contract management
poor design/ delay in providing design
rework due to wrong work
problems in land acquisition
wrong estimation/ estimation method
long period between design and time of bidding/tendering

Source :-(Taken from Subramani, et al, 2014)

Similarly, some studies were conducted in South Africa by (Ramabodu and verster 2010) who aimed to identify the major cost overrun factors in the construction sector of the Free State Province of South Africa. The survey was sent to 25 professionals in the construction industry, comprising architects, Engineers, quantity surveyors, project managers and contractors. The results were analyzed taking into account the different professions and the role of each respondent in the project. Therefore, the authors concluded that The five critical factors considered by the respondents and indicated by them as very critical for cost overrun, is shown in Figure 2 with importance of between 65% and 85 %.(Ramabodu and verster 2010).

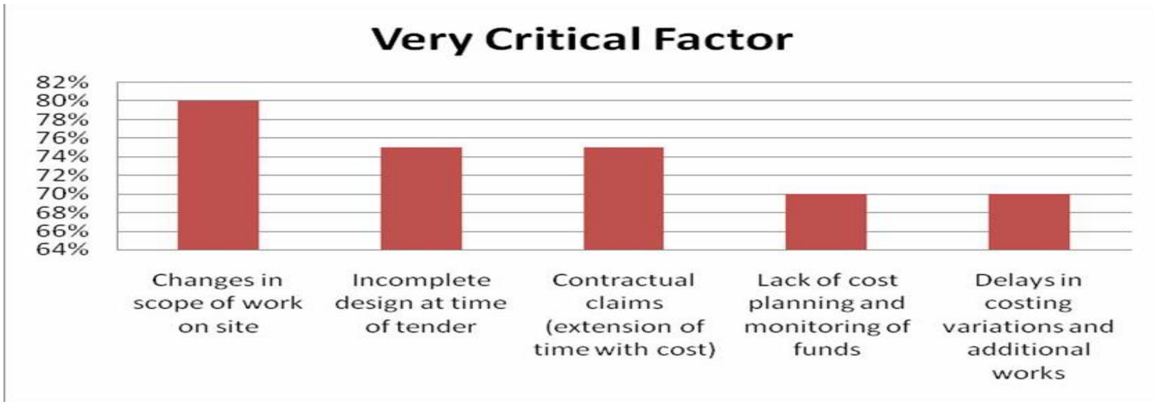


Figure 2.2. Very critical factors of cost overrun

Source: (Ramabodu and verster 2010).

The study carried out by (Ramabodu and verster 2010). Used in the following years as the basis for other studies in South Africa. In 2011, Lucius and Michiel created a different questionnaire taking into account the factors highlighted by (Ramabodu and verster 2010). In this study, 60 questionnaires were distributed to clients, contractors and consultants. Moreover, (Lucius and Michiel 2011) identify the most important cause of cost overruns were *Increase in material cost, Inaccurate material estimates, Shortage of skilled labor and Client's late contract award*. The following year, (Nafkote 2015) distributed questionnaires to contractors, client and consultants' in eThekwini Municipal area, Durban, Office construction projects, South Africa. The author supported the main reasons highlighted before by other authors (Lucius and Michiel, 2011; Ramabodu and verster 2010,1988); nevertheless, the author added that *contractor's cash flow problems, delay in progress payments by the client, poor site supervision and management by contractor, inefficient quality control by the contractor during construction leading to rework due to errors, and contractor's difficulties in financing the project*, can also be reasons for cost overruns in south Africa constructions. Some of the causes resulted from these studies can be seen in Table 2.2.

Table 2.2. Main causes of cost overruns in South Africa

Main causes of cost overruns	Ramabodu and verster (2010)	Lucius and Michiel (2011)	Nafkote (2015)
Change in scope of work on site	✓		
Incomplete design at time of tender	✓		
Contractual claim (extension of time with cost)	✓		
Lack of cost planning and monitoring of funds	✓		
Delay in costing variation and additional work	✓		
Increase in material cost		✓	
Inaccurate material estimates		✓	
Shortage of skilled labor		✓	
Clients late contract award			✓
cash flow problems			✓
delay in progress payments			✓
poor site supervision and management			✓
inefficient quality control			✓
difficulties in financing the project			✓

Source: (Adapted from Ramabodu and verster, 2010; Lucius and Michiel, 2011; and Nafkote 2015)

Emmanuel, et al. (2017) stated that the construction industry has over the years been challenged with cost and time overruns of construction projects all over the world including Ghana because they have similar problems in construction projects. Moreover, this statement is reinforced by (Nida, et al. 2008) who made part of the survey questionnaire in total forty two (42) factors were short-listed and the survey was conducted with representatives from local general contracting firms in Pakistan to find the main factors cause cost overruns in this type of projects. The authors concluded that *fluctuation in prices of raw materials, unstable cost of manufactured materials, high cost of machineries, lowest bidding procurement procedures, poor project (site) management, poor cost control, delays between design and procurement phases, inappropriate methods of cost estimation, additional work, improper planning, and unsupportive government policies* are the main factors that cause cost overruns in Pakistan. Another study that had similar results in a developing country was the research done by (Roya and Jose' Manuel. 2014), who wanted to find the causes of cost overruns in the construction of gasoil projects in Iran. For this reason, this paper presents the results of a questionnaire conducted to identify and evaluate the relative importance of the significant factors contributing to the Gas-Oil construction industry of Iran as a case study for developing countries. The results pointed out that the main factors that caused overruns in Iran are similar to those in other developing countries. These factors were: *Improper Planning*, *Frequent design changes*, *inadequate labor/skill availability*, *Inflation of machinery, labor*, *raw material and transportation prices, Prices fluctuation of raw construction materials, Inappropriate contract policies*, *Inadequate cost estimating approach, Lack of coordination between the design team and the general contractor*, *Inadequate preconstruction study, Errors during construction, and Inappropriate government policies* (Emmanuel, et al.2017, Nida, et al. 2008, Roya and Jose' Manuel. 2014). A summary of the causes mentioned by these authors can be seen, although some of the causes resulted from these studies were similar, there were some difference that can be seen in Table 2.2.

Table 2.3.Main causes of cost overruns in developing country

Main causes of cost overruns	(Emmanuel,et al.2017)	(Roya and Jose' Manuel. 2014)	Nida, et al. 2008,)
Incomplete design at the time of tender	✓		
Contractual claims, such as, extension of time with cost claims, etc	✓		
Inadequate project preparation, planning and implementation	✓		
Underestimation of cost of projects	✓		
Design changes	✓		✓
Lack of cost planning/monitoring during	✓		
pre-and post-contract stages	✓		
Resources constraint: funds and associated auxiliaries not ready	✓		
Additional work at owner's request	✓	✓	✓
Price fluctuations	✓		
Change in the scope of the project	✓		✓
Frequent design changes	✓		✓
Inadequate labor/skill availability			
Inflation of machinery, labor, raw material and Transportation prices			
Prices fluctuation of raw construction materials	✓	✓	
Inappropriate contract policies			
Inadequate cost estimating approach		✓	
Lack of coordination between the design team and the General contractor			
Inadequate preconstruction study			
Errors during construction			
Inappropriate government policies		✓	
Unstable cost of manufactured materials		✓	
Fluctuation in prices of raw materials	✓	✓	✓
High cost of machineries		✓	
Lowest bidding procurement procedures		✓	
Poor project (site) management		✓	
poor cost control		✓	
Delays between design and procurement phases		✓	
Inappropriate methods of cost estimation		✓	✓
Additional work	✓	✓	
Improper planning		✓	
Unsupportive government policies		✓	

Source: (Adapted from Emmanuel, et al.2017, Nida, et al. 2008, Roya and Jose' Manuel. 2014).

PWC (2014) Capital Projects and Infrastructure project team developed a standard questionnaire that was used to conduct interviews with key players in the infrastructure sector, including donor funders, financiers, government organizations and private companies across East, West and Southern Africa. Sectors surveyed included water, transport and logistics, energy (power and oil & gas), mining, social infrastructure, telecoms and real estate, with the main focus being on primary infrastructure.

Respondents attributed cost overruns to delays in client decision-making, the government approval process and completion of commercial agreements. Respondents also cited project management issues such as poor planning or design work and insufficient project preparation as reasons for delays. Project changes such as failure to achieve a design freeze or variations in design after commencement were further highlighted as a significant cause of cost overruns, along with economic factors, including inflation, currency depreciation and currency exchange controls.

The main reason for cost overruns varied by region: In East Africa, respondents cited lack of internal capacity and lack of skills as the main causes. Economic factors were the leading cause of cost variances in West Africa, while in Southern Africa, project management problems were the most frequent cause. Overall, across all regions, a lack of project cost estimation, commercial management and project management skills usually underlie the problem of cost overruns. Some survey respondents cited such project management deficiencies as poor planning, poor technical decision making, inadequate risk assessments, and lack of proper controls and inadequate monitoring of projects.

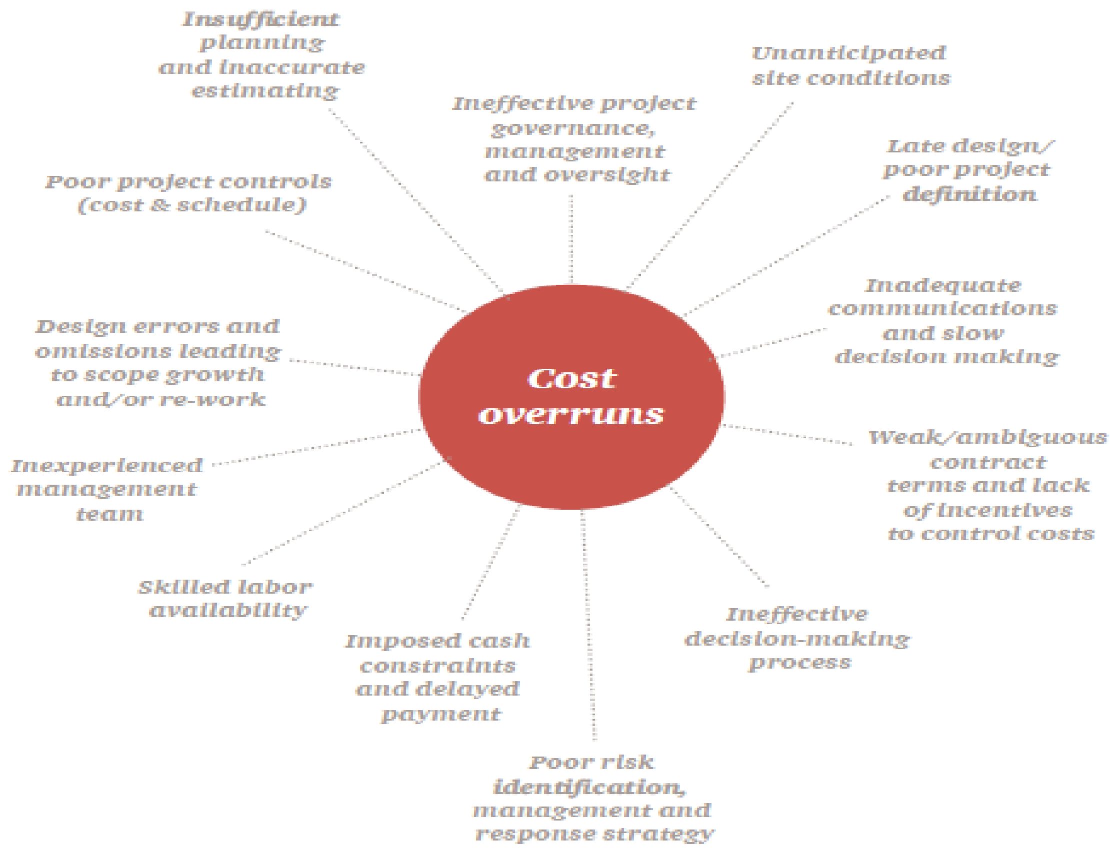


Figure 2.3. Most common factors that cause cost overruns

Source: correcting the course of capital projects' Pwc, 2014

2.6 Studies Concentrated on Ethiopia

Some studies of cost overruns have been carried out in Ethiopia. A study made by (Fetene 2008) attempted to find the reasons why construction projects spend more money than the initial budget. For this reason, the author were collected A total of 42 questionnaires from clients, consultants and contractors and a desk study of 70 completed public building construction projects in Ethiopia were investigated and analyzed using both descriptive and inferential statistics. From the results it was found that 67 out of 70 public building construction projects suffered cost overrun. Moreover, he mentioned that the most important causes of cost overrun were *inflation or increase in the cost of construction materials, poor planning and coordination, change orders due to enhancement required by clients, excess quantity during construction, are severe factors that cause overruns in* *construction projects in Ethiopia.* Nevertheless, this study was complemented by (Abubekir 2015) in a more recent study.

Abubekir (2010) distributed A total of 94 questionnaires from client, consultants and contractors were collected and a desk study of 10 completed road construction projects in Addis Ababa were investigated. From the results it was found that 100% of the road construction projects suffered both time and cost overrun. The rate of time overrun ranges from a minimum of 25% to the maximum of 264.38% of the contract amount and cost overrun ranges from a minimum of 4.11% to the maximum of 135.06% of the contract amount. Respondents identified 47 causes of time and cost overrun for Addis Ababa case. The most important causes of time overrun were delay to furnish and deliver the site (Right of way problem), financial problems and improper planning. Whereas the most important causes of cost overrun were found to be *delay in construction, inadequate supply of raw materials and equipment by contractors, design changes, Incomplete design at the time of tender.* The most common effects of cost overrun identified by this research are delay, supplementary agreement, adversarial relations among stakeholders, and budget shortfall of project owners. Similarly in the same year (Zinabu and Getachew 2015) study on causes of contractor's cost overrun in construction projects in Ethiopia. This study was conducted to identify the top five cost over-run factors and survey is conducted on 140 respondents. The samples were drawn using convenient sampling approach. Primary data is collected using the self-administered questionnaires. While secondary data is collected through reviewing of related materials and the analysis is conducted using SPSS version 20. As per the contractor' response, the top five factors that causes cost overrun of construction projects were from medium to high. On the other hand, the top five factors as per the response of consultants and clients ranged between high to very high. The contractors outlined the top five factors that causes cost overrun in construction projects are *poor planning, fluctuation of price of materials, poor productivity, inflationary pressure and project financing in descending order.* This study answers one of the objectives of this research which is "to identify the main causes of cost overruns in Addis Ababa water and sanitation construction projects". It can be considered as correct because it is a recent study in construction projects in Ethiopia; the results, as mentioned before, are reliable, the rate of response is high and it takes into account the different perceptions of project participants [owners, consultants and contractors].which gives credibility to this study. A summary of the causes mentioned by these authors can be seen in Table 4 although some of the causes resulted from these studies were similar, there were some difference that can be seen

Table 2.4 Main causes of cost overruns in Ethiopia (Fetene 2008, Abubekir 2015, Zinabu and Getachew 2015).

Main causes of cost overruns	Fetene (2008)	Abubekir (2015)	Zinabu and Getachew (2015)
Inflation or increase in the cost of construction materials	✓		✓
Poor planning and coordination	✓		✓
Change orders due to enhancement required by clients	✓		
Excess quantity during construction	✓		
Delay in construction		✓	
Inadequate supply of raw materials and equipment by contractors		✓	
design changes		✓	
Incomplete design at the time of tender		✓	
Poor planning,	✓		✓
Fluctuation of price of materials			✓
Poor productivity			✓
Inflationary pressure	✓		✓
Project financing in descending order			✓

Source: (Fetene 2008, Abubekir 2015, Zinabu and Getachew 2015).

2.7 Summary

Taking these into account, this research is aimed at investigating the problems as to why most Water and sanitation construction projects in Addis Ababa are require additional budget beyond the initial contract prices. Furthermore, the research looks into the responsible party for the causes of cost overrun in water and sanitation construction projects are identified from the stake holders. In order to attain these objectives and identify the factors influencing cost overrun in water and sanitation construction projects in Addis Ababa, a comprehensive literature review undertakes to generate a set of factors that are believed to be the most common and frequently occurring causes. From the literature review, more than sixty variables are identified that are known to cause cost overrun of construction projects worldwide. Based on these identified variables, a questionnaire is developed which are distributed to the main office construction stakeholders (clients, contractors and consultants) that operate in Addis Ababa so as to identify the most important factors that cause cost overrun in construction projects in the area and come with possible solution or recommendations to the problems.

2.7. Conceptual frame work

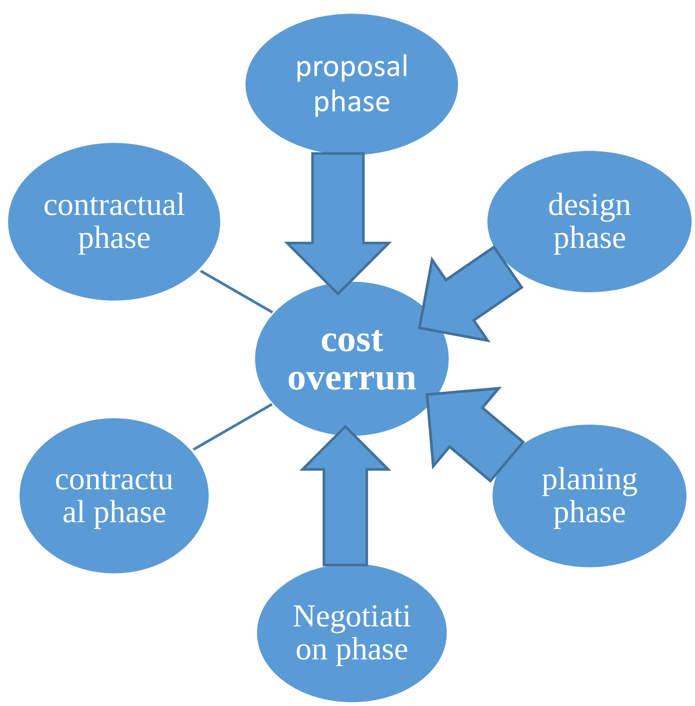


Figure 2.4 conceptual frame work

Source: (Kerzner H.2009)

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

Research methodology is the step by step procedure used to determine a solution to a particular problem. The methodology adopted in this research provides the procedures that are necessary for obtaining the information needed to structure the research questionnaire, collect data, analyze the collected data, and interpret and present the results. The methodology followed in this research outlined in the following sections.

3.2. Research types

Research could be descriptive or exploratory. Exploratory research is a research used to explore or search through a problem or a situation to provide insights and understanding. Descriptive research is to portray an accurate profile of persons, events or situations (Malhotra 2004). This research which deals with investigation of the practical problem cost overruns is undertaken on the basis of observation of construction projects. The research questions were designed to explore the causes of project cost overrun. A research can be categorized as exploratory and descriptive type. The research is exploratory because it is initiated from practical problems and investigates whether the causes of cost overrun exist. It is also descriptive because it tries to describe the causes of cost overrun in the water and sanitation construction projects in Addis Ababa. The descriptive research method adopted in this study is to reveal an accurate picture of the respondents' (professionals) opinion that might help to assess the dominant causes and identify possible and practical measures for minimizing cost overruns in water and sanitation construction project in Addis Ababa

3.3. Research Approaches

There are two basic approaches to research: quantitative and qualitative (Leedy *et al*. 2005). The former involves the generation of data in quantitative form which could be subjected to accurate quantitative analysis in a proper and rigorous manner and in the form of a data base from which to realize characteristics or relationships. In quantitative research, samples of a population are studied (observed or questioned) to establish its characteristics, in short, a quantitative approach attempts to produce “real answers” from “hard data”, whereas a qualitative approach is concerned with subjective evaluation of opinions, behavior and attitudes. Research in such a situation is a purpose of the researcher's insights and impressions, and the techniques involved are projective techniques, focus group interviews and depth interviews. Qualitative methods are not good at giving direct answers, but are good at developing more questions, because of consistent use of “soft data” (Higgins, 2009). Therefore in this research quantitative approach is used.

3.4. Research Design

The strategy follow in this research were started with problem identification which has been done through unstructured literature review, 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, journals, internet sources and other documents. After an in-depth literature review and desk study a questionnaire listing the various causes of cost overrun were distributed to reputed construction contractors, clients and consultants to get their professional opinion based on experience. Upon obtaining the desired data, checking and sorting of data were done. The data 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. An objective type survey design was used for this research. It was attempted to collect data from relevant population to rank the causes of cost overrun on the basis of importance. This survey-based research design has selected as it is useful in demonstrating the prevalence of the problem throughout the population. Once the distribution of the problem has determined and major causes 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.

3.5 Population and sample

The research samples were taken from stakeholders in the water and sanitation construction industry which are clients (project owners), contractors and consultants, that were selected depending on their direct exposure to water and sanitation construction activities. Project owners were selected from Addis Ababa water and sanitation project office. Consultants were selected based on their class categories and their lists were taken from water and sanitation project office The researcher identified clients, consultants and contractors as the target groups for the effective conduct of this research, sixty respondents comprising of twenty clients, twenty consultants and twenty contractors were be randomly selected using purposive sampling technique as a type of probability sampling in order to give everyone that falls into any of these identified target groups equal and independent chance of being included in the sample.

3.6 Data Source and data collection

There are two types of research data collection, namely: primary and secondary data collection. When the data is collected either through survey or through experiment, it is defined as primary data. If the researcher performs an experiment, one can observe a number of quantitative measurements or data that help to examine the truth contained in the hypothesis. But when a survey is undertaken, data can be collected through observation, personal interview, telephone interview, by mailing of questionnaires and other methods.

Secondary data can be collected by the user or someone other than the user. It is rapid and can be relatively inexpensive to collect if available through open source channels. It plays an important role in the literature survey assessment, helping to define the key issues. The secondary data was used in this research from water and sanitation construction project annual report. The primary data also used in this study and collected through a questionnaire survey. A questionnaire designed from extensive literature review of various causes of cost overrun in construction projects and from secondary data sources were distributed to the main office construction stakeholders (clients, contractors and consultants) that operate in and around water and sanitation construction project in Addis Ababa so as to identify the most important factors that cause cost overrun in construction projects in the area and come up with possible solutions/recommendations to the problem.

3.6.1 Pilot testing of the instruments

Conclusions made by researchers are based on the information obtained from the research instruments used. It is therefore important to ensure that the instruments are reliable and valid. This is achieved by conducting a pilot test of the instruments before the commencement of data collection for the full study in order to collect data that is used to test the validity and reliability of the research instruments.

Pilot study of the questionnaire was conducted in Oromia water work construction that is also similar to the study projects. Self-administered questionnaires were distributed to personnel heading the three project implementation teams (Clients, consultants and contractors) of the pilot study projects. To achieve a high questionnaire return rate, respondent's willingness to participate in the study was sought before administering the questionnaires.

3.6.2. Validity of Research Instruments

Mugenda and Mugenda (2003) define validity as the degree to which results obtained from the analysis of the data actually represent the phenomenon under study. To achieve this, both internal and external validity of research instruments has to be ensured. Internal validity refers to the instrument's ability to measure what is intended to be measured while content validity refers to the extent to which the questions provide adequate coverage of the subject matter. According to Mugenda and Mugenda (2003), determination of validity is primarily judgmental and intuitive. It can also be determined by using a panel of persons who shall judge how well the measuring instrument meets the standards, but there is no numerical way to express it.

Validity of this study was verified using experienced professionals in research who assessed and reviewed the suitability of the instrument in measuring the intended variables and its comprehensiveness in content using best and Kahn's two-step method of demonstrating evidence of validity. The method requires that, first the universe of content that could be included in the test be defined followed by ensuring that the test items are representative of the universe.

3.6.3 Reliability test result

Alpha reliability is regarded as a measure of internal consistency of the mean of the items at the time of administration of the questionnaire. Cornbrash's Alpha is a reliability coefficient that indicates how well the items in a set are positively related to one another (WWW.Wikipedia.com). It is computed in terms of the average inter correlations among the items measuring the concept.

Reliability is calculated in such a way that it represents the reliability of the mean of the items, not the reliability of any single item. So, the alpha reliability of 10 items would be higher than that of 5 similar items. This coefficient can hold a value of 0 to 1

The result of 0.7 and above implies an acceptable level of internal reliability. The result of reliability test for the questionnaire is shown in the following table. As it is indicated in the table, the test result is 0.89 and 0.94. Therefore, based on the test, the results for the items are reliable and acceptable.

Table 3.2: Reliability test result for the questionnaire

Item	Number of Item	Cornbrash's Alpha
Impact index	47	0.895
Frequency index	47	0.940

Source: own survey 2017

3.7. Data analysis

For each of the variables that cause cost overrun, respondents were requested to indicate the degree of impact (or severity) and frequency of occurrence. The degree of impact was categorized into five scales and the frequency of occurrence into four scales (Table 3.1). The responses given by each of the respondents was summarized and counted in their respective categories separately for client, consultant and contractor. Le-Hoai *et al*. (2008), Al-Khalil and Al Ghafly (1999), Assaf and Hejji, (2006), Apolot *et al* (2012) and Nafikote (2015) used Severity Index (SI), Frequency Index (FI) and Importance Index (II) data analysis methods to identify, to rank and to examine the importance in terms of degree of occurrence and level of severity for the root causes of delay and cost overruns in construction projects. The same method was adopted in this study to analyze and assess the research data collected. Data are analyzed using Equations 1 to 3 and other statistical methods. These equations are described as follows (Assaf and Hejji, 2006):

a) The Severity Index (SI) for each of the variables is computed with the formula:

$$1.\quad SI\% = \frac{\sum_{i=1}^{5} \text{Ai Ni}}{5\sum_{i=5}^{5} \text{Ni}}$$

Where A is the constant expressing the weighting given to each response, it ranges from 1 for none to 5 for very high; N is the frequency of the responses.

b) Similarly, the Frequency Index (FI) for each of the variables is computed with the formula:

$$2.\quad FI\% = \frac{\sum_{i=1}^{4} \text{Ai Ni}}{4\sum_{i=4}^{4} \text{Ni}}$$

Where B is the constant expressing the weighting given to each response, it ranges from 1 for never to 4 for high; N is the frequency of the responses.

c) Importance Index (II) for each of the variables is computed as a product of both severity and frequency indices. It is given by:

3. II (%) = (FI (%) * SI (%)/100%

3.8. Ethical Considerations

Ethical issues related to the study will be addressed by maintaining high level confidentiality of the information volunteered by the respondents and not using the information for other purposes other than drawing the conclusion of the study. The names of the respondents were not a requirement and if known to the researcher were not disclosed to protect their identities. All personal details were limited to general information. Permission was sought from the general manager to collect data from the respondents and a letter of introduction to respondents attached to each questionnaire.

3.9 Variables of Cost Overruns in Construction Projects

There is no consensus in the literature on the identification of factors which affect cost of a construction project, as each independent research views the subject from different perspectives. This may be the project type, size, location, type of contract, etc. The global nature of the construction cost overrun problems meant that most ideas from other researchers' findings would be relevant to water and sanitation construction projects in Addis Ababa. The purpose of this section is therefore to screen the factors identified from literature review that are relevant to the conditions of water and sanitation construction projects in Addis Ababa.

3.9. 1 Identification and classification of Relevant Variables

Out of the fifty four variables identified in the literature review, forty nigh is found to be relevant to this research. The forty nine variables that cause cost overrun have been classified into six groups (table 3.1). The grouping or classification of variables into groups is based on the source of cost overrun, i.e., those related to proposal phase, planning phase, negotiation phase, contractual phase, design phase, production phase.

Table (3.1) List of identified causes cost overruns in water and sanitation construction projects

Proposal phase	**Design phase**
Failure to understand customer requirements	Accepting customer requests without management approval,
Unrealistic appraisal of in-house capabilities	Problems in customer communications channels and data items
underestimating time requirements	Problems in design review meetings
Planning phase	*Late design and/ poor project Definition*
Omissions	*Incomplete design at the time of tender*
Inaccuracy of the work breakdown structure	*Design error and omissions leading to scope growth and /rework*
Misinterpretation of information	poor design/ delay in providing design
Use of wrong estimating techniques	*Frequent design changes*
Failure to identify and concentrate on major cost elements	**construction phase**
Failure to assess and provide for risks.	Excessive material costs
Lack of cost planning and monitoring of funds	Specifications that are not acceptable
Underestimation of cost of projects	manufacturing and engineering disagreement
Inappropriate government policies	Contractual claim (extension of time)
Inadequate cost estimating approach	Delay in costing variation
Poor planning and coordination	poor site supervision and management
Poor risk identification management	inefficient quality control
Negotiation phase	delay in progress payments
Procurement ceiling costs	cash flow problems
Negotiation team that must “win this one”	Resources constraint: funds and associated auxiliaries not ready
of bidding/tendering	Additional work at owner’s request
difficulties in financing the project	*Inflation of machinery, labor, raw material and Transportation prices*
problems in land acquisition	*Errors during construction*
long period between design and time	*Inadequate preconstruction study*
Contractual phase	*Poor project (site) management*
Contractual discrepancies SOW different from RFP requirements	*Poor project control(cost and schedule)*
Proposal team different from project team.	*Inexperienced management team*
Inadequate supply of raw materials and equipment by contractors	*Ineffective decision making process*
Inadequate supply of raw materials and equipment by contractors	*Imposed cash constraints and delay payment*
Unsupportive government policies	*Project financing in descending order*
Delays between design and procurement phases	*Change orders due to enhancement required by clients*
High cost of machineries	*Excess quantity during construction*
Lowest bidding procurement procedures	*Delay in construction*
Inappropriate contract policies	*Inexperienced management team*
Lack of coordination between the design team and the General contractor	Change in the scope of the project
poor Contractual claims, such as, extension of time with cost claims, etc. contract management	

Source: literature review

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter describes the results and discussion of questionnaire survey concerning cost overruns from contractors, consultants and owner viewpoints in AAWSA and focuses on describing the respondent's characteristics in addition to the discussion of the factors that influence cost overruns. The principal purpose of the survey is to rank the already identified variables of AAWSA projects cost overruns and then to find out the critical factors that are required to be given due attention in order to substantially minimize cost overrun problems in AAWSA projects.

4.2 Questionnaire Response Rate

Hand-to-hand delivery is preferred to improve the response rate and to encourage respondents Moreover, phone calls are frequently made to remind respondents to complete the questionnaire. A total of 60 questionnaire sets were aimed to be distribute to individuals; i.e., 20 professionals working for the client, 20 for consultants and 20 for contractors, however only 15 questionnaires could be distributed to the client due to extended holiday and Kaizen training.

Table 4.1 Questionnaire distribution and response

Description	Number distributed	Number of respondent	% of responses received	% of response from total
Client	20	13	65%	28%
Consultant	20	19	95%	40%
Contractor	20	15	75%	32%
Total	60	47	78%	100%

Source: own survey 2017

From the total of 60 questionnaires distributed, 47 responses are received (Table 3). These are 13 (28%) from the client, 19 (40%) from consultants and 15 (32%) from contractors. The overall response rate is 78% (Table 3). As compared with that of the contractors and consultants, the response rate from the clients (65%) seems to be on the lower side, most likely because of their busy schedule and training. However, the client's response rate for this survey is considered to be adequate for data analysis. According to Moser and Kalton (1993), in order for data to be acceptable for analysis, the response rate should be as much as possible above 40% and if the response rate is lower than 30%, the data fails to be representative and the result of the analysis are of little value for further interpretation.

4.2. Population characteristics

This part mainly designed to provide general information about the respondents in terms of the types of organization, experience of their organization, work experience and position in there organization.

4.3 General Characteristics of Respondents

The demographic characteristics of the respondents surveyed in this research that is their organization's experience in AAWSA projects, the types of organization and the position of the respondents within their organization are presented in below.

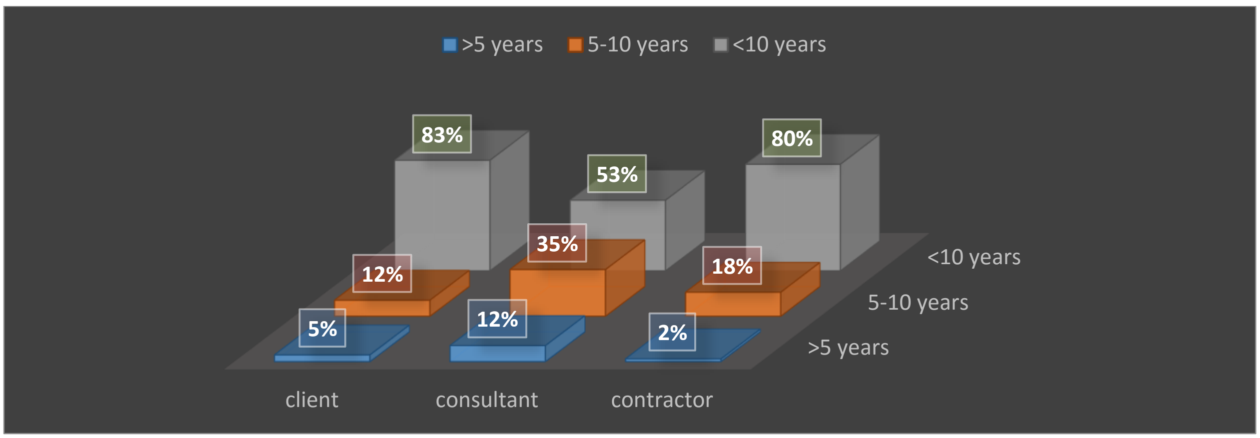


Figure 4.1. The range of experiences of the respondents' organization involved in this research survey

Source: own survey 2017

As shown in Figure 4 the percentage of respondents from the clients side work for organizations (companies) having the following experience: 5% of them work for organizations having less than 5 years' experience, 12% work for organizations having experience between 5 to10 years and 83 % work for organizations having more than10 years' experience. additionally , 12% of the respondents from the consultant's side work for firms that have less than five years' experience, 35% work for firms having between 5 to 10 years of experience and 53% work for firms having more than 10 years of experience. Likewise, 2%, 18% and 80% of respondents on the contractors' side work for companies having less than five years, between 5 and 10 years and more than 10 years of experience respectively.

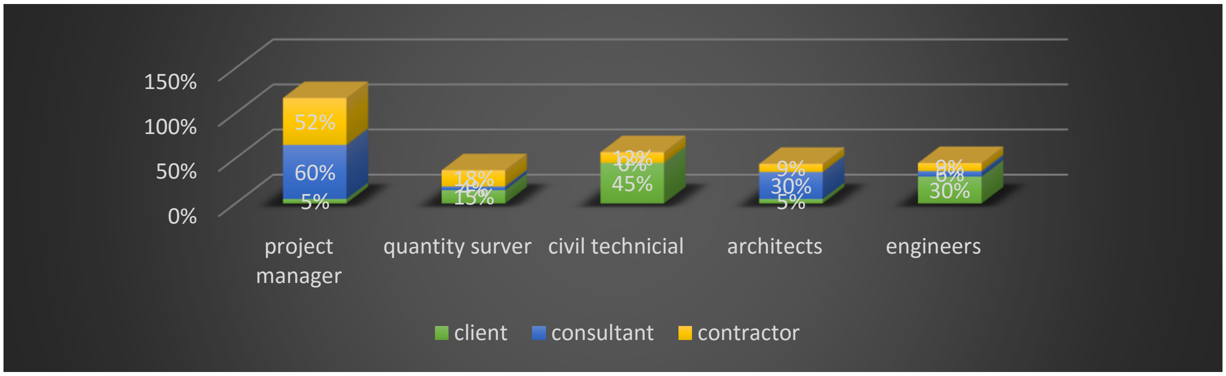


Figure 4.2 the qualification of respondent to the survey in each group

Source: own survey 2017

As shown in Figure 4.2 the predominant respondents representing clients are 45 % civil technician followed by 30 % structural engineers, quantity surveyor 15% supervisor, and 5% both project manager and Architects. Similarly the majority of respondents representing the consultants are project manager (60%) followed by Architects (30%), structural engineers (6%) quantity surveyor (4%) the least is civil technicians (0%). Likewise, (52%) of respondents on the contractors' side are project manager, followed by (18%) quantity surveyor and civil technical with (12%) and 9% both Architects and structural engineer. The preceding information explains the diversity of qualified professionals deployed in the construction industry and which in turn points out the fact that their perceptions can be relied up on.

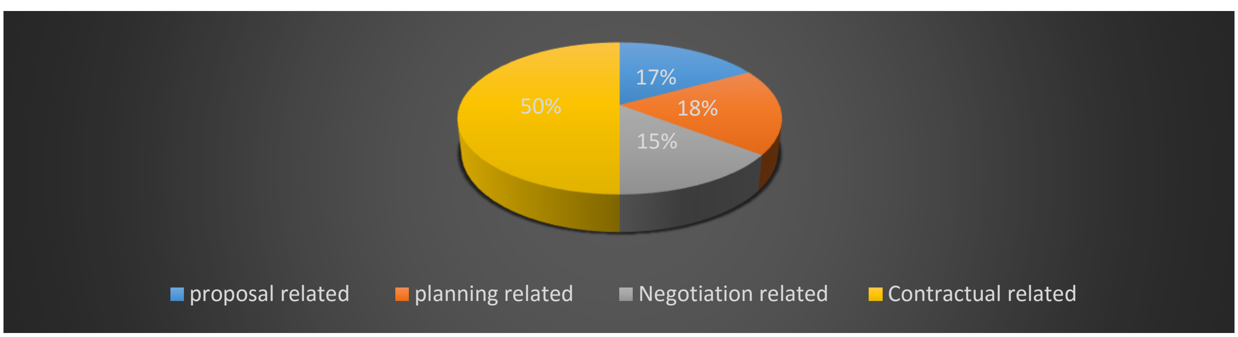


Figure 4.3: Total percentage distribution of respondents' qualifications in this survey

Source: own survey 2017

The percentage distribution of professions among the respondents are comparable as can be illustrated in Figure 4.3 , where 39% are project manager followed by civil technician (19%), both architects and have (15%) and The least percentage is recorded for quantity surveyor (12%)

4.4. Data Analysis Approach

For each of variables of cost overruns respondents are requested to indicate the degree of impact (or severity) and frequency of occurrence of these variables. The degree of impact is categorized into five scales and the frequency of occurrence into four scales. Before the start of the analysis, weightings have been assigned to each of the categories. For degree of impact the weightings assigned are 5 for very high, 4 for high, 3 for moderate, 2 for neutral, and 1 for none. Similarly, the weightings for frequency of occurrence are 4 for high, 3 for medium, 2 for low, and 1 for never. Then the responses given by each of the respondents are summarized and counted in their respective categories summaries of responses are reported in Appendix B.

4.5. Research Findings and Results

Analysis of the data is undertaken using SPSS and the statistical methods outlined in chapter three. The analysis illustrates the findings and results of the survey for the severity, frequency and importance indices of all the variables cost overruns; and also for the six major categories of causes of cost overrun.

4.6. Severity of the causes of cost overruns

Severity indices of all the variables of cost overruns are computed using equation (1) for both of the three parties' client, consultant and contractor and the results are presented in Table 4.2.

Table 4.2. The most severe causes of cost overrun identified in this research

Rank	Client	Consultant	Contractor
1	Delays between design and procurement phases	Excessive material costs	Poor project control(cost, schedule and quality)
2	Inadequate supply of raw materials and equipment by contractors	Delay in construction	Incomplete design at the time of tender
3	underestimating time requirements	Inadequate supply of raw materials and equipment by contractors	Delay in construction
4	Problems in land acquisition	Poor project control(cost, schedule and quality)	Late design and/ poor project Definition
5	Contractual claim (extension of time)	underestimating time requirements	underestimating time requirements
6	Poor project control(cost, schedule and quality)	Inadequate project preparation, planning and Implementation	Underestimation of cost of projects
7	Incomplete design at the time of tender	Poor risk identification management	Delays between design and procurement phases
8	Lowest bidding procurement procedures	Poor risk identification management	Poor planning and coordination
9	poor site supervision and management	Unanticipated site condition	Lowest bidding procurement procedures
10	Delay in construction	Inadequate preconstruction study	Design error and omissions

Source: own survey 2017

The analysis of severity of variables indicates that, with respect to client's opinion the top five most severe causes of cost overrun are:

- *Delays between design and procurement phases*
- *Inadequate supply of raw materials and equipment by contractors*
- *Underestimating time requirements*
- Problems in land acquisition
- Contractual claim (extension of time)

This shows that the top five severe causes of cost overrun are related to: contractual, negotiation and proposal phase related cost overrun problem

From the consultants’ viewpoint the top five severe causes of cost overruns are:

- Excessive material costs
- *Delay in construction*
- *Inadequate supply of raw materials and equipment by contractors*
- *Poor project control (cost, schedule and quality)*
- *Underestimating time requirements*

This indicates that the five most severe causes of cost overruns are related to construction and proposal phases of cost overrun problems it is also to be noted that two of these factors are similar to those asserted by the clients and contractors.

According to the contractors’ perspective the first five severe causes of cost overruns are:

- Excessive material costs
- Delay in construction
- Inadequate supply of raw materials and equipment by contractors
- Poor project control (cost, schedule and quality)
- Underestimating time requirements

These causes are related to proposal, construction and contractual phase. It is also found that one of the factors, which are “Underestimating time requirements” is commonly identified by the three parties as most severe cost overrun causes.

4.7 Frequency of cost overrun causes

Frequency indices are calculated using equation 2 and the significant frequent causes of cost overrun according to contractors, clients and consultants are shown in Table 4.3.

Table 4.3. The most frequent causes of cost overrun identified for the study area

Rank	Clint	Consultant	Contractor
1	Contractual claim (extension of time)	Underestimating time requirements	underestimating time requirements
2	Inflation	Poor project control(cost, schedule and quality)	Inflation
3	Delays between design and procurement phases	Delay in construction	delay in progress payments
4	problems in land acquisition	Contractual claim (extension of time)	Delays between design and procurement phases
5	underestimating time requirements	Inadequate preconstruction study	Inadequate supply of raw materials and equipment by contractors
6	Use of wrong estimating techniques	Lowest bidding procurement procedures	Delay in construction
7	Design error and omissions	Poor planning and coordination	Poor project control(cost, schedule and quality)
8	Lowest bidding procurement procedures	Inadequate project preparation, planning and implementation	difficulties in financing the project
9	Lack of coordination between the design team and the General contractor	Underestimation of cost of projects	Design error and omissions
10	poor contract management	Poor risk identification management	Contractual discrepancies SOW (statement of work) different from RFP(request for proposal) requirements

Source: own survey 2017

The results in Table 4.3. indicate that contractors are realizing that underestimating time requirements, inflation, delay in progress payments, Delays between design and procurement phases, Inadequate supply of raw materials and equipment by contractors, and Poor project control(cost, schedule and quality)are the highest frequent factors of cost overrun.

Inputs of the client indicate that the more frequent causes of cost overrun are allied to the planning, negotiation and contractual phases. Like Contractual claim (extension of time), Delays between design and procurement phases, problems in land acquisition, Underestimating time requirement, Use of wrong estimating techniques and inflation.

Unlike the contractors and clients, the consultants point out that the most important frequent cost overrun causes are related to proposal and construction phases. The results also indicate that underestimating time requirements, Poor project control(cost, schedule and quality), Delay in construction, Contractual claim (extension of time), Inadequate preconstruction study and Lowest bidding procurement procedures are the most frequent causes of cost overrun.

4.8. Importance Index of the causes of cost overruns

The importance index (II) is computed for each cause to point out the most significant causes. The Importance index is a product of severity and frequency indices and it is used to rank the variables for cost overrun using equation 3. The variables are ranked independently based on the II value of responses given by clients, consultants and contractors, and the results are shown in Appendix B. From the ranking assigned to each variable of cost overrun, it is possible to identify the most significant important causes of cost overrun in AAWSA projects (Table 4.4).

Table 4.4. The 20 Most Important Causes of cost overrun identified in the current research survey

Rank	Over all	Client	Contractor	consultant
1	Underestimating time requirements	**Delays between design and procurement phases**	underestimating time requirements	Contractual claim (extension of time)
2	Poor project control (cost, schedule and quality)	Underestimating time requirements	Poor project control (cost, schedule and quality)	Delay in construction
3	Contractual claim (extension of time)	Contractual claim (extension of time)	**Delays between design and procurement phases**	Underestimating time requirements
4	*Delay in construction*	Problems in land acquisition	Delay in construction	Poor project control (cost, schedule and quality)
5	*Inadequate supply of raw materials and equipment by contractors*	Inadequate supply of raw materials and equipment by contractors	Delay in progress payments	Inadequate preconstruction study
6	*Delays between design and procurement phases*	Poor project control (cost, schedule and quality)	Inadequate supply of raw materials and equipment by contractors	Inadequate project preparation, planning and Implementation
7	*Lowest bidding procurement procedures*	Lowest bidding procurement procedures	Difficulties in financing the project	Lowest bidding procurement procedures
8	*Inflation*	**Inflation**	Design error and omissions	**Inadequate supply of raw materials and equipment**
9	*Design error and omissions*	Delay in construction	**Inflation**	Procurement ceiling costs
10	*Inadequate preconstruction study*	**Design error and omissions**	Underestimation of cost of the projects	Underestimation of cost of projects
11	*Poor planning and coordination*	Lack of coordination between the design team and the General contractor	Contractual claim (extension of time)	Forcing a speedy compromise
12	*Unanticipated site condition*	**High cost of machineries**	**Inexperienced management team**	Excessive material costs
13	*Poor risk identification management*	Inadequate project preparation, planning and implementation	**High cost of machineries**	**Inaccuracy of the work breakdown structure**
14	Underestimation of cost of projects	**Incomplete design at the time of tender**	Lowest bidding procurement procedures	
15	Delay in progress payments	Unanticipated site condition	Unanticipated site condition	Late design and/ poor project Defini
16	Inadequate project preparation, planning and implementation	**Poor planning and coordination**	Poor risk identification management	**Incomplete design at the time of tender**
17	*High cost of machineries*	Proposal team different from project team.	Contractual discrepancies SOW different from RFP requirements	Poor site supervision and management
18	*Inexperienced management team*	**Inaccuracy of the work breakdown structure**	Inadequate preconstruction study	Design error and omissions
19	*Incomplete design*	**Change in the scope of the project**	**Poor planning and coordination**	Excess quantity during construction
20	Poor site supervision	**Inexperienced management team**	**Change in the scope of the project**	Inflation

Source: own survey 2017 **II = Importance Index**

Twenty most important causes of construction project cost overrun in AAWSA are selected from each set of rankings, and these are listed in Table 4.4. The results show that there are several important variables that explain the underlying causes of cost overrun. From these variables, the top five most important causes identified by the analysis of the survey, and based on overall results, are: *Underestimating time requirements, Poor project control (cost, schedule and quality), Contractual claim (extension of time), Delay in construction and Inadequate supply of raw materials and equipment by contractor.*

From client's point of view, the top most five important factors which are the main causes of cost overrun are: *Delays between design and procurement phases, Underestimating time requirements, Contractual claim (extension of time), Problems in land acquisition, inadequate supply of raw materials and equipment by contractors.*

The top five important causes of cost overrun as perceived by the consultants are the following:

- Contractual claim (extension of time)
- Delay in construction
- Underestimating time requirements
- Poor project control (cost, schedule and quality)
- Inadequate preconstruction study

The contractors' top five important causes of cost overrun are: *underestimating time requirements, Poor project control (cost, schedule and quality), Delays between design and procurement phases, Delay in construction and Delay in progress payments.*

With regard to cost overrun variables, 20 most important factors have been identified for each set of rankings. Out of these most important delay variables, seven are found to be common for all parties, *Underestimating time requirements, Contractual claim (extension of time), Inadequate supply of raw materials and equipment by contractors, Poor project control (cost, schedule and quality), Lowest bidding procurement procedures, Delay in construction and Design error and omissions* There are also many causes which are shared common between two parties, such as *Delays between design and procurement phases, Inflation, Design error and omissions, High cost of machineries* etc. which are highlighted in bold from Table 4.4.

4.8 Analysis of Major Categories of cost overrun Causes and Responsible parties

Identifying the responsible parties who are accountable for causing cost overrun in AAWSA projects is the most important information needed to take remedial measures for eliminating or minimizing cost overrun. Identification of responsible party is useful to recognize who is causing cost overruns so that the concerned parties will give more attention to avoid or to minimize the problem of cost overruns.

It is recalled that the causes of cost overrun have been categorized into six major groups depending on the source of cost overrun proposal related, planning related, negotiation related, contractual related, design related and construction related Kerzner H. (2009) The responsibility is assessed for each category of cost overrun among the major stakeholders that can be involved directly or indirectly in a AAWSA projects: from the client, consultant and contractor.

Client's contractual responsibilities could be generalized to responsibilities to providing finances, project site, design, approvals and as well as contract administrations. The contractors have the major responsibility for cost overrun causes in construction related cost overrun. The consultants play a very important role in design related cost overrun because they are in charge of the design procedure in conjunction with the owner of the project.

The ranking of major groups and the responsible parties have also been exercised based on the frequency, severity and importance indices of the variables under each of them. The indices of each group are determined by taking the average of the frequency, severity and importance indices of the variables under the group in question.

The following tables (Tables 4.5 to Table 4.7) show the severity, frequency, importance of indices and rankings of major categories of cost overrun and responsible parties for the cost overrun causes consistent with various parties. The responsibility of the cost overrun causes is illustrated in the responsibility column of Table 4.6 in conjunction with categories of cost overrun.

Table 4.5 FI and ranking of categories of cost overrun causes

	client		consultant		contractor		overall	
Categories sources	FI	Rank	FI	Rank	FI	Rank	FI	Rank
proposal related	0.67	5	0.72	3	0.72	4	0.70	4
planning related	0.73	1	0.74	2	0.72	3	0.73	3
Negotiation related	0.65	6	0.63	6	0.69	5	0.66	6
Contractual related	0.71	3	0.71	5	0.78	2	0.73	2
design related	0.68	4	0.71	4	0.67	6	0.69	5
construction related	0.71	2	0.77	1	0.84	1	0.78	1

Source: own survey 2017

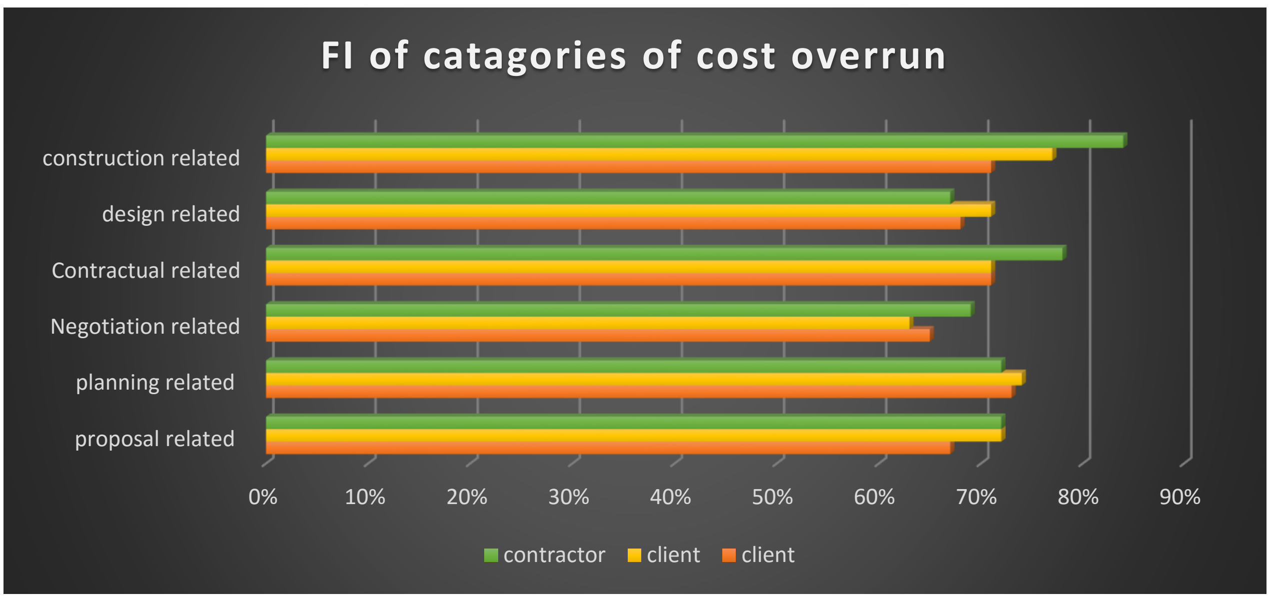


Figure 4.4 FI of categories of cost overrun causes

Source: own survey 2017

FI= frequency index

Table 4.6 SI and ranking of categories of cost overrun causes

Categories	client		consultant		contractor		overall	
	SI	Rank	SI	Rank	SI	Rank	SI	Rank
proposal related	0.66	4	0.59	6	0.69	5	0.64	5
planning related	0.67	3	0.71	2	0.74	3	0.70	2
Negotiation related	0.61	6	0.65	5	0.59	6	0.61	6
Contractual related	0.68	2	0.68	3	0.72	4	0.69	3
design related	0.62	5	0.67	4	0.75	2	0.68	4
construction related	0.73	1	0.76	1	0.83	1	0.77	1

Source: own survey 2017

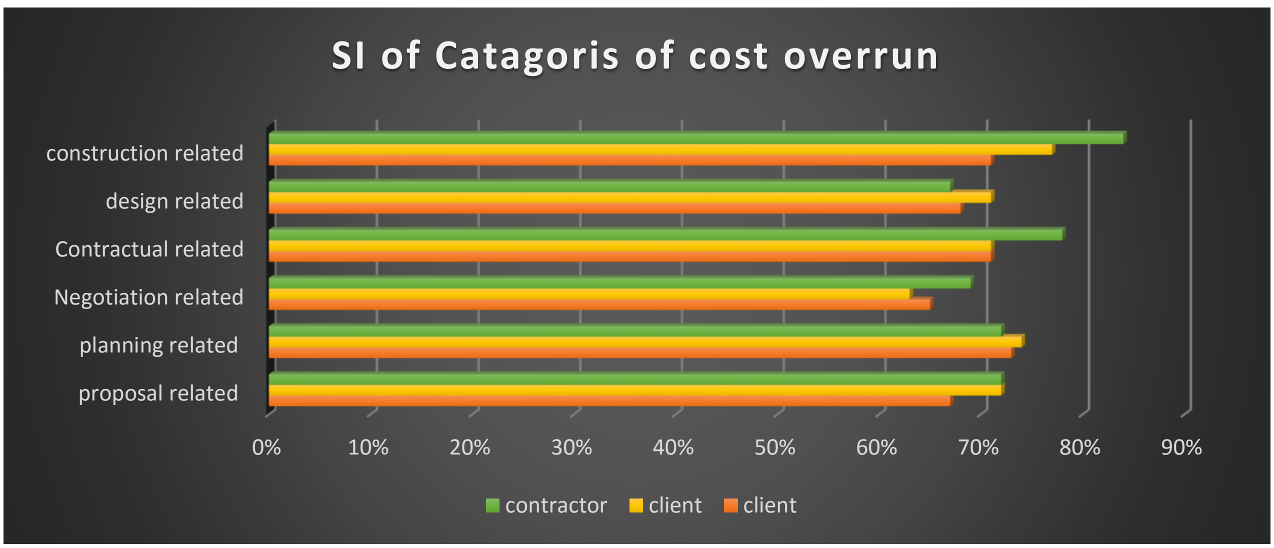


Figure 4.5 SI categories of cost overrun causes

Source: own survey 2017

SI= severity index

Table 4.7 II and ranking of categories of cost overrun causes

Categories	client		consultant		contractor		overall		responsible party
	FI	Rank	FI	Rank	FI	Rank	FI	Rank	
proposal related	0.46	3	0.44	5	0.52	4	0.47	4	client and consultant
planning related	0.45	4	0.53	2	0.54	3	0.51	3	client and consultant
Negotiation related	0.40	6	0.41	6	0.43	6	0.41	6	client
Contractual related	0.49	2	0.49	3	0.57	2	0.52	2	client
design related	0.43	5	0.48	4	0.51	5	0.47	5	client, consultant and contractor
construction related	0.52	1	0.59	1	0.71	1	0.61	1	client, consultant and contractor

Source: own survey 2017

II= important index

Table 4.7, Figure 4.4 and Figure 4.5 shows the summary of severity, frequency and importance indices of all categories of cost overrun causes in office building construction projects in AAWSA consistent with various responsible parties. As importance index is the product of frequency index and severity index, the corresponding ranking is made based on Pareto rule assumption that the highest ranked have the greatest influence.

As shown in Table 4.7, the result of construction related category of cost overrun indicates the greatest sources of cost overrun for the three respondents of the survey and is ranked first, both the client, consultant and contractor. This result is consistent with the outcome of the overall analysis as construction related category of cost overrun is highly ranked and is placed at the first position. Of the 13 factors, *“poor project control (cost, schedule and quality)", contractual claim (extension of time) and "delay in construction"* are the major factors causing cost overrun during the construction process. During the execution, specific equipment and labor skills are required to complete construction activities. Project manager need to consider the characteristics of the project such as the site layout, skills of personnel, the possibility of using certain equipment, time variable and the degree of project complexity. This result shows that the three parties (contractors, consultants and owners) in AAWSA are unfamiliar to the work execution procedures.

The results of Table 4.7 show that contractual related and planning related sources of cost overruns are highly ranked by the contractor, consultant and client respondents in the second and third position respectively. among the 12 contractual related cost overrun factors *inadequate supply of raw material and equipment by the contractors and delay between design and procurement phases* are the most important factor for cost overrun causes identified by the respondent both the contractor, consultant and client. And also *poor planning and coordination, poor risk identification management, and inadequate project preparation, planning and implementation* are the most important causes of cost overrun in planning related phases.

Overall cost overrun sources in AAWSA projects are caused by various factors, some of which are within the consultant's responsibilities, some are owner's responsibilities and some are within the contractor's responsibilities. Cost overrun in AAWSA projects can be reduced through the joint efforts of the participants of the projects i.e. clients, contractors and consultants. It is also the responsibility of Government to create stable economy, to co-operate necessary facilities and to renew or develop infrastructure to control cost overruns.

Based on overall results, Negotiation related categories of cost overrun have less important causes identified by the survey. The results show good agreement between the respondents of project parties in ranking of sources of cost overrun.

Summary of combined frequency index, severity index, importance index, rank for the categories (sources) of cost overrun and responsible parties by all respondents of the survey in AAWSA projects are shown in Table 4.7. From the analysis of the results, it is found that the most frequent, severe and important source of delay is construction related as it has the first rank among all categories of cost overrun and scores a similar rank for all indices. Similarly contractual related cost overrun has been ranked in the second position and has got a similar score. For these sources of cost overrun, project owners (clients), contractors, consultants are found to be responsible. Negotiation related category of cost overrun is the least frequent, severe and important source of cost overrun and has been ranked in 6th position.

Table 4.8: Overall ranking of sources (categories) of cost overrun by all parties (combined)

Categories	FI	Rank	SI	Rank	II	Rank
proposal related	0.703014	4	0.645	5	0.472	4
planning related	0.730787	3	0.705	2	0.505	3
Negotiation related	0.658157	6	0.613	6	0.414	6
Contractual related	0.731703	2	0.693	3	0.516	2
design related	0.687075	5	0.679	4	0.471	5
construction related	0.777056	1	0.775	1	0.607	1

Source: own survey 2017

4.9. DISCUSSION

This part focuses on discussion of results obtained in data analysis and answer how cost overruns could be substantially minimized in AAWSA projects. The critical factors have already been identified and it is deemed that mitigating these factors would substantially minimize the problems of cost overruns in AAWSA projects. Accordingly, and the results of the data analyses are discussed, interpretations and mitigating solutions are provided under the respective categories of cost overrun causes.

4.9.1 Proposal related causes of cost overrun

The major category "Proposal related cost overrun causes" includes causes 1-3 of Table 3.1. Out of the tree variables underestimating time requirements is the only one identified important variable by both the contractor, client and consultant in the 20 most important cost overrun causes. This shows that underestimation of time requirement is highly influence the cost of AAWSA Projects. And leads to conflict between the contractor and consultant. Due to this factor the project manager cannot provide the deliverables on time to the need of the project owner. This result is line with the results of Kerziner (2002) agreement show that underestimation at time requirements affect the world wide project of cost overrun.

4.9.2 Planning related causes of cost overrun

The major category "Planning related cost overrun causes" includes causes 4 -12 of Table 3.1 out of the nine variables poor planning and coordination were the first position with importable Index (I.I 63%) this indicates that the high important of planning and coordination in order to minimize cost overrun poor planning and coordination affect the project works and leads to rework, conflict and may failure to the projects which leads to cost overrun. This result is consistent with the results of Fetene (2008) and Zinabu and Getachew (2015) the suitable description of this agreement is that poor planning and coordination are not affected by project to project any problems related to poor planning and coordination can lead to project cost overrun.

The second important factor related to planning is " poor risk identification Management" II =62% this is strong indication that poor risk identification and management will lead to cost overrun sometimes the risk of the project will terminate the work of the project or Break works for long period of time which in turn create frustration in the next project phases. This result is not consistent with Abubekir (2015). This may traced to the work of AAWSA project complexity different from Ethiopia Road Authority.

“Underestimation of costs of Projects” is the third important factors related to this phase. I.I = 61% the reason of cost over run is one of the clearest factors that causes cost overrun in AAWSA Project underestimation of Project costs can lead to inadequate resource and time and the project team may start off the project this result coincides with results of Emmanues et al (2017) this may linked to underestimation of cost of projects is the futures of developing country.

4.9.3 Negotiation phase related cost overrun

Table 4.8 shows that negotiation phases are ranked the last factors of causes of cost overrun. It does not include the 20 most important factors in table 4.4 but “problem in land acquisition” is ranked the fourth most important factors identified by the client in Appendix B. This shows that land acquisition is the most important factor of causes of cost overrun related to client and the client take the responsibility. This may be lead to conflict between the client and society around the projects. The result of Fetene (2008), Abubekir (2015) and Zinabu and Getachew (2015) did not coincide with this finding problems in land acquisition is one of the important factor of causes of cost overrun but this is the case in AAWSA Project, where “Problems in land acquisition” is frequently accurse due to the sever political situation and constrains Subramani et al (2014) agree with the result obtained in this research that problems in land acquisition cause cost overrun.

4.9.4 Contractual Related Cost Overrun

Table 4.4 shows that the “inadequate supply of raw material and equipment by the contractors”. As the first factor to cause of cost overrun in this category. There are many possible reasons for inadequate supply of raw material and equipment by the contractor some of the possible reasons are lack of cash at hand, different project site at one time, shortage of foreign currency and one supplier of raw material and equipment this result is similar to Marris (1990) and Abubekir (2015). Inadequate supply of raw material and equipment by the contractor is the problem of cost overrun in the world wide project even different researcher find the same result but the stakeholders could not save this problem.

The second important factor related to contractual cost overrun was “delay between design and procurement phase” (I.I = 68%). This is a strong indication that any delay between design and procurement phase will cause cost overrun. This result shows that the delay design leads to increase the cost of material, rent of machinery cost and also delay of projects. Because of late procurement phase. This result coincide with the results of Roya and Jose (2014) causes of cost overrun in developing country. The third important factor ranked by consultant, contractor and client was high costs of machinery (I.I = 59%) due to different reasons the cost of machinery increase time to time and leads to high cost overrun of projects. This result is similar to Roya Jose (2015) this shows that high cost of Machinery is the problems of developing country. The last important factors related to contractual causes of cost overrun was lowest bidding procedures (I.I =65%) highly ranked by the client this shows that there is dispute between the respondent.

4.9.5 Design related causes of cost overrun

Table 4.4 Shows that according to respondent “design error and omissions” is the most critical factors in increasing the final costs of the project. This factor is one of the clearest factors that lead to cost overrun through the design change and error due to unskilled manpower, poor planning, project complexity and unforeseen condition which changing the cost estimated in the bill of quantity or estimation cost documents of the project. The results of Fetene (2008), Abubekir (2015) and Zinabu and Getachew (2015) did not coincide with this finding that design error and omission is one of the important factors cause cost overrun.

The research where conducted the place where design error and omissions is not present as road construction project in Addis Ababa, Public Building project in Ethiopia and construction projects in Ethiopia. But this is not the case in AAWSA projects. Where design error and omissions is frequently occurs due to different reasons.

4.9.6 Cost Overrun related to construction phase

Table 4.4 shows that “ poor project control” is the most important factors of cost overrun in AAWSA projects identified by the respondent according to Mostafa (2016) project control has a direct correlation to project progress and stakeholder’s expectation. Projects rarely fail because of the one issue Rather, failure is usually a collection of minor items that individual have negative impact in a specific project area, However, when looked at over the life span of a project this minor item can cause significant impact to cost, Schedule, risk and themselves as deviations from the original project plan. This shows that poor project control (cost, schedule and quality) is critical factor for cost overrun. This result consider with Fetene (2008), Abubekir (2015) and Zinabu and Getachew (2015) Mostafa Et al (2016) and other researches that “poor project control” is one major critical factor at cost overrun.

“Delay in construction” was ranked as the second major factor to cause cost overrun in this group. Therefore each day of construction delay cost the contractor additional losses such as overhead, costs of sub-contractors and penalty. The delay of construction works lead to time lost, hence the cost increase. In case of delay the cost of construction may increase than the cost overrun may occur. This result considers with Abubekir (2015) that the "delay in Construction" is one of major factors of cost overrun. Respondents on the questioner believed that the third important factor in this category was "Inflation" with (II = 64%) the majority of the cost overrun related with construction projects are the consequences of financial inflation that increase the price of material, equipment and labor wage between the time when the original prediction was made in Appraisal phase and the time the project was finally constructed.

The fourth major factor in this category is "Inexperienced management team" that cause cost overrun in AAWSA projects based on the opinion of the respondents. This outcome make clear that the experience of management team in construction project will lot the project team to construct work more cost effective and within budget due to the same reason, It is understandable that the failure of any activity caused by in experienced management team leads to high cost overrun in the project any un successful activities makes the constructor to rework and accordingly increase in the cost of project.

"Poor site supervision and management" has been selected 5th factors that influence the causes of cost overrun in this category. As a result of poor site management and supervision construction errors, delay in buying material for the project in time, improper consideration of the project team, contractors and consultant and inappropriate timing for the beginning and finishing the activities. During construction increase the cost of the project dramatically that leads to cost overrun. The result of Ramabodu and Verster (2010), Feten (2008), Abubakir (2015) and Zinabu and Getachew (2015) did not related with this finding that poor site supervision and management is one of the important factors causes cost overrun. This shows that projects have unique characteristics.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter presents conclusion and recommendation made based on the analysis and findings of the study. Identification of causes of cost overrun is a prerequisite to minimize or to avoid cost overrun in the construction industry. The main objective of this research is, therefore, to identify the critical causes of cost overrun on AAWSA projects. Questionnaire survey was used to identify the causes of cost overrun. Clients, consultants and contractors were asked to identify the variables of cost overrun in the AAWSA project. Frequency of occurrence of the variables of cost overrun, and their impacts on the final cost of the project were also asked. The data gathered from the survey are analyzed using SPSS, severity index, frequency index and important index. The analysis of the results from the open-ended part of the questionnaire was carried out using descriptive analysis.

There are many causes cost overruns in construction projects and several studies have pointed out various factors based on the underlying conditions that their specific study is concerned with. Therefore, this research attempts to investigate the problems particularly for AAWSA projects in Addis Ababa.

The research has been undertaken by reviewing literature, which was used to identify the possible variables causing cost overruns in construction projects as a whole. Then the variables have been scrutinized in line with the water and sanitation construction projects. Fifty four variables for cost overruns have been identified. The variables for cost overruns have been categorized in six major groups based on the sources of cost overruns. These variables are then used to design a questionnaire, which is designed to consist of two major sections. It basically aims to acquire data on the general background information of the respondents and their organization; degree of impact and frequency of occurrence of the identified variables/factors.

After distributing the questionnaire for professionals who have experience in AAWSA projects in Addis Ababa area, sufficient responses are collected. With a response rate of more than 78%, which is well above the minimum required for conducting the analysis. The data has been classified into three groups according to the type of respondents: client, contractor and consultant. From the data retrieved in each group, severity, frequency and importance indices are calculated. Based on the respective importance indices.

With regard to cost overrun variables the 20 most important factors have been identified for each set of ranks. The most important causes identified by the survey, and based on overall results, are: under estimating time requirement, poor project control (cost, quality, and schedule) delay in construction, inadequate supply of raw material by the contractor and delay between design and procurement phase.

Furthermore, the categories of causes of cost overrun with respect to responsible parties are analyzed based on the overall results. The categories of indices of each group are determined by taking the average of the frequency, severity and important indices of the variables under the group in question. The results of the construction categories show the greatest source in project cost overrun as it is highly ranked by all parties.

5.2 Conclusion

The overall result shows that most important of the causes of cost overrun in AAWSA projects in Addis Ababa originate from poor project management (cost, schedule and quality) and poor resources management (technical, human, and materials). In order to minimize these causes, owners should have an available fund for project and pay in time to the contractors according to the agreement. On the other hand, contractors should have strong backing from financial institution and be financially sound. The cost of individual construction projects needs to be accurately estimated and any potential project risks that can lead to cost and time overruns are to be adequately identified and managed accordingly. Moreover, human resources should have good training in managerial and technical aspects of the projects. These programs can update participants to have good practice in planning coordinating, controlling and monitoring of resources in scheduled time and budget. Finally, recommendations are made to substantially minimize the impacts of these critical factors causing cost overruns. The outcome of the analysis indicates that all of the parties are deeply involved in causing the problems due to the overlapping nature of construction events and it is difficult to distinguish what proportion of the overall cost overrun source is which party's responsibility. Blaming each other on who causes cost overrun is not very helpful and a lot of work is expected to be done by each of the parties in order to minimize the problems of cost overruns in AAWSA.

5.3. Recommendations

The problems of cost overrun are badly affecting the AAWSA projects. All stakeholders (clients, contractors and consultants) should work together to achieve successful projects within the stipulated time and budget, and exceed the anticipated quality standard. Especially competent project team and construction managers' should pay close attention to planning and preventive action to keep the construction project on budget and schedule, and play an important role in preventing projects from extra cost. Therefore, implementing quality management system through skilled, competent and trustworthy project managers is vital, since project managers are the individuals who are engaged in the overall planning, coordination, monitor of risks and control of a project from beginning to completion. In order to minimize the incidences cost overrun in AAWSA projects. The following recommendations are proposed to address completion budget of water projects in AAWSA.

The following recommendations are expected from consultant

- Continuous coordination and direct communication, which will eliminate design discrepancies and errors as well as omissions in design and also provide an opportunity for professionals to review the contract documents thoroughly. This would help in minimizing variations orders resulting from the discrepancy in contract documents
- Adopt efficient information retrieval and distribution systems to guard against communication gaps; respond as quickly as possible to contractor and client questions and requests for clarification to avoid associated delays and confusions which consequentially will lead to cost overrun hence affect implementation process.
- Implement the necessary measures to reduce construction cost, since construction cost has a direct bearing on the smooth project implementation based on the findings earlier stated.

The following recommendations are expected from clients.

- Fulfill contractual obligations, especially as regards to payment of contractor's works duly executed, or settlement of fees accounts of consultants and possession of construction site. Clients should ensure that adequate funds are available before projects are started, so that contractors can be paid in accordance with the contract agreement. This will reduce cost overrun.
- Select suitable contractors not only on the basis of price and time offerings, but also on experience, financial standing, capacity and expertise. Experience contractors tend to have learnt from the past projects and having such contractors will help to reduce cost overrun

The following recommendations are expected from contractor

- Procure construction materials and other items in collaboration with the client ahead of time. This will ensure short lead time required between different replenishing phases of the construction materials
- Ensure that he employs competent Personnel to ensure the interpretation of drawings is done correctly. This helps in minimizing time wastage and double handling of other related resources. Poor workmanship can result into demolition hence wasting of resources.
- Ensure efficient time management through proper resource planning, duration estimation, and schedule development and control; to avoid cost overrun.

Further studies are recommended to be undertaken in other areas of Ethiopia on various water and sanitation projects in order to come up with a nationwide mechanism for minimizing cost overrun in the general construction industry.

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APPENDIX A

Questionnaire

Dear participant,

I am currently working on a research study on Cost Overruns in Water and sanitation Construction Projects in Addis Ababa. Study in project management at Addis Ababa university school of commerce. This research is aimed to investigate the problem why Water and sanitation construction projects within Addis Ababa are require additional budget than agreed contract prices. Identifying the factors/variables that contribute to cost overruns in water construction projects in Addis Ababa and rank them in their order of severity have paramount importance to conduct analysis and subsequent recommendation of the possible solutions towards minimizing the problem.

To successfully undertake this research it is mandatory to look into the issues from different perspectives by involving professionals who have experience in the Water and sanitation construction sector within Addis Ababa. In this respect, you are the one who can give the correct and necessary information. Hence, I kindly request you to complete the accompanying questionnaire.

I would like to confirm you that your response will be kept strictly confidential and it will be used exclusively for the purpose of this research. Besides, your quick response is vitally important in order to finalize the research timely and I would appreciate if you return the completed questionnaire within ***one weeks*** of your receipt of same.

Thank you very much for your time and cooperation, and looking forward to receiving your response.

Yours Sincerely,

Daniel Bekele Dibaba

Addis Ababa university school of commerce

Department of project Management

Questionnaire Section 1: General Background Information

The questions below are related to your organization and yourself. **Please indicate your response by marking (X)** the appropriate boxes, and filling the blank spaces provided as appropriate.

1. Type of organization:

1. Client ----------   2. Contractor -------   3. Consultant----------

2. Years of your organization involved in construction

1. < 5 years ----------   2. 5 – 10 years---------   3. > 10 years---------

3. Your work experience in water and sanitation construction project related projects

1. < 5 years ----------   2. 5 – 10 years---------   3. > 10 years--------

4. Position in your organization: …………………………………………

5. Educational back ground ……………………………………………...

Section 2: Assessment of Degree of Impact and Frequency of Occurrence Please indicate your response by marking (√)

No.	**2. Factors Causing Cost overrun**	**Degree of Impact**					**Frequency**			
		Very high	**High**	**Moderate**	**Neutral**	**None**	**High**	**Medium**	**Low**	**Never**
	2.1 **proposal related cost overrun cause**									
1	Failure to understand customer requirements									
2	Unrealistic appraisal of in-house capabilities									
3	underestimating time requirements									
	2.2. planning related cost overrun cause									
4	Inaccuracy of the work breakdown structure									
5	Misinterpretation of information									
6	Use of wrong estimating techniques									
7	Inadequate project preparation, planning and Implementation									
8	Underestimation of cost of projects									
9	*Inappropriate government policies*									
10	*Inadequate cost estimating approach*									
11	*Poor planning and coordination*									
12	*Poor risk identification management*									
	3.Negotiation phase causes of cost overrun									
13	Forcing a speedy compromise									
14	Procurement ceiling costs									
15	Negotiation team that must “win this one”									
16	off bidding/tendering									
17	difficulties in financing the project									
18	problems in land acquisition									
	4.Contractual phase causes of cost overrun									
29	Contractual discrepancies SOW (statement of work) different from RFP(request for proposal) requirements									
20	Proposal team different from project team.									
21	*Inadequate supply of raw materials and equipment*									
22	*Weak /ambiguous contract term*									
23	*Unsupportive government policies*									
24	*Delays between design and procurement phases*									
25	*High cost of machineries*									
26	*Lowest bidding procurement procedures*									

No.	2. Factors Causing Cost overrun	Degree of Impact					Frequency			
		Very	High	Moder	Neutr al	None	High	Mediu m	Low	Never
	4.Contractual phase causes of cost overrun									
27	*Inappropriate contract policies*									
28	*Lack of coordination between the design team and the General contractor*									
29	poor contract management									
30	Clients late contract award									
	5.design phases of cost overrun									
31	Accepting customer requests without management approval									
32	Problems in customer communications channels									
33	Problems in design review meetings									
34	*Late design and/ poor project Definition*									
35	*Incomplete design at the time of tender*									
36	*Design error and omissions*									
	6. construction phases cost overrun									
37	Excessive material costs									
38	Contractual claim (extension of time)									
39	poor site supervision and management									
40	delay in progress payments									
41	*Inflation*									
42	*Inadequate preconstruction study*									
43	*Poor project control(cost, schedule and quality)*									
44	*Inexperienced management team*									
45	*Excess quantity during construction*									
46	*Delay in construction*									
47	*Unanticipated site condition*									
48	Change in the scope of the project									
49	Specifications that are not acceptable									
	Additional factors if any									

Appendix B

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables –consultant

No	Degree of impact: Very High	High	Moderate	Neutral	None	Total response	Severity index %	Rank	frequency of occurrence: high	medium	low	Never	total response	frequency index	rank	importance of index	Rank
	5	4	3	2	1				4	3	2	1					
	proposal related cost overrun								**proposal related cost overrun**								
1	0	4	8	2	5	19	0.52	46	0	10	9	0	19	0.63	41	0.33	46
2	0	1	4	13	1	19	0.45	49	0	11	8	0	19	0.64	40	0.29	48
3	4	12	2	1	0	19	0.80	5	10	9	0	0	19	0.88	1	0.71	3
	Planning related cost overrun								**Planning related cost overrun**								
4	3	8	8	0	0	19	0.75	18	8	6	5	0	19	0.79	10	0.59	13
5	0	5	8	6	0	19	0.59	40	5	4	4	6	19	0.61	43	0.36	41
6	2	9	3	3	2	19	0.66	34	8	4	2	5	19	0.70	32	0.46	34
7	6	6	7	0	0	19	0.79	6	8	7	4	0	19	0.80	8	0.63	6
8	5	6	8	0	0	19	0.77	10	7	9	3	0	19	0.80	8	0.62	10
9	0	4	8	7	0	19	0.57	42	7	1	4	7	19	0.61	43	0.34	44
10	5	4	8	1	1	19	0.72	28	7	5	4	3	19	0.71	30	0.51	29
11	4	7	7	1	0	19	0.75	18	9	6	4	0	19	0.82	6	0.61	11
12	3	12	4	0	0	19	0.79	6	8	7	3	1	19	0.79	10	0.62	9
	Negotiation Phase								**Negotiation Phase**								
13	4	5	9	1	0	19	0.73	23	2	8	9	0	19	0.66	39	0.48	31
14	0	5	6	8	0	19	0.57	42	1	9	7	2	19	0.62	42	0.35	42
15	3	5	6	5	0	19	0.66	34	4	7	7	1	19	0.68	33	0.45	35
16	2	3	9	5	0	19	0.62	37	2	4	11	2	19	0.58	45	0.36	40
17	0	8	6	2	3	19	0.60	38	4	3	6	6	19	0.57	47	0.34	45
18	4	5	6	4	0	19	0.69	31	3	9	5	2	19	0.67	36	0.47	33
	Contractual phase								**Contractual phase**								
19	3	7	6	3	0	19	0.71	30	3	7	9	0	19	0.67	36	0.47	32
20	2	9	4	4	0	19	0.69	31	6	6	7	0	19	0.74	21	0.51	28

21	6	10	2	1	0	19	0.82	3	9	3	6	1	19	0.76	14	0.63	8
22	2	8	7	1	1	19	0.69	31	7	6	5	1	19	0.75	20	0.52	27
23	0	8	4	5	2	19	0.59	40	1	6	7	5	19	0.54	49	0.32	47
24	2	8	9	0	0	19	0.73	23	4	11	3	1	19	0.74	21	0.54	24
25	4	8	3	4	0	19	0.73	23	6	5	8	0	19	0.72	26	0.53	26
26	4	8	7	0	0	19	0.77	10	8	8	3	0	19	0.82	6	0.63	7
27	1	1	10	4	3	19	0.53	45	1	6	8	4	19	0.55	48	0.29	49
28	3	7	7	2	0	19	0.72	28	3	9	6	1	19	0.68	33	0.49	30
29	0	2	11	1	5	19	0.51	48	4	9	6	0	19	0.72	26	0.37	39
30	3	8	6	2	0	19	0.73	23	4	12	3	0	19	0.76	14	0.55	21
	Design phase								**Design phase**								
31	1	4	9	4	1	19	0.6	38	3	3	10	3	19	0.58	45	0.35	43
32	0	8	8	3	0	19	0.65	36	3	7	9	0	19	0.67	36	0.44	36
33	0	0	11	8	0	19	0.52	46	4	9	6	0	19	0.72	26	0.37	38
34	3	8	8	0	0	19	0.75	18	5	11	3	0	19	0.78	12	0.58	15
35	6	5	6	2	0	19	0.76	14	7	6	6	0	19	0.76	14	0.58	16
36	4	7	6	2	0	19	0.74	21	9	2	8	0	19	0.76	14	0.56	18
	Construction phase								**Construction phase**								
37	4	11	1	3	0	19	0.77	10	8	5	6	0	19	0.78	12	0.60	12
38	6	13	0	0	0	19	0.86	1	10	7	2	0	19	0.86	3	0.74	1
39	3	9	7	0	0	19	0.76	14	5	10	4	0	19	0.76	14	0.58	16
40	3	10	5	1	0	19	0.76	14	5	8	5	1	19	0.72	26	0.55	22
41	4	9	4	2	0	19	0.76	14	6	6	7	0	19	0.74	21	0.56	20
42	4	10	5	0	0	19	0.79	6	8	10	1	0	19	0.84	5	0.66	5
43	4	12	3	0	0	19	0.81	4	10	8	1	0	19	0.87	2	0.70	4
44	4	6	7	2	0	19	0.73	23	5	8	6	0	19	0.74	21	0.54	24
45	4	8	4	3	0	19	0.74	21	9	2	8	0	19	0.76	14	0.56	18
46	6	11	2	0	0	19	0.84	2	11	5	3	0	19	0.86	3	0.72	2
47	2	14	3	0	0	19	0.79	6	7	4	8	0	19	0.74	21	0.58	14
48	4	9	5	1	0	19	0.77	10	5	6	8	0	19	0.71	30	0.55	23
49	0	8	3	5	3	19	0.57	42	5	6	6	2	19	0.68	33	0.39	37

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Client

No	Degree of impact: Very High	High	Moderate	Neutral	None	Total response	Severity index %	Rank	frequency of occurrence: high	medium	low	never	total response	frequency index	rank	importance of index	Rank
	5	4	3	2	1				4	3	2	1					
	proposal related cost overrun								**proposal related cost overrun**								
1	0	4	3	3	3	13	0.52	45	1	7	3	2	13	0.63	36	0.33	42
2	1	4	5	1	2	13	0.62	39	0	4	7	2	13	0.54	45	0.33	43
3	7	1	5	0	0	13	0.83	2	7	4	2	0	13	0.85	5	0.70	2
	Planning related cost overrun								**Planning related cost overrun**								
4	2	4	4	3	0	13	0.68	28	4	7	0	2	13	0.75	15	0.5077	18
5	2	2	6	2	1	13	0.63	34	0	8	4	1	13	0.63	36	0.40	35
6	0	4	5	2	2	13	0.57	41	1	8	3	1	13	0.67	24	0.38	36
7	3	5	3	2	0	13	0.74	14	4	6	2	1	13	0.75	15	0.55	12
8	2	3	6	1	1	13	0.66	30	2	4	7	0	13	0.65	28	0.43	31
9	2	4	1	3	3	13	0.58	40	0	2	8	3	13	0.48	48	0.28	46
10	3	2	6	2	0	13	0.69	23	1	7	3	2	13	0.63	36	0.44	28
11	4	3	5	1	0	13	0.75	11	2	8	2	1	13	0.71	18	0.54	15
12	2	4	6	1	0	13	0.71	19	2	6	4	1	13	0.67	24	0.48	25
	Negotiation Phase								**Negotiation Phase**								
13	1	2	10	0	0	13	0.66	30	1	6	6	0	13	0.65	28	0.43	31
14	2	1	4	4	2	13	0.55	43	2	4	5	2	13	0.62	39	0.34	41
15	1	7	2	3	0	13	0.69	23	0	5	5	3	13	0.54	45	0.37	38
16	1	1	6	3	2	13	0.54	44	5	2	3	3	13	0.67	24	0.36	40
17	0	0	5	2	6	13	0.38	48	1	6	1	5	13	0.56	44	0.21	48
18	4	5	4	0	0	13	0.80	4	9	2	1	1	13	0.87	2	0.69	4
	Contractual phase								**Contractual phase**								
19	1	2	8	2	0	13	0.63	34	2	7	3	1	13	0.69	21	0.44	29
20	3	3	5	1	1	13	0.69	23	6	3	3	1	13	0.77	10	0.53	17

21	6	4	2	1	0	13	0.83	2	6	5	0	2	13	0.79	7	0.66	5
22	3	4	3	3	0	13	0.71	19	0	5	4	4	13	0.52	47	0.37	39
23	0	2	2	3	6	13	0.40	47	0	1	6	6	13	0.40	49	0.16	49
24	5	6	2	0	0	13	0.85	1	8	3	2	0	13	0.87	2	0.73	1
25	1	8	3	1	0	13	0.74	14	5	4	3	1	13	0.75	15	0.55	12
26	4	4	4	1	0	13	0.77	8	5	6	1	1	13	0.79	7	0.61	7
27	0	3	5	0	5	13	0.49	46	0	7	4	2	13	0.60	41	0.29	45
28	3	2	8	0	0	13	0.72	17	3	8	2	0	13	0.77	10	0.56	11
29	0	6	4	2	1	13	0.63	34	3	9	0	1	13	0.77	10	0.49	23
30	0	3	10	0	0	13	0.65	32	4	6	3	0	13	0.77	10	0.50	22
	Design phase								**Design phase**								
31	1	3	4	3	2	13	0.57	41	1	5	4	3	13	0.58	43	0.33	44
32	0	4	8	0	1	13	0.63	34	2	6	5	0	13	0.69	21	0.44	29
33	0	0	6	0	7	13	0.38	48	0	8	5	0	13	0.65	28	0.25	47
34	1	1	11	0	0	13	0.65	32	1	7	4	1	13	0.65	28	0.42	33
35	2	8	3	0	0	13	0.78	5	2	6	5	0	13	0.69	21	0.54	14
36	2	5	5	1	0	13	0.72	17	5	5	3	0	13	0.79	7	0.57	10
	Construction phase								**Construction phase**								
37	2	4	6	0	1	13	0.69	23	1	8	2	2	13	0.65	28	0.4527	27
38	2	8	3	0	0	13	0.78	5	7	6	0	0	13	0.88	1	0.69	3
39	2	7	4	0	0	13	0.77	8	0	8	5	0	13	0.65	28	0.50	21
40	0	7	6	0	0	13	0.71	19	2	4	7	0	13	0.65	28	0.46	26
41	3	3	5	1	1	13	0.69	23	10	1	0	2	13	0.87	2	0.59	8
42	1	9	1	2	0	13	0.74	14	1	7	4	1	13	0.65	28	0.48	24
43	3	7	2	1	0	13	0.78	5	7	3	3	0	13	0.83	6	0.64	6
44	2	5	4	2	0	13	0.71	19	4	4	4	1	13	0.71	18	0.50	20
45	2	3	6	2	0	13	0.68	28	1	6	4	2	13	0.62	39	0.41	34
46	3	6	3	1	0	13	0.77	8	3	8	2	0	13	0.77	10	0.59	9
47	1	8	4	0	0	13	0.75	11	3	5	5	0	13	0.71	18	0.53	15
48	3	5	4	1	0	13	0.75	11	3	4	5	1	13	0.67	24	0.50	19
49	1	3	7	1	1	13	0.63	34	2	4	4	3	13	0.60	41	0.37	37

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables – Contractor

No	Degree of impact					Total response	Severity index %	Rank	frequency of occurrence				total response	frequency index	rank	importance of index	Rank
	Very High	High	Moderate	Neutral	None				high	medium	low	never					
	5	4	3	2	1				4	3	2	1					
	proposal related cost overrun								**proposal related cost overrun**								
1	3	3	6	3	0	15	0.68	34	4	0	9	2	15	0.60	43	0.41	39
2	0	1	3	11	0	15	0.47	46	1	4	10	0	15	0.60	43	0.28	47
3	11	3	0	1	0	15	0.92	4	12	3	0	0	15	0.95	1	0.87	1
	Planning related cost overrun								**Planning related cost overrun**								
4	3	1	11	0	0	15	0.69	31	2	10	3	0	15	0.73	30	0.51	30
5	1	1	7	6	0	15	0.56	40	1	5	9	0	15	0.62	40	0.35	42
6	2	1	4	8	0	15	0.56	40	2	2	11	0	15	0.60	43	0.34	43
7	4	5	6	0	0	15	0.77	25	3	9	3	0	15	0.75	28	0.58	24
8	9	6	0	0	0	15	0.92	4	4	11	0	0	15	0.82	16	0.75	10
9	1	2	8	4	0	15	0.60	38	2	10	3	0	15	0.73	30	0.44	35
10	2	11	1	1	0	15	0.79	23	4	3	8	0	15	0.68	35	0.54	29
11	9	5	0	1	0	15	0.89	8	4	8	3	0	15	0.77	26	0.68	19
12	8	4	2	1	0	15	0.85	17	8	3	4	0	15	0.82	16	0.70	15
	Negotiation Phase								**Negotiation Phase**								
13	0	1	4	10	0	15	0.48	44	0	3	12	0	15	0.55	48	0.26	48
14	1	3	10	1	0	15	0.65	35	7	8	0	0	15	0.87	12	0.57	28
15	0	3	2	10	0	15	0.51	43	4	9	0	2	15	0.75	28	0.38	40
16	0	2	0	3	10	15	0.32	49	0	3	7	5	15	0.47	49	0.15	49
17	8	5	2	0	0	15	0.88	13	11	2	2	0	15	0.90	6	0.79	7
18	1	7	5	2	0	15	0.69	31	2	4	9	0	15	0.63	38	0.44	36
	Contractual phase								**Contractual phase**								
19	4	6	5	0	0	15	0.79	23	8	7	0	0	15	0.88	9	0.69	17
20	1	10	3	1	0	15	0.75	27	3	2	10	0	15	0.63	38	0.47	32

21	9	2	4	0	0	15	0.87	15	11	3	1	0	15	0.92	3	0.79	6
22	1	6	3	2	3	15	0.60	38	2	12	1	0	15	0.77	26	0.46	34
23	1	10	3	1	0	15	0.75	27	0	5	10	0	15	0.58	47	0.44	37
24	10	4	1	0	0	15	0.92	4	11	3	1	0	15	0.92	3	0.84	3
25	3	11	1	0	0	15	0.83	19	8	7	0	0	15	0.88	9	0.73	13
26	8	6	1	0	0	15	0.89	8	6	8	0	1	15	0.82	16	0.73	14
27	0	3	3	5	4	15	0.47	46	2	11	0	2	15	0.72	33	0.33	44
28	3	4	6	1	1	15	0.69	31	5	10	0	0	15	0.83	14	0.58	25
29	0	5	1	0	9	15	0.43	48	4	6	5	0	15	0.73	30	0.31	45
30	1	4	8	2	0	15	0.65	35	3	7	5	0	15	0.72	33	0.47	33
	Design phase								**Design phase**								
31	0	4	2	5	4	15	0.48	44	0	9	4	2	15	0.62	40	0.30	46
32	0	2	7	6	0	15	0.55	42	0	10	5	0	15	0.67	36	0.36	41
33	1	9	2	3	0	15	0.71	29	0	8	5	2	15	0.60	43	0.42	38
34	11	3	0	1	0	15	0.92	4	2	4	8	1	15	0.62	40	0.57	27
35	10	5	0	0	0	15	0.93	2	4	3	6	2	15	0.65	37	0.61	23
36	8	6	1	0	0	15	0.89	8	11	2	1	1	15	0.88	9	0.79	8
	Construction phase								**Construction phase**								
37	4	4	7	0	0	15	0.76	26	7	5	3	0	15	0.82	16	0.62	22
38	5	10	0	0	0	15	0.87	15	10	3	1	1	15	0.87	12	0.75	11
39	6	6	0	3	0	15	0.80	22	7	3	5	0	15	0.78	24	0.63	21
40	7	8	0	0	0	15	0.89	8	10	5	0	0	15	0.92	3	0.82	5
41	6	5	4	0	0	15	0.83	19	12	3	0	0	15	0.95	1	0.79	9
42	8	6	0	1	0	15	0.88	13	6	5	4	0	15	0.78	24	0.69	18
43	11	4	0	0	0	15	0.95	1	9	6	0	0	15	0.90	6	0.85	2
44	8	6	1	0	0	15	0.89	8	8	4	3	0	15	0.83	14	0.74	12
45	4	0	6	4	1	15	0.63	37	6	6	3	0	15	0.80	22	0.50	31
46	10	5	0	0	0	15	0.93	2	9	6	0	0	15	0.90	6	0.84	4
47	4	11	0	0	0	15	0.85	17	4	11	0	0	15	0.82	16	0.70	15
48	3	11	1	0	0	15	0.83	19	3	12	0	0	15	0.80	22	0.66	20
49	0	11	2	1	1	15	0.71	29	5	9	1	0	15	0.82	16	0.58	26