

**ASSESSING ANTECEDENTS AND CONSEQUENCES OF SCOPE CHANGE: THE
CASE OF BUILDING CONSTRUCTION PROJECTS IN ADDIS ABABA**

By: Yibekal Adamu

APPROVED BY BOARD OF EXAMINERS:

Graduate Committee:

Dr. Mengistu Bogale

Advisor

Signature

Date

Ato Bantie

Internal Examiner

Signature

Date

Dr. Azmine

External Examiner

Signature

Date

DECLARATION

I the undersigned, declare that this thesis is my original work and that all sources of materials used for the thesis have been dully acknowledged.

Signature: _____ **Date:** _____

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

Dr. Mengistu Bogale

Advisor

Signature

Date

ABSTRACT

Scope changes are inevitable in construction projects. Even though literatures have acknowledged scope changes as a significant factor inhibiting construction project performance, there seems to be limited studies in this domain to systematically synthesizing preceding studies. This paper critically assessed causes of scope changes on project deliverables in the construction management field. The objectives are to analyse the severity and frequency of the causes of scope change during the implementation phase of building construction projects and to provide insights for directing further studies on building construction projects on similar and related topics in Ethiopia. The findings indicate that causes of scope changes list the causes. Though building construction projects commonly share key characteristics scope changes as a major cause of quality problems, project delays and cost overruns are not studied in Ethiopia. Therefore suggestions for future research recognizing the causes and effects of scope changes in construction project in Ethiopia, by identifying factors for scope changes and their resulting impacts on project deliverance. Thus, the analytical framework for future study is presented.

Keywords: Scope changes, quality, project deliverables, overruns.

Acknowledgement

I would like to praise my saviour and God almighty for His Unceasing Mercy on me helped me to reach this level. Then I would like to thank my advisor Dr. Mengistu for his guidance and valuable comments on my proposal and all draft submissions for each of the chapters of the dissertation.

It is a pleasure to record my gratitude to all survey respondents for apportioning their time to respond to the questionnaire to supply such important information.

Table of contents	Page
Declaration.....	i
Abstract.....	ii
Acknowledgement.....	iii
1. Introduction.....	10
1.1 Background of the study	10
1.2 Statement of the problem.....	11
1.3 Objectives of the study.....	11
1.4 Scope of the study.....	11
1.5 Limitations.....	12
1.6 Research questions.....	12
1.7 Significance of the study.....	12
1.8 Organization of the report.....	12
2. Literature Review	13
2.1 Introduction.....	13
2.2 Definition of Scope change	13
2.3 Theoretical approach.....	13
2.4 Empirical study on impact of scope change on projects during Implementation.....	20
2.5 Research gap on scope change on building Construction project in Addis Ababa.....	20
2.6 Conceptual framework.....	22
3. Methodology of the study.....	24
3.1 Research design.....	24
3.2 Research procedure.....	24
3.3 Data sampling and type.....	24
3.4 data analysis.....	25

4. Potential Factors for Scope Changes in building construction	
Projects in Addis Ababa city	26
4.1 Introduction	26
4.2 Identification of relevant variables.....	26
4.3 Data collection and analysis	29
4.4 Questionnaire response rate.....	29
4.5 Characteristics of respondents.....	30
4.6 Approach to data analysis.....	30
4.7 Research findings and results	31
4.8 Important categories of causes of scope change.....	33
4.8.1 Severity of scope change	33
4.8.2 Frequency of scope change causes.....	34
4.9 Importance of scope change causes	35
4.9.1 Analysis of Major Categories of scope change and their relation with consequences.....	35
4.9.1.1 Contractual related scope change causes.....	37
4.9.1.2 Market related scope change causes.....	37
4.9.1.3 Technical related scope change.....	37
4.9.1.4 Internal scope change causes (contractor related)	38
4.9.1.5 Market related scope change	38
4.9.1.6 Equipment related scope change.....	38
4.9.1.7 Labour related scope change.....	39
4.9.1.8 Consultant related scope change.....	39
4.9.1.9 External scope change	39
5 Discussions and Recommended Mitigation measures	40
5.1 Introduction.....	40
5.2 General objectives of the research.....	40
5.2.1 Contractual scope change causes.....	40

5.2.2 Market Related scope change causes.....	41
5.2.3 Technical scope change causes.....	41
5.2.4 Contractor related scope change causes.....	41
5.2.5 Material related scope change	41
5.2.6 Equipment related scope change	42
5.2.7 Labour related scope change.....	42
5.2.8 Consultant related scope change.....	43
5.2.9 External scope change.....	43
5.3 Specific objectives of the research.....	44
5.4 Conclusion.....	46
Appendix A: Questionnaire.....	47
Appendix B: Computation of indices and Ranking of variables.....	51
References.....	57

List of table	page
Table 4.1: Factors for scope change	23
Table 4.2: Questionnaire distribution and response.....	29
Table 4.3: Weighing assigned to degree of Impact and frequency of occurrence.....	30
Table 4.4: Importance of scope change causes.....	31
Table 4.5: Top five importance of scope change based On average value	35
Table 4.6: Ranking of major categories of scope change causes.....	36

Lists of figures	page
Figure 2.1 the triple constraints.....	14
Figure 2.2 conceptual frame work.....	23

Chapter 1 Introduction

1.1 Background of the Study

Modern project management theory asserts that every project has three dimensions, known to be budget, schedule, and performance requirements. The budget dimension is the specified or allowable cost for the project; it is the target cost of the work to be done. The schedule dimension includes the time period over which the work will be done and the target date for when it will be completed. The performance dimension features the final product's quality and its quantitative measures (Michael C. 2002).

The implementation of a project is said to be successful when it satisfactorily meets all the three-dimensional goals, which are completing the project within the schedule, within the allocated budget, and according to the specified quality standards by the client (Phillips et al 1983). This study focuses on scope change and the likely consequences of the change on the three dimensions of a project deliverables and goals during the implementation of building construction projects in Addis Ababa.

Formal increase in scope will likely result in both a cost increase and a schedule slip due to this scope change the main task is to identify the impact and risks are, and then get formal approval from the customer before implementing the scope change (Tucson, 2012).

Tucson (2012) argues that it is crucial to identify ways of minimizing the impact of the scope increase. Changing from expensive materials, for instance, to less expensive materials potentially save enough to pay for deliverable. It's a question of balance— or asking for, and receiving, additional money and/or time to perform the work.

Another common problem encountered is a customer asking for a faster delivery of the product. Instead delivering a building with the specified period on the contract, the customer might ask to complete the work early. This changing of the schedule requires crashing the schedule or fast-track parts of it to decrease the overall project duration, but these things might come at the expense of additional money and/or reduced quality. Or, it needs to reduce the overall scope; by reducing the some parts from the overall part of the project. Again, all four things (scope, quality, schedule, and budget) can often be balanced and traded off against each other in an effort to find the best overall solution (Tucson, 2012).

The purpose of this study is to identify the factors, as exhaustively as possible, that prompt scope change and the effects of the change on quality issues, the schedule of the project and cost incurred in building construction projects in Addis Ababa by looking into previous studies made on the subject and scholarly articles on the subject matter of scope change and from personal experience, and the effects of the scope change on the overall project deliverable. This study is important as it provides substantial inputs for the future building construction projects by listing factors considered in the research and provide possible ways to handle scope change during implementation phase of the building construction project and mitigation strategies to minimize the associated cost overruns, schedule slippage and quality problems. The study also serves as an input for future researches focusing on scope change and other related topics in the field of building construction projects.

1.2 Statement of the Problem

Scholars on project management discipline agree that changing a scope of a project during the implementation phase of the project affect the projects' cost, quality and/or schedule. However, the extents as well as the causes behind causes of scope change and the resulting consequences remained under-studied in the construction sector of the economy. This study aims on examining the causes and effects of scope change during the construction phase of building construction projects in Addis Ababa and recommend possible ways to mitigate the resulting effects of the scope change.

1.3 Objectives of the study

Due to scope changes quality problems, cost and time overruns have been common problems in building construction project in Addis Ababa. However, the extents as well as the causes behind the quality, the time and the cost overruns have remained under-studied in the construction sector of the economy. The study aims on examining the effects of scope change during the construction phase and its effect on quality of the output and the schedule overrun the extent and the frequency of time and cost overruns in building construction projects in Addis Ababa and recommend possible ways to minimize project cost and time overrun problems substantially.

The general objectives of the study are:

- To identify the factors causing scope change
- Assess the consequences of scope change
- To recommend measures to substantially minimise the causes and the effects of scope change in the implementation of the upcoming projects.

Specific objective

1. To evaluate the projects completed in the past ten years in Addis Ababa.
2. To identify common problem areas in building projects in Addis Ababa.
3. To assess the effect of scope change during the implementation phase of the projects
4. To come up with a recommendation for future building construction projects in Addis Ababa.

1.4 Scope of the study

The scope of the study is to investigate scope change during the implementation of building construction projects as a cause to quality problems, cost and schedule overrun in building construction projects in Addis Ababa city. And also the possible mitigation measures to minimize the problems will be recommended.

1.5 Limitations

During the course of the study the writer of this paper have come across the following limitations:

- Response bias from the respondents if they are responsible for the incidence, those respondents who work for the client
- Access to get project documents. To solve this problem an interview was conducted with key respondents who are responsible for the related issues.

1.6 Research questions

The main research questions of this study are as follows;-

1. What are the major variables that cause scope change during the implementation phase of building projects in Addis Ababa?
2. What are the consequences of scope change during the implementation phase of building projects in Addis Ababa?
3. To what extent do the variables for scope change affect the projects?

1.7 Significance of the study

The study will be supportive for building construction projects in Addis Ababa and all over Ethiopia in the future. The findings of this study can be used as a reference for future researches on the same topic and related issues and can also help students planning to undertake their research.

1.8 Organization of the report

The study is organized in to five chapters. Accordingly, the first chapter deals with the introduction part of the study. The second chapter critically discusses causes and consequences of scope change in detail, literatures published on books, journals and uploaded on the internet on the same topic are reviewed. The third chapter focuses on methodology of the study the research design, kinds of data used for the study, collection procedure and ethical statements. In the fourth chapter the studies focuses on research findings on causes and consequences of scope change, important categories and relationships of variables for scope change, ranking of the scope change causing factors and qualitatively assess the causes and consequences of scope change and conclusion is forwarded. Finally the fifth chapter provides discussions and recommend mitigation measures.

Chapter 2 Literature Review

2.1 Introduction

Building construction in Ethiopia dates back to time immemorial and cannot be predicted exactly. But we have the traditional building construction and the modern building construction methods which are still widely in use throughout the country. In the traditional building construction method there are various practices by each nations and nationalities. For example the traditional housing construction methods of the Sidama, the Guraghe, the Tigray and the thatch roofed construction methods of Amhara are the most famous to name.

The modern building construction method began in Ethiopia during emperor Minilik's reign especially after the victory of Adwa and since then it passed through various phases whenever there was a change in government. During Minilik's reign the Italian war prisoners of Adwa and the coming of the Armenian refugees sought to be the first phase of modern building construction in Ethiopia. After the completion of the Ethio - Italian five year war the second era of modern building construction began. War prisoners who got mercy to live in the country began the construction business and this practice led to the establishment of the construction industry, the establishment of municipalities at various then known towns and cities in Ethiopia and eventually the exercise of modern construction practices. During the Dergue regime the third phase of modern building construction saw a major change in scope and methodology which retarded the industry though considerable amount of labours involved and trained professionals were also available.

The current phase of the modern building construction began after the coming to power of the existing government which brought about major shift in the economic system of the country that simultaneously witnessed the revival of the construction industry and bringing into use of modern construction project management practices.

The purpose of this chapter is to identify the factors, as exhaustively as possible, that prompt scope change during project implementation phase and identify the effects of the change on the three project constraints by looking into previous studies made on the subject and scholarly articles on the subject matter of scope change and its effect on the overall project deliverable. This investigation is important as it provides substantial part of the inputs for the lists of factors to be considered for the research.

2.2 Definition of scope change

Scope Change is an official decision made by the project manager and the client to change the feature of the project deliverable either by expand or reducing its functionality. Generally, scope change involves making adjustments to the cost, budget, other features, or the timeline (Sharma,2010).

2.3 Theoretical approach

Defining the project sets the stage for developing a project plan argues Clifford (Clifford et. al 2007). And he further argues that project scope is a definition of the end result of a project- a product or service for the client or the customer.

Tsongas on the other hand argues that Scope is the functional elements that, when completed, make up the end deliverable for the project. The scope itself is generally identified up front so as to give the project the best chance of success (Although scope can potentially change during the project life-cycle, a concept known as ‘scope creep’). Note that the common success measure for the scope aspect of a project is its inherent quality upon delivery (Tsongas, 2011).

According to Clifford scope describes the expected deliverable that the client requires. And the scope should be defined and developed under the direction of the project manager and the customer so as to define the end results to be achieved in specific, tangible and measurable terms (Clifford et. al 2007).

Tucson argues that the scope of a project is a product Scope that the project manager and the project team are ultimately going to produce and deliver at the end of the project. It includes all the various bits and pieces, assembled together, and containing all the required features and functions that were defined and documented during the early phases of the project (Tucson, 2012).

Tsongas argues that one cannot adjust or alter one of the constraints without in effect, altering the other sides. So for example, if there is a request for a scope change mid-way through the execution of the project, the other two attributes (cost and time) will be affected in some manner. How much or how little is dictated by the nature and complexity of the scope change. As an added example, if the schedule appears to be tight and the project manager determines that the scoped requirements cannot be accomplished within the allotted time, both cost AND time are affected (Tsongas, 2011).

According to Tucson(2012) there are always constraints, or boundary conditions, that are placed when organizing and planning the delivery of a product scope. In fact, informally referred to in project management parlance as the “triple constraints,” or sometimes as the “golden triangle” of project management

The Triple Constraints

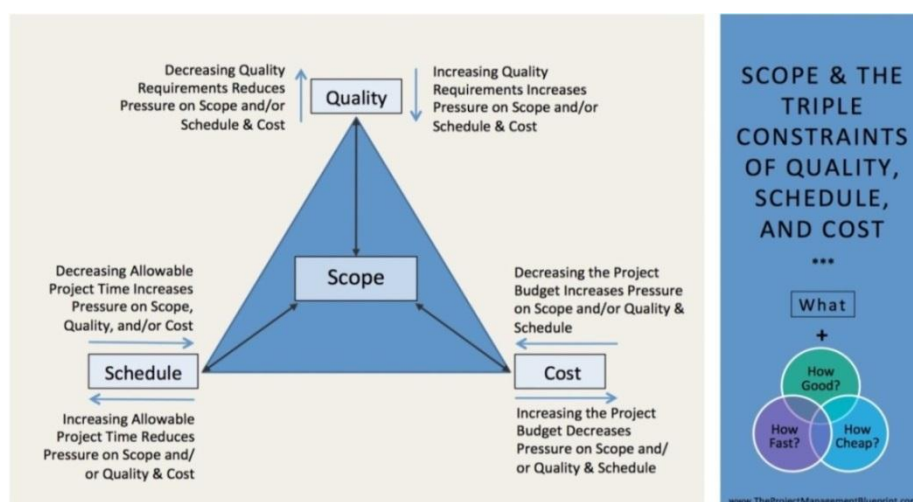


Figure 2.1 the triple constraints (Tucson, 2012)

Constraint #1: Quality

Quality defines the “how good” aspect of the scope. Quality defines exactly what it sounds like: the minimum acceptable standard of quality of the delivered scope (Tucson, 2012).

Constraint #2: Schedule

At a high-level, the schedule defines when to make the final delivery. At a lower level, the schedule also lays out other important dates and milestones that you might be required to hit along the way (Tucson, 2012).

Constraint #3: Budget

The final constraint placed on a project is budget, and then staying within it during the entire construction project, is the third and final constraint placed a project (Tucson, 2012).

For Tucson(2012) there is an intrinsic “push-pull” relationship between product scope and the triple constraints of quality, schedule, and budget. For example, reducing budget puts pressure on the other three items, and vice versa.

Most projects have an intrinsic priority of importance that can be assigned to the scope and the triple constraints, with one or two of these things often having higher importance than the others. In other words, when making trade-offs and balancing between the constraints, one might have flexibility in changing only one or two of the constraints, but not the others (Tucson, 2011).

For some projects the constraint of quality would almost certainly be much more important—and hence, less changeable—than that of schedule; and when the customer asks for additional scope, quality would not be something that could not be relaxed to offset the cost of the additional scope. Another project the constraint of schedule would probably be much more important than the final cost, or perhaps even quality of the construction (Tucson, 2011).

Oyvind & Roberg (Roberg, 2017) argues that very few projects are ever completed according to the original plan and budget. Poorly managed or un-controlled changes can harm a project severely; including missed deadlines, budget overruns, and even project failure. Adding extra work and the requirement for extra budget and resources may impact the ability to deliver on target.

According to Roberg (2017) defining a project scope that is specific, clear and attainable and ensuring any scope changes carefully controlled is key to capital project management success.

Clear scope definition ensures when a change in scope occurs during project implementation argues Clifford by providing an administrative plan that can be used to develop operational plan and the scope definition should be as brief as possible (Clifford et. al 2007).

Scope Change is an official decision made by the project manager and the client to change a feature of a project to expand or reduce its functionality. Generally, scope change involves making adjustments to the cost, budget, other features, or the timeline (Roberg, 2017).

The change can be either upwards or downwards. Scope can be removed, or added as required. Proper scope change should involve planning, costing, and approval. Scope change can induce scope creep if the new scope is not properly communicated.

Projects may provide some time to handle missed requirements. This contingency budget can result in scope creep if it is not well managed. Without a clear process for allocation of the contingency, it will be difficult to tell whether the features are scope creep or scope change. Features which does not resolve a missing feature preventing meeting the scope, are likely scope creep.

Scope change is inevitable on a project argues O' Berry and can be caused by new discoveries during the project, external circumstances or internal changes in the business. It can be disruptive and if not handled properly, it can doom the project. No matter how well defined the project is at the beginning, it is not known what will be the change to be encountered. And things are going to crop up during the process that will require scope changes to occur. The job of the project manager is to make sure you manage them properly so it doesn't take your project down the black hole of despair (O'Berry, 2015).

The best line of defence is to make sure that the scope is clearly defined as possible at the outset of the project. That means you'll define what is and what isn't included. Sometimes people forget "what isn't" and that's a big mistake.

Two steps are needed to take before making any change to your project are:

1. Clearly understand the change, and
2. Determine how the change will impact your project

Experienced project managers know that change is inevitable and there are many consequences of failing to manage project changes. Some of the critical consequences are: Scope creep, Cost and budget overruns, Project delays, Poor quality of the project deliverable, Often the project team performs incomplete work for the project deliverables, Stakeholders express concerns about the project manager's ability to manage the project (Sarkar, 2010).

So the problem is not the change itself but how the change is managed argues Sarkar, there are many benefits of managing changes properly such as increased stakeholders' satisfaction, improved quality of the project deliverables, opportunities for the additional project work etc. (Sarkar, 2010). For Saktar there are basically three types of changes that need to be addressed in order to ensure a project success. These are:

Technical changes: These are the internal modifications in scope of the work of the project.

Market changes: These are changes that are inevitable due to external market conditions such as competitors' product or service enhancements or regulatory changes.

Contractual changes: Changes made on the contract with the stakeholder or supplier. These changes include but not limited to the terms & conditions, scope of work, requirements, schedule, costs etc. (Sarkar, 2010).

A change in one of the three scope triangle will make a change in one or two of the remaining dimensions, argues Sarkar(2010), though changes occur in the life of the project, the three dimensions should be kept in equilibrium. Experienced project managers know that change is inevitable and there are effects of failing to manage project changes. Some of the critical effects are:

Delays

Cost and budget overruns

Poor qualities of project deliverables (Sarkar, 2010).

According to Shi, (2001) delays are incidents that impact a project's progress and postpone project activities. Delay causing incidents during building construction project implementation may include weather delays, unavailability of resources, delays due to scope change, etc.

In general, project delays occur as a result of project activities that have both external causes beyond the control of the project and internal causes due to scope change and the effects and relationship of which is the core purpose of this paper. When one-activity experiences a delay due to a late start or late finish, the proceeding activities will also experience a late start and cause the project extra time and money. An activity's delayed completion may cause delays in other succeeding activities, which in turn can cause a delay in the project completion (Shi 2001).

In construction all projects are time bound. Contract Time can either be competitively or directly assigned. Completing building projects on time and within budget has been a chronic problem for so long time. According to Birkby delays can result in loss of time and money as well as inconveniences to the public (Birkby et. al 2002).

A time overrun is simply the project's duration difference between the project's original contract time agreed upon at the time of contract signature and its overall actual contract time at the end of construction (Birkby et. al 2002).

In most construction projects, specifically in our country the client determines the construction duration during the design phase; and the same is informed to contractors during the tendering process so that they could provide their respective prices based on this information (Birkby and Brough, 2002) and also prepare their work program to complete the works by the specified time.

Any delaying event in construction could happen from the fault of the employer as a result of changing requirements or by changing the major component of scope of the project, or the contractor may change the scope of the project for various implementation reasons or for a condition that is beyond the control of both parties. According to Bramble there are four types of construction delays that can be encountered in construction projects (Bramble 1987):

1. Excusable or non-excusable
2. Concurrent or non-concurrent
3. Compensable or non-compensable, and
4. Critical or non-critical delay

The types of delays above have internal or external impacts on project process. Internal causes of delay include causes that come from the owner, designers, contractors, and consultants. External causes of delays are originated from outside of construction projects such as utility companies, government, subcontractors, suppliers, labour unions, nature etc. the business competition.

Excusable delays are unforeseeable events beyond anyone's control. They are broken down further into compensable or non-compensable delays. If the delay is considered compensable, then the contractor is entitled to additional financial compensation as well as extra project time. Under certain circumstances where non-compensated excusable delays occur, the contractor receives extra time but not extra money for the additional completed work (Bramble 1987).

Non-Excusable delays are foreseeable and are events that occur within the control of the contractor. In such situation, the contractor is not entitled to any extra time or compensation for the delay. The owner and the designer are liable to make sure that the contract documents are made clear and fully understandable on what is considered excusable and non-excusable delays prior to signing the contract (Bramble 1987).

Excusable and non-excusable delays can occur concurrently, non-concurrently, or simultaneously in a project. Concurrent delays occur at the same time or close to the same time. They can also contain critical and non-critical delays. Critical delays are delay claims that affect the progress, time, and compensation. Non-critical delays do not affect the completion date of the project. They affect the succeeding activities that are not on the critical path of the schedule. This can set back the activities if they do not have a float in the schedule (Bramble 1987).

According to Jähren(1990) the size of a project is one of the influential factors in affecting the completion time of the project time, whereas Rowland(1981) on the other hand indicated that the project complexity is also has an effect in increasing the project time due to issuing of many change orders.

As per S. M. Vidalis and F.T. Najafi time delays can be caused externally or internally. External causes of delays are originated outside of the organization, where projects that are executed by various parties such as utility companies, government, subcontractors, suppliers, weather, etc. which all can force the scope change. Internal causes of delays are harder to depict and are due to problems that may have been started by the designers, owners, or contractors within the project by changing the scope of the project (Vidalis et al, 2002)

There is simultaneity between delays and cost overruns. According to Ardity (1985) the major causes of project cost overrun are: the length of the project-implementation phase, the size of the project and the type of project ownership.

Cost and budget overruns is the per cent difference in cost between the final cost of the project and the contract award amount (Rowland 1981).

There is simultaneity between delays and cost overruns; the contractual and the institutional failures are economically and statistically significant causes behind cost overruns. If a project completion is delayed due to the reasons attributable to the Employer, extension of time will be granted to the contractor which will implicate requirement of additional payment for time related costs; such as overhead and profit

Delay involves additional costs incurred by the contractor as a result of the extended duration of its performance. These typically include costs of idle labours and equipment, higher costs of performance during the later period of time and extended general conditions. Examples of the type of additional costs associated with delays include:

- Extended or Increased management / supervisory costs
- Additional payment / performance bond premiums
- Additional liability insurance premiums
- Extended equipment / trailer rental costs
- Materials escalation costs
- Overhead associated with the delay period.
- Idle labour / equipment charges

Completing a building projects within the specified cost agreed on the contract has been a chronic problem in our country. Some of the causes of cost overruns in construction projects can be avoided and controlled by the parties involved in the contract. However, some of them are beyond the control of the parties to the contract because virtually all projects are planned under the context of uncertainties.

According to Ardity and Akan the major causes of construction project cost overrun are; (1) the length of the project-implementation phase, a delay resulting from to frequent scope change (2) the size of the project and (3) the type of project ownership (Ardity et al, 1985)

In survey conducted by Odeh and Battaineh (2002), contractors and consultants agreed that owner interference is among the top ten most important factors that directly or indirectly causes cost overruns in construction project with traditional type of contracts whereas according to Roberg changing project scope is a major source of schedule and cost overrun (Roberg, 2017).

Quality is one area which a sound project management should not compromise argues Fried, since the payoff is a higher probability of successfully completing the project and satisfying the customer (Fried, et al 2008)

Tucson argues that the scope of a project is a product Scope that the project manager and the project team are ultimately going to produce and deliver at the end of the project. It includes all the various bits and pieces, assembled together, and containing all the required features and functions that were defined and documented during the early phases of the project (Tucson, 2012).

Scriptures agree that there are two types of quality as part of every project. The first is product quality referring to the quality of the deliverable from the project. The second type of quality is process quality, which is the quality of the project management process itself. The focus is on how well the project management process works and how can it be improved. Continuous quality improvement and process quality management are the tools used to measure process quality (Naylor,1995).

A sound quality management program, according to Naylor, with processes in place that monitor the work in a project is a good investment. A good quality management contributes to customer satisfaction, and also it helps organizations use their resources more effectively and efficiently by reducing waste and rework (Naylor,1995).

2.4 Empirical study on impact of scope change on projects during implementation

Scriptures clearly show that a poorly defined scope is the most frequently mentioned barrier to project success. A study by Smith and Tucker in a large processing plant found that poor scope definition on major segment of the project resulted schedule and cost overrun on the total output.

In 2014 Global PPM survey indicates that poor estimates in the planning phase (39%) and changes in scope mid-project (41%) were reported as the top two reasons for project delays.

A study by Gobeli and Larson on the other hand found that approximately 50 per cent of the planning failure relates to unclear definition of scope and goals. Other studies also suggested that there is a strong correlation between project success, success on the three criterion cost, schedule and quality, and clear definition of scope.

2.5 Research gap on scope change on building construction project in Addis Ababa

Scope change during the implementation phase of a project is the main reason for cost and time overruns and it remained common problem in every construction project in general and critical mainly in building projects in Addis Ababa. However, the extents as well as the frequency of occurrence of scope change have remained under-studied. These consequences of scope change, delays and cost overruns, have huge implications from economic and political points of view. Delays in project implementation mean that the organization owning the project, the customers of the project and other stakeholders directly or indirectly related to the project suffer longer than is necessary. This in turn limits the growth potential of the economy of the client organization at large.

Hence, future studies are requisite to capture the dynamics of scope changes and systematically assess their impacts to facilitate effective construction project management. Good understanding of causes and effects is always a requirement for successful construction project management (Sun et.al, 2009). Scope change is a cause for schedule overrun, cost

overrun and quality compromise of a project. Therefore whenever scope changes occur, immediate attention is imperative so as to plan for a sound actions and responses (Love et al., 2002). Thus, if the problem is recognized at the earlier phase of the project, the impact it will have on project performance (time and cost) can be effectively inhibited (Hwang & Low, 2012). In view of that, construction project delay and cost overruns can ultimately be well mitigated. But the problem of scope change is exhibited at mid-way of the project implementation the likely of time and cost increase is huge.

Scope changes can come from internal or external sources, but if requests for change are frequent and numerous it can be a clear indicator of a poorly-defined project scope and a poorly defined project baseline (Roberg, 2017).

Various seen and unforeseen factors are also culprits for scope change during the implementation phase of the project. The first factor is a change made by the project manager, when the project gets further and further the manager obtain a better understanding of what needs to be done to accomplish the project and this may lead to a major change in the project plan which can result in a change to schedule and cost. For a commercial project a change in scope have to be made midstream to respond to a new demand by the customer. A changing project scope is a major source of schedule and cost overrun. To minimize frequent scope change of a project effort has to be made at the very beginning of the project though it is becoming increasingly difficult to do so in the present fast changing world (Roberg, 2017).

Scope change according to Elyse, have the power to change project deliverables, the project team, and the budget, so it is essential to have a good process to manage these changes (Elyse, 2009) but Mochal argues that during implementing a project there will be many good reasons why things need to change.

And according to Mochal there are change drivers as follows, which are unavoidable for the good of the project deliverable (Mochal, 2006).

The business needs have changed

Business needs are changing ever more rapidly, particularly as competitors explore the new business models of e Commerce. All businesses must be willing to change if they are to remain competitive.

The organization has changed

Most often an organization undergoes some form of restructuring during the life of a project. This could involve mergers, acquisitions, being taken over, new departments, new business leaders, new products, new accounting structures, new locations etc.

Exploit technology improvements

The available technology improves constantly. All the time the Project Team are trying to exploit the various technology components, each of those components has a large team of people working to create a better version - and thus to make your version obsolete.

The organization's priorities have changed

Although the scope and objectives of a project remain valid, the organization may decide that there are other business needs that have high priority and should be addressed.

New business partners and channels

Organizations are responding to the rapidly changing marketplace by forming new business partnerships and alliances. New business channels are becoming available through those relationships, e.g. using industry hub portals and intermediaries.

New legislation and regulations

There may be unavoidable external requirements over which no one has a control, such as new regulations for data privacy, changed regulatory reporting requirements etc.

Globalization, standards etc...

When an organization is making progress in presenting and managing itself as a global entity there may happen new or revised standards for such things as website design, database definitions, corporate knowledge sharing, data warehouses etc.

Effect of other projects and initiatives

Other initiatives within the organization result in revised needs for this project, e.g. there is a new accounting system so the interface from our new system will have to be changed.

Poor scoping

When elements of the project's design and deliverables do not fully meet the defined need and will need to be re-worked (Mochal, 2006).

2.5 Conceptual framework

Based on the literature review, a conceptual framework for assessing the causes of scope change and the possible consequences on building construction and identifying the relationships between the identified variables and the consequences has been constructed. The identification of factors causing scope change are based on the works of Mochal(2006) ten good factors for scope change during the implementation phase of a project, Saktar's (2010) three types of scope change, Technical change, Market change and Contractual change and according to O'Berry(2015) there are internal and external causes of scope change. The impacts of these scope change factors are quantitatively and ranked according to their importance and their relationship with the consequences is qualitatively examined. The first part of this framework considers the factors causing scope change. The second part of the framework examines the relationships with scope change. The factors for scope change

are evaluated in terms of their severity and frequency of occurrence and their impact on schedule, cost and quality of the project deliverable completion time, completion cost, and quality and customer satisfaction. The conceptual framework is described in Figure 2.2.

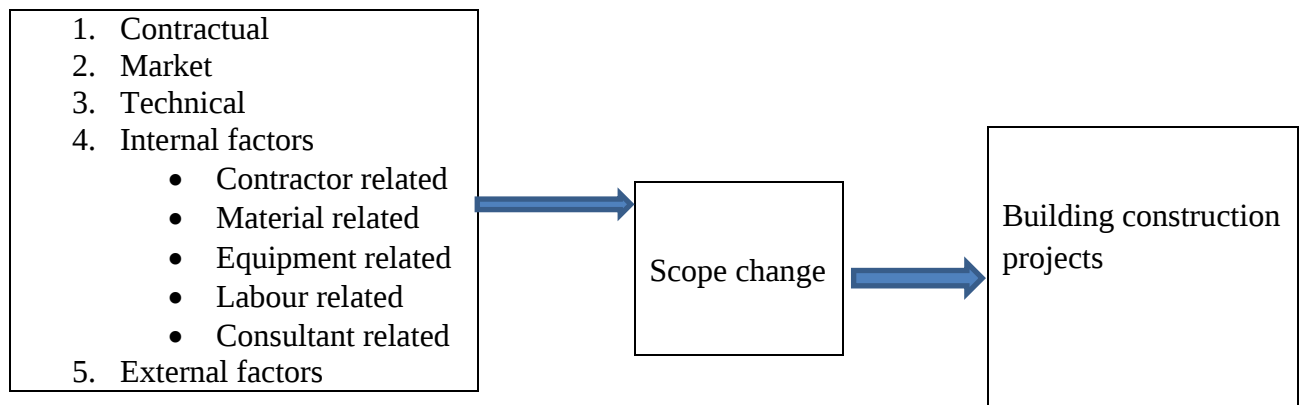


Figure 2.2 conceptual framework

Chapter 3 Methodology of the Study

Due to scope changes quality problems, cost and time overruns have been common problems in building construction project in Ethiopia. For several reasons delays and cost overruns have significant implications on economy and business of any organization. Delays in project implementation mean that there is additional cost to complete the project, quality compromise and delayed investment return so as to redirect the fund to expanding the business or invest in another area. This in turn limits the growth potential of the client organization at large. However, the extents as well as the causes behind scope change remained under studied.

3.1 Research design

This study is aimed to assess the cause of scope change in building construction projects and the likely effects as a result of the scope change in the building construction sector in Addis Ababa. The study will try to obtain primary data from the targeted respondents in the field of building construction, and was aimed to distribute the questionnaire to individual professionals working for the client, for consultants and for contractors. Ten questionnaires for each respondent will be distributed. The study is conducted on building projects completed within the past ten years from 2008 to date and projects which are underway at the current budget year.

3.2 Research procedure

The study assess the severity and frequency of occurrence of the factors identified from literature review in line with the appropriate conditions of the building construction sector in our country; including any other relevant variables observed from the case study. And the factors are classified in to groups that have relations with regard to their source. And the research methodology will be:

- A questionnaire survey is conducted on pertinent stakeholders working on behalf of a client, consultant or contractor in most building construction projects in Addis Ababa.
- Critical analysis and interpretation of the data and presentations of the findings will follow.
- Recommendations of the possible mitigations measures

3.3 Data sampling and type

The study will try to obtain primary data from the targeted respondents in the field of building construction, and ten questionnaires to individual professionals working for the client, for consultants and for contractors are distributed. At least nine factors causing scope change during the implementation phase of the building construction are identified which in turn affect the quality, time and cost dimensions of the project, as each independent research views the subject from different perspectives. This may be the project type, size, location and type of contract, etc.

3.4 Data analysis

The data analysis ranks the already identified variables of scope change and then find out the critical factors that needs to be given due attention so as to substantially minimize the problems in the future building construction projects in Addis Ababa

Chapter 4 Potential Factors for Scope change in building Construction Projects in Addis Ababa City

4.1 Introduction

As each independent research views the subject scope change from different perspectives, such as project type, size, location, type of contract, etc. in this chapter several factors are identified as causes of scope change during implementation phases of the project. All these causes of scope change their effect on the project deliverables, their impact and frequency of occurrence are assessed in the study.

4.2 Identification of Relevant Variables

The purpose of this chapter is therefore to assess the factors identified from literature review in line with the appropriate conditions of the building construction sector in our country; including any other relevant variables observed from the case study or personal experience.

The factors are classified in to five groups with a total of forty-nine variables relevant to the underlying requirement of the study from the literature review, case study, personal experience and discussion with professionals with in depth experience in the sector.

According to Mochal(2006) ten factors for causing scope change of a project during implementation of the construction are identified, which in turn affect the quality, time and cost dimensions of the construction project, These change drivers are categorized under Saktar's (2010) three types of scope change, from the literature review, Technical change, Market change and Contractual change. According to O'Berry (2015) there are internal and external causes of scope change

This chapter deals with the issues associated with the distribution of the questionnaire, the collection of responses and successive analysis of the data received from the respondents working for the client, consultants and contractors involved in building construction sector. The objective of the data analysis is to rank the already identified variables for scope change and to identify the critical factors that need due attention so as to substantially minimize the problems in the future building construction projects in Addis Ababa

Table 4:1 Factors for scope change

No.	Factors For Scope Change
	Contractual Scope Change Causes
1	Original contract duration is too short
2	Inadequate definition of specifications
3	Proper scope is not done
4	Lack of Stakeholder engagement during scoping
5	Projects schedule change
6	Scope creep

7 8 9 10 11 12 13 14 15 16 17 18	Market Related Scope Change Causes (customer related) Business needs changed Business benefits changed Project Resource changes Changes in project funding Increasing the scope of the project Decreasing the scope of the project Scope change due to new demands for commercial buildings during construction Budget overrun Contractual change such as contract conditions & terms, scope of work, requirements Change in standard of the building Scope change during construction (major change from the original) Schedule change by downsizing the original plan during implementation
19 20 21 22 23	Technical Scope Change Causes Corrective actions needed to occur during implementation Unclear and inadequate details in drawings Complexity of project design Realized risk Inadequate investigations by the designer during the design phase
24 25 26 27 28 29 30	Internal Scope Change Causes (Contractor related) New discoveries of construction methods during implementation New discoveries of needs to be included in the plan during implementation Poor quality of the project deliverables Project implementation and complementation delays Ineffective construction management by the project manager Improper construction methods implemented by the contractor Scope modification due to Technical changes
31 32 33	Material Related Scope Change Causes Change in material prices Shortage of construction materials required Changes in material types and specifications during construction
34 35 36	Equipment Related Scope Change Causes Equipment breakdowns Unavailability the of equipment required Low level of equipment-operator's skill
37 38 39	Labour Related Scope Change Causes Unavailability of technical professionals in the contractor's organization for the project Unavailability of skill of manpower Poor qualification of the contractor' s technical staff assigned to the project

40	Consultant Related
41	Poor and incomplete design
42	Poor qualification of consultant/ engineer' s staff assigned to the project
43	Poor communication between the consultant/ engineer and other parties involved
44	Poor coordination by the consultant/ engineer with other parties involved
45	External Scope Change Causes
46	Unforeseen factors during planning
47	Delay in obtaining permits from different government offices
48	Severe weather conditions on the job site
49	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)
50	Effect of social and cultural factors
51	Changes in government regulations and laws
52	Interference by financiers during planning
53	Market change

The above factors that drive scope change are identified from the literature review based on the works of Mochal(2006) ten good reasons for scope change during the implementation phase of a project combined with Saktar's (2010) three types of scope change which are Technical change, Market change and Contractual change and according to O'Berry (2015) there are internal and external causes of scope change.

Many scholars who worked on scope change agreed that a change in scope of a project during the implementation phase of a project result in delays, cost overrun and quality problems on the project deliverable. Tsongas(2011) argues that one cannot adjust or alter one of the constraints without in effect, altering the other sides, that is, if there is a request for a scope change mid-way through the execution of the project, the other two attributes (cost and time) will be affected in some manner.

For Tucson(2012) there is an intrinsic "push-pull" relationship between product scope and the triple constraints of quality, schedule, and budget. For example, reducing budget puts pressure on the other three items, and vice versa. It is agreed that any scope changing factor directly is a cause for schedule and cost overrun therefore all the fifty-one variables identified on Table 4:1 are causes of time and cost overrun. Besides scope change is a cause for quality problems therefore in addition to time and cost overrun most of the factors such as inadequate definition of specification, lack of stakeholder engagement during scoping, scope creep, scope change by downsizing the original plan, unclear and inadequate details in drawing, complexity of project design, poor quality of project deliverables, ineffective project

management, improper construction method, change in material, low level of equipment operators, all labour related causes, consultant related issues are identified as causes of quality problem on the project deliverables.

All the identified factors are parts of the questionnaire used in the research that respondents from the client, consultant and contractor side are required to consider.

4.3 Data Collection and Analysis

The basis of this study is on data collected from different personnel working on various building construction projects in Addis Ababa. And the research methodology will be:

- A questionnaire survey conducted on professionals working for a client, consultant and contractor on building construction projects in Addis Ababa.
- Critical analysis and interpretation of the data and presentations of the findings will follow.
- Recommendations of the possible mitigations measures

4.4 Questionnaire Response Rate

It was aimed to distribute the questionnaire to individuals; i.e., professionals working for the client, for consultants and for contractors. And it was possible to distribute 10 for the client and the same to the consultants and the contractors.

Table 4.2: Questionnaire distribution and response

Description	Number distributed	Number of respondents	% from distributed	% of number of responses
Client	10	5	50	22.72
Consultant	10	9	90	40.91
Contractor	10	8	80	36.36
Total	30	22	70	100.00

From the 30 questionnaires distributed a total of 21 responses were received, consisting of 4 (19.05%) from the client, 9 (42.86%) from consultants and 8 (38.09%) from contractors. The overall response rate was 87.50% as shown in Table 4.2

4.5 Characteristics of Respondents

Consultants with more than ten years of experience and contractors with more than five years of experience have responded all of which involved in building construction projects of different functions and sizes. Besides, 80% of contractors' respondents are from firms having more than ten years of experience in building construction projects.

4.6 Approaches to Data Analysis

In the questionnaire the respondents were requested to indicate the degree of impact and frequency of occurrence for each of the factors causing scope change during the implementation phase of the project. The degree of impact has five scales whereas the frequency of occurrence has four scales. Weighing is assigned to each of the categories as shown below.

Table 4.3: Weighing assigned to degree of impact and frequency of occurrence

Degree of Impact		Frequency of Occurrence	
Description	Weight	Description	Weight
Very high	5	High	4
High	4	Medium	3
Moderate	3	Low	2
Neutral	2	Never	1
None	1		

Then the responses given by each of the respondents have been summarized and counted in their respective categories separately for client, consultant and contractor. Summaries of responses have been attached as Appendix B.

The following indices as given by Assaf and Hejji (2006) and other statistical methods have been used to analyse the data.

a) The Severity Index for each of the variables has been computed with the following formula.

$$\text{Severity Index (S.I) (\%)} = \left(\frac{\sum_{i=1}^5 A_i N_i}{5 \sum_{i=1}^5 N_i} \right) * 100\% \dots\dots\dots [1]$$

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 for each of the variables has been computed with the following formula.

$$\text{Frequency Index (F.I) (\%)} = \dots\dots\dots * 100\%$$

$$\text{Frequency Index (F.I) (\%)} = \left(\frac{\sum_{i=1}^4 B_i N_i}{4 \sum_{i=1}^4 N_i} \right) * 100\% \dots\dots\dots 2$$

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 for each of the variables is computed as a product of both severity and frequency indices.

$$\text{Importance Index (I.I) (\%)} = [\text{S.I}(\%)*\text{F.I}(\%)]/100 \dots\dots\dots 3$$

d) Ranking of cause of scope change variables considers the severity index, frequency of occurrence and the important index on the basis of the values for each factors calculated from the response of the client, consultant and contractor by assigning the first rank for the highest value, the second rank to the next highest value and so on.

Kendall (1970) pointed out that there are cases that two or more rankings are similar and no preference can be expressed between them. Such rankings are called tied ranks. In such instances ranks are allocated using the “mid-rank method” where the values are determined by taking the average of the ranks, which they would possess if they were untied.

4.7 Research Findings and Results

Data analysis is done using the above mentioned statistical methods from the viewpoints of the client, consultants and contractors and illustrates the findings and results of the survey for the severity, frequency and importance indices of all the variables of scope change. And from the data analysis twenty factors are identified (Table 4:4) from the total of fifty-one scope change drivers.

Table 4.4: Importance of scope change causes

Rank	Client	Consultant	Contractor
1	Scope change	Proper scope is not done	Change in material price

2	Market change	Change in material price	Budget overrun
3	Inadequate definition of specification	Business needs changed	Proper scope is not done
4	Project resource change	Scope change	Change in standard of the building
5	Change in project funding	Lack of stake holder engagement during scoping	Poor and incomplete design
6	Budget overrun	Project implementation and complementation delays	Project implementation and complementation delays
7	Change in material prices	Inadequate definition of specification	Project schedule change
8	Shortage of construction materials required	Poor and incomplete design	Ineffective construction management by the project manager
9	Unforeseen factors during planning	Shortage of construction materials required	Inadequate definition of specification
10	Lack of stakeholder engagement during scoping	Business benefits changed	Delay in obtaining permits from different government offices
11	Business benefits changed	Scope Creep	Scope change
12	Project schedule change	Project Resource changes	Unavailability of utilities in site (water, electricity, telephone, etc.)
13	Proper scope is not done	Delay in obtaining permits from different government offices	Market change
14	Business needs changed	Ineffective construction management by the project manager	Corrective actions needed to occur during implementation
15	Changes in material types and specifications during construction	Change in standard of the building	Shortage of construction materials required
16	Project implementation and complementation delays	Scope change during construction (major change)	Unforeseen factors during planning
17	Scope change due to new demands for commercial buildings during construction	Original contract duration is too short	Scope change due to new demands for commercial buildings during construction
18	Poor and incomplete design	Project schedule change	Unavailability of technical professionals in the contractor's organization for the project
19	New discoveries of needs to be included in the plan during implementation	Scope change due to new demands for commercial buildings during construction	Original contract duration is too short
20	Decreasing the scope of the project	Unforeseen factors during planning	Unavailability of skill of manpower

4.8 Important categories of causes of scope change

4.8.1 Severity of scope change

Severity indices of all the variables of scope change have been computed using equation (1) for each of the three party's client, consultant and contractor independently.

The analysis of severity of variables indicates that the client is of the opinion that the most severe causes scope change ranked according to importance of index are first related to market; Business needs changed, Business benefits changed, Project Resource changes, Changes in project funding, Scope change due to new demands for commercial buildings during construction, Budget overrun and Scope change during construction (major change from the original) second in rank according to the client is related to contractual scope change causes which are Inadequate definition of specifications, Proper scope is not done, Lack of Stakeholder engagement during scoping and Projects schedule change. The third is related to material; Change in material prices, Shortage of construction materials required and Changes in material types and specifications during construction. The fourth severe cause of scope change for the client is related to external factor that is unforeseen factors during planning and the last in the rank is related consultant which is Poor and incomplete design

From the consultants' viewpoint the top five severe causes of scope change ranked according to importance of index are related to contractual related of scope change causes which are; Proper scope is not done and Lack of Stakeholder engagement during scoping. Second the most severe causes of scope change are material related Change in material prices and Shortage of construction materials required the third severe cause is related to market which are; Business needs changed, Business benefits changed, Project Resource changes, Scope change due to new demands for commercial buildings during construction, the fourth is related to consultant which is Poor and incomplete design.

From the contractors' perspective the first five severe causes of delays are: related first to contractual scope change causes; Original contract duration is too short, inadequate definition of specifications, Proper scope is not done, Projects schedule change. Second in the rank based on importance of index is related to market which are Scope change due to new demands for commercial buildings during construction, Budget overrun, Change in standard of the building and Scope change during construction (major change from the original). The third severe causes according to the contractor is related to material; Change in material prices, and Shortage of construction materials required. The fourth ranked cause for scope change is related to external factors which are Unforeseen factors during planning, Delay in obtaining permits from different government offices and Unavailability of utilities in site (such as, water, electricity, telephone, etc.) the fifth cause for scope change according to the contractor is related to consultant that is Poor and incomplete design.

It is observed that (table 4:6) for the three parties the five most severe causes for scope change are related to contractual, market, material, consultant and external factors for scope change. And the three most scope change factors are identified to be though the three parties ranking is different.

Contractual related

Market related

Material related

Calculation of the severity indices for all the variables separately for client, consultant and contractor are indicated in Appendix B.

4.8.2 Frequency of scope change causes

Similarly, frequency indices are calculated using the aforementioned equation (2). According to the client, the most frequent delay causes are: Business needs changed, Business benefits changed, Project Resource changes, Changes in project funding, Scope change due to new demands for commercial buildings during construction, Budget overrun and Scope change during construction (major change from the original) which are all related to market and Inadequate definition of specifications, Proper scope is not done, Lack of Stakeholder engagement during scoping and Projects schedule change are the second most frequent scope change causes related to contractual scope change causes.

According to the Consultants; the first in frequent scope change causes are contractual related which are; Original contract duration is too short, inadequate definition of specifications, Proper scope is not done, Lack of Stakeholder engagement during scoping, Projects schedule change and Scope creep. The second ranked frequent causes for scope change according the consultant are; Business needs changed, Business benefits changed, Project Resource changes, Scope change due to new demands for commercial buildings during construction and Scope change during construction (major change from the original)

According to the contractor's perspective the contractual related causes are the first frequent causes for scope change and are; Original contract duration is too short, inadequate definition of specifications, Proper scope is not done and Projects schedule change. The second frequent scope changes of the opinion of the contractor is related to market and are; Scope change due to new demands for commercial buildings during construction, Budget overrun, Change in standard of the building and Scope change during construction (major change from the original).

The client and consultants have two of the variables in common out of their respective five most frequent delay causes. Whereas the consultant and the contractor also has two common variables as the most frequent delay causes.

Concerning frequency of causes of scope change, all of the parties identified (Table 4:6) the same variables as the three most frequent causes, though ranking of each party is different. As for the severity the most frequent causes identified are:

Contractual related

Market related

Material related

Determination of the frequency indices for all the variables separately for client, consultant and contractor are indicated in Appendix B.

4.9 Importance of scope change causes

As illustrated in equation (3) above the Importance index is a product of severity and frequency indices, and same is used to rank the variables scope change. The variables were ranked independently based on the responses given by the client, consultants and contractors, and it is indicated in Appendix for C.

Twenty most important scope change variables from each set of rankings were identified and listed in Table 4.4 tens of these variables were common for the three sets; and are indicated in bold and shaded in Table 4.4 And also six variables were common for two of the sets, and fourteen of these variables were included in neither of the other two sets of top twenty rankings.

All the three parties agree on forty-five variables in the top twenty most important scope change variables out of total of fifty-one. This shows that there is more agreement between the three parties.

Based on the average of the important indices computed for each scope change variables for the three parties ranking is done to select the five most significant factors for scope change in building construction projects in Addis Ababa.

The three parties have ranked the top five important factors in the most ten scope change factors as indicated on Table 4:

Table 4.5: The top five Importance of scope change based on average

Rank	Causes of scope change	Importance index			
		Client	Consult.	Contractor	Average
1	Change in material price	91.20	88.58	84.38	88.05
2	Inadequate definition of specification	91.2	88.58	84.38	88.05
3	Cost change	100	88.15	71.09	86.41
4	Proper scope is not done	83.6	90.25	80.94	84.93
5	Budget overrun	91.2	62.65	81.56	78.47

4.9.1 Analysis of Major Categories of scope change and their relation with consequences.

The identified variables are grouped in to nine major categories as identified from the literature review. These major groups have also been ranked on the basis of the importance

indices of the variables under each of them. The importance indices of each group were determined by taking the average of the importance indices of the variables under the group in question.

These groups have then been ranked by assigning the first rank for the highest value, the second rank to the next highest value and so on. The results of ranking have been indicated in Tables 4.6. The result shows that the client, the consultant and the contractor have given the same rank to one important categories of scope change that is Contractual scope change causes, whereas the consultant and the contractor have given the same rank to four important categories which are materials related equipment related, consultant related and external scope change causes. In addition, the ranks one up to five are given to consultant related, contractual related, material related, market related scope change and technical causes accordingly by the three parties on Table 4.6

Table 4.6: Ranking of major categories of scope change cause

I. No	Major categories of scope change causes	Client		Consultant		Contractor	
		Imp. Index	Rank	Imp. Index	Rank	Imp. Index	Rank
1	Contractual scope change causes	79.85	2	79.9	2	68.03	2
2	Market related scope change causes	78.25	3	67.47	4	58.84	5
3	Technical scope change causes	67.56	5	47.42	9	57.23	6
4	Internal scope change causes (Contractor related)	63.74	6	62.69	5	48.66	9
5	Material related	88.4	1	77.7	3	64.84	3
6	Equipment related	61.8	7	51.19	8	52.21	8
7	Labour related	58.87	9	55.39	6	61.41	4
8	Consultant related	78.2	4	81.48	1	76.56	1
9	External scope change causes	61.43	8	52.23	7	55.21	7

Based on the data of table 4:6 to identify the critical factors causing scope change causes on building construction projects in Addis Ababa, the already identified factors have been ranked in their order of importance from the view points of the client, consultants and contractors.

Severity, frequency and importance indices have been determined using statistical methods for three groups according to responses from the client, consultants and contractors and the rankings have been performed independently for each of the parties by analysing the respective data gathered through questionnaire survey. The relationship of the scope changing factors with their consequences is analysed qualitatively based on the obtained quantitative result and the nine categories of scope change causes are analysed consecutively according to each severity and frequency of occurrence as follows.

4.9.1.1 Contractual scope change causes

Based on the average importance index calculated the rank given by the client, consultant and contractor for this major scope change category is 2, this indicate that there is an agreement in their rankings. The client gave a weight of 79.85%, the consultant, 79.9% and the contractor 68.03% to this category of cause.

Tsongas(2011) argues that one cannot adjust or alter one of the constraints without in effect, altering the other sides, that is, if there is a request for a scope change mid-way through the execution of the project, the other two attributes (cost, time and quality) will be affected in some manner. Therefore it is clear that contractual related scope change is the first causes of cost and schedule overrun in terms of severity and frequency of occurrence.

4.9.1.2 Market scope change causes

Based on the average importance index calculated the rank given by the client, consultant and contractor for this major scope change category 3, 4, and 5 this indicate that there is more agreement in the rankings of the three parties. From the twenty major causes of scope change business needs changed, business benefits changed, scope change due to new demands for commercial buildings during construction and scope change during construction (major change from the original) are selected for ranking by the three parties. The client gave a weight of 78.25%, the consultant, 67.47% and the contractor 58.84% to this category of cause.

Tsongas(2011) argues that one cannot adjust or alter one of the constraints without in effect, altering the other sides, that is, if there is a request for a scope change mid-way through the execution of the project, the other two attributes (cost, time and quality) will be affected in some manner. Therefore it is clear that market related scope change is the fourth causes of cost and schedule overrun in terms of severity and third reason in terms of frequency of occurrence.

4.9.1.3 Technical related causes of scope change

Based on the average importance index calculated the rank given by the client is 5, the consultant 9 and the contractor 6 for this major scope changes this indicates that there is an agreement in the rankings between the three parties. No cause for scope change is selected from this category for ranking by the three parties in the twenty major causes of scope change. The client gave a weight of 67.56%, the consultant, 47.42% and the contractor 57.23% to this category of cause.

Therefore technical related scope change is the fifth causes of cost and schedule overrun in terms of severity and third reason in terms of frequency of occurrence.

4.9.1.4 Internal scope change causes (contractor related)

Based on the average importance index calculated the rank given by the client is 6, the consultant 5 and the contractor 9 for this major scope changes this indicates that there is more agreement in the rankings between the client and consultant. From the twenty major causes of scope change Project implementation and complementation delays is selected for ranking by the client and consultant. The client gave a weight of 63.74%, the consultant, 62.69% and the contractor 48.66% to this category of cause.

Therefore it is clear that contractor related scope change is among the factors that cause cost and schedule overrun in terms.

4.9.1.5 Material relate scope change causes

Based on the average importance index calculated the rank given by the client is 1, the consultant and the contractor ranked this category 3 for this major scope changes this indicates that there is more agreement in the rankings between the three parties. Change in material prices and shortage of construction materials required are selected and ranked by the three parties in the twenty major causes of scope change. The client gave a weight of 88.4%, the consultant, 77.7% and the contractor 64.84% to this category of cause.

Tsongas(2011) argues that one cannot adjust or alter one of the constraints without in effect, altering the other sides, that is, if there is a request for a scope change mid-way through the execution of the project, the other two attributes (cost, time and quality) will be affected in some manner. Therefore it is clear that material related scope change is the third causes of cost and schedule overrun in terms of severity and second reason in terms of frequency of occurrence.

4.9.1.6 Equipment related scope change causes

Based on the average importance index calculated the rank given by the client is 7, the consultant and the contractor ranked this category 8 for this major scope changes this indicates that there is more agreement in the rankings between the three parties. And no cause for scope change is selected for ranking from this category by the three parties among the twenty major causes for scope change. The client gave a weight of 61.8%, the consultant, 51.19% and the contractor 52.21% to this category of cause.

Equipment related scope change is the cause of cost, schedule overrun and quality problem in terms of severity and frequency of occurrence.

4.9.1.7 Labour related scope change causes

Based on the average importance index calculated the rank given by the client is 9, the consultant 6 and the contractor ranked this category 4 for this major scope changes this indicates that there is more agreement in the rankings between the client and consultant and no cause for scope change is selected by the two parties. The client gave a weight of 58.87%, the consultant, 55.39% and the contractor 61.41% to this category of cause.

Therefore it is clear that labour related scope change is causes of cost and schedule overrun in terms of severity and frequency of occurrence.

4.8.1.8 Consultant related causes of scope change

Based on the average importance index calculated the rank given by the client is 4, the consultant and the contractor ranked this category 1 for this major scope changes this indicates that there is more agreement in the rankings between the consultant and the contractor. The factor Poor and incomplete design is selected and ranked by the three parties among the twenty major causes of scope change.

The client gave a weight of 78.25%, the consultant, 67.47% and the contractor 58.84% this category of cause. Therefore it is clear that consultant related scope change is the first causes of cost and schedule overrun according to consultant and contractor but according to the client it is fourth in terms of severity and frequency of occurrence

4.8.1.9 External scope change causes

Based on the average importance index calculated the rank given by the client is 7, the consultant and the contractor ranked this category 8 for this major scope changes this indicates that there is more agreement in the rankings between the consultant and the contractor. Delay in obtaining permits from different government offices is selected and ranked by the consultant and the contractor among the twenty major causes of scope change. The client gave a weight of 61.43%, the consultant, 52.23% and the contractor 55.21% this category of cause. Therefore external related scope change is causes of cost and schedule overrun in terms of severity and frequency of occurrence.

Chapter 5 Discussions and Recommended Mitigation Measures

5.1 Introduction

This chapter focuses on answering the general and specific objectives of the research question: how quality problems, delays and cost overruns as a result of scope change could be substantially minimized the causes and effects of scope change in the implementation of the upcoming building construction projects in Addis Ababa. The critical factors of scope change and their consequences are assessed have in Chapter 4, and it is believed that mitigating these factors would substantially minimize the problems of quality, delays and cost overruns the city building projects in the future.

5.2 General objectives of the research

This section focuses on recommending measures to substantially minimise the causes and the effects of scope change in the implementation of the upcoming projects.

5.2.1 Contractual scope change causes

This major cause of scope change includes causes 1-6. The consultant ranked all the identified items in this category in the first 20 most scope change causes whereas the contractor included items 1, 2, 3 and 5 in the most 20 most scope change causes. The client ranked items 2, 3, 4 and 5 in the most 20 scope change causes

All the parties ranked Original contract duration is too short, inadequate definition of specifications, Proper scope is not done and Lack of Stakeholder engagement during scoping in the most 20 scope change causes.

To mitigate this major scope change causes the three parties:

- The consultant shall provide adequate and full specification of the work together with clear and detailed working drawings of the project and Bill of Quantities with minimum percentage of quantity discrepancy so as to avoid future dispute over under or over quantified items that can be prone to cost overrun which can lead to scope change.
- Prior to signing the contract three parties shall come together to revise all the furnished contract documents and agree on the scope of the work, the contract duration and all other issues included on the contract document.
- The three parties shall select dispute resolution method.
- The client shall provide clear objectives of the project to consultant to prepare full contract document. Hence, it is recommended that, in order to define a clear and comprehensive project objective, the client shall give sufficient time for the project development phase and consider the interest of all potential stakeholders.
- The client should have sufficient number of qualified professionals for quicker analysis of contractors' submissions. Besides, well-established system of recording of day-to-day activities of a project in order to support any recommendation with documented evidences; this will help to facilitate the decision process.

5.2.2 Market related scope change causes

This major cause of scope change causes includes items 7-19. The consultant ranked items 7,8,9,13,17 and 18 of this category in the first 20 most scope change causes whereas the contractor included items 7,8,13,14,16 and 17. The client ranked items 7, 8, 9, 10, 13, 14, 17 and 20 in the most 20 scope change causes

This category of major scope change causes is the most agreed upon cause by all the three parties and it is one of the many factors for project success. Due to external market conditions and competitors' action it is inevitable that market conditions influence the scope of the project during implementation phase of the project. To mitigate this major scope change causes the three parties:

- The client shall identify a suitable business which is feasible and promising prior to scoping the project.
- The client shall provide ample time to the business consultant to examine and further appraise the already selected business.
- The required finance to implement the project has to be secured with minimum contingency prior to the implementation phase of the project.
- Due attention shall be given to assess the business needs and certain priorities of the area so as to provide a suitable building that can accommodate the needs.
- During scoping of the project all the stakeholders should take into account the depriving factors which might have adverse impact during implementation.

5.2.3 Technical scope change causes

This cause of scope change includes items 20-24. The consultant did not rank any of the items outlined but the contractor ranked item 20 as the seventh most scope changing causes in the most 20 scope change causes whereas the client ranked no items from technical scope change causes in the most 20 scope change causes.

This category of major scope change causes is the least agreed upon by the three parties. To mitigate this major scope change causes the three parties:

- The consultant shall investigate all the soil, sub-soil and surrounding conditions, set the project baseline at the planning stage to measure performance, shall provide clear and adequate drawings with detailed and clear specifications of the work.
- Adequate risk assessment shall be conducted taking into account all the related resources which are pertinent to complete the project.
- During implementation of any project it is believed that change is inevitable for any sound reason, the client and the consultant shall ensure that the scope of work is well defined, that the schedule and the resource plan is focused on the deliverables and how to complete the deliverables described.

5.2.4 Internal scope change causes

This scope changing cause is particular to the implementation phase of the project and has an impact on the project due to the following five identified factors:

5.2.5 Contractor related

This cause of scope change includes items 25-31. The consultant ranked items 28,29 and 30 in the most 20 scope changing whereas the contractor ranked item 29 as the tenth causes among the 20 most scope change causes but the client ranked no item from this category of factors that cause scope change during implementation phase of a building project.

This category of scope change causes is substantially agreed upon by the three parties. To mitigate this major scope change causes the three parties:

- The contractor shall include experienced and competent project manager for the project in the project team.
- In pre-qualification stage, contractors' ability to avail the minimum requirement for provision of skilled human resources shall be considered as major criteria.
- During the course of construction, contractor's deployment of resources shall be periodically reviewed in line with the approved work program.
- During the implementation phase of the project the contractors' use of appropriate construction techniques shall be assessed and if any new construction technique is provided by the contractor the consultant shall approve it before proceeding with the technique.
- Contractors' quality assurance manual shall be reviewed before the award of contract and during construction there has to be close follow-up by the consulting engineer towards its implementation.

5.2.6 Material related

This cause of scope change includes items 32-34. The consultant and the contractor both ranked items 32 and 33 in the most 20 scope changing whereas the client ranked all the three items in the 20 most scope changing causes.

This category of scope change causes is the most agreed factor by all the three parties. To mitigate this major scope change causes the three parties:

- During the design phase detailed investigation of construction materials shall be conducted with reliable estimation of quantities and their availability on the market.
- The consultant shall follow up status of material procurement starting from the day of ordering until time of delivery in line with the work program of the contractor.

5.2.7 Equipment related

This cause of scope change includes items 35-37. The consultant and the client ranked none of these items as major causes in the most 20 scope changing but the contractor ranked item 35 as the last factor in the 20 most scope change causes.

This category of scope change causes is not agreed upon by the three parties. To mitigate this major scope change causes the three parties:

- The consultant shall check the ability and the availability of major equipment required for the construction with sufficient stock of spare parts and/or access to replacement equipment in cases of breakdown of major equipment during bidding stage.
- During construction phase the consultant shall assess the average productivity of contractors' major equipment in line with the approved work program.

5.2.7 Labour related

This cause of scope change includes items 39-40. The three parties ranked none of these items in the most 20 scope changing cause.

This category of scope change causes is not agreed upon by the three parties but to mitigate this scope change causes the consultant and the client:

- The quality and experience of the contractors' personnel assigned to the construction project shall be assessed.
- Number and experience of the technical professionals during bidding stage and same has to be carefully monitored during construction. Any proposal for replacement of these personnel shall also consider better or equivalent qualifications

5.2.8 Consultant related

This cause of scope change included item 41. All the three parties fully agreed on this item and ranked in the most 20 scope changing causes. To mitigate this major scope change causes the three parties:

- The client shall introduce a system of evaluating and selecting the experience of consultants for possible award of other project.
- The client shall evaluate and select potential and competent consultant with similar work experience to the intended project.
- The client shall set and follow strict qualification criteria in the approval of the proposal for the supervision staff assigned on the project and create a system to monitor their performance periodically.
- The client shall reasonably relax the restrictions on the engineer's duties and authority for designing the project and proper administration of contract between the client and contractor.

5.2.9 External scope change causes

This cause of scope change includes items 42-49. The consultant ranked items 42 and 43 in the most 20 whereas the contractor ranked item 42, 43, 45 and 49 but the client ranked 42 and 49 as the major causes among the 20 most scope change causes.

This category of scope change causes is substantially agreed upon by the three parties. To mitigate this major scope change causes the three parties:

- To mitigate unforeseen factors the client shall set a contingency plan accompanied by substantial funds in resources and budgets.
- The client shall provide ample time to the consultant to process and obtain the necessary permits from different government offices.
- The client shall make available the necessary utilities such as electric power, municipality water supply and telephone line to the contractor.
- Any boundary condition with neighbouring property line has to be settled by the client prior to bidding and awarding the construction project.
- For any change due to government regulations and laws the client and the consultant shall make a tight change control process to keep the project on track.
- For externally financed project the client shall ensure the full consent and approval of the project by the financier.
- All the three parties shall follow-up the market periodically to assess the availability of construction materials on the market to avoid shortage which lead to scope change.

5.3 Specific objectives of the research

This section focuses on evaluating the three selected building construction projects completed in the past ten years and one project under construction during the research is conducted, identify common problem areas in these building projects and come up with a recommendation for future building construction projects in Addis Ababa.

a. Africa Insurance Company Bole Branch Head Office

This project is a new construction with two basements, Ground floor, one mezzanine and twelve upper floors. The project location is at Bole Sub City on Africa Avenue near Japan Embassy area. The project commenced on 21 October 2015 and the original completion date was 12 April 2017 with a contract period of 545 calendar days. The Original contract amount was ETB 130,534,276.54.

However, this project has been substantially completed on 05 May 2018; that is after 596 days of the expected completion date, with a total project cost of ETB 134,359,972.82. This project is delayed by 109.40% of the original project duration and the cost overrun is 2.93% more than what was budgeted originally.

According to the project client and consultant the reason for the cost overrun is due to change of the material of the partition wall. Originally it was considered to be built of Hollow Concrete Blocks but during construction the client changed the functional scope of the building proposing some floors for rent, therefore to meet customers' requirement the partition wall is changed to Aluminium panels which resulted the 2.93% cost overrun. The reason for the schedule slippage are first design change as a result of unforeseen events during scoping and planning phase of the project, the second reason is due to scope change of the partition wall which took more time to import the Aluminium panels from abroad.

b. Ethiopian Construction, Design, Supervision and Works Corporation (ECDSWC) Head Quarter.

This project is a new construction with two basements, Ground floor, one mezzanine and twelve upper floors. The project location is at Bole Sub City on the ring road leading to Megenanga near Imperial Hotel. The project commenced on 21 September 2011 and the original completion date was 25 March 2014 with a contract period of 900 calendar days. The Original contract amount was ETB 81,000,000.00.

However, this project has been completed on 05 May 2015; that is after 360 days of the expected completion date, with a total project cost of ETB 86,250,000.00. This project is delayed by 140.11% of the original project duration and the cost overrun is 7.72% more than what was budgeted originally.

According to the project client the reason for the cost overrun is due to scope change of Block 3 of the office complex, addition of data System on all blocks and changing of the type of water proof work which all accounted for 140.11% of schedule overrun and a 7.72% of cost overrun from originally anticipated.

c. Higher Government Officials and Head of State Residential Buildings.

This residential project is a new four blocks construction with Ground floor, one two upper floors. The project location is at yeka sub-city. The project commenced on 18 May 2014 and the original completion date was 18 May 2016 with a contract period of 262 calendar days. The Original contract amount was ETB 133million.

However, this project has been completed on 18 May 2018; that is after 1198 days of the expected completion date, with a total project cost of ETB 262million. This project is delayed by 608.33% of the original project duration and the cost overrun is 197% more than what was budgeted originally.

According to the project contractor the reason for the cost overrun is due lack of subsurface investigation, several changes on the main building's finishing materials, redesigned of the site work with jobs including the fence, asphalt compound roads, drainage works and compound utilities and addition of security Systems on all blocks and changing of the type of water proof work which all accounted for 608.33% of schedule overrun and a 197% of cost overrun from originally anticipated.

d. Ethiopian Government Communications Affairs Head Office Complex.

This project is a new construction project which is now on implementation with two basements, Ground floor and fifteen upper floors. The project location is at Arada Sub-City around 4 Kilo. The project commenced on February 8 2017 and the original completion date was 8 February 2019 with a contract period of 730 calendar days. The Original contract amount was ETB 1.2Billion.

Though the project is under way and expected to be complete on 8 February 2019 due to some changes made on the four sides of the buildings' external finishing works the contractor has already claimed an amount of ETB 100million for the new scope of the work and the

consultant and the client have approved the claimed amount. There is also an approved additional 180 days of time extension for the contractor to compensate the time lapsed due to unclear design of the work that required design revision of the building and this led to 8.33% of cost overrun and 24.66% of schedule slippage at a stage where it is found now.

In general the above cases give a clear picture of the existence and extent of severity of scope change that resulted in schedule slippage and cost overrun problems in building projects undertaken in Addis Ababa city. Further, it is observed that in one of the projects which is underway, the Ethiopian Government Communications Affairs Head Office Complex; there is the symptom of delay and overrun with 8.33% of cost overrun and 24.66% of schedule slippage due to changing of the scope of the project which is in its implementation phase. On the Ethiopian Higher Government Officials and Head of State Residential Buildings project the additional time required was six times much more than the original contract period with almost double the contract price. In the projects selected in the case study the common problems were similar such as scope change during implementation phase of the projects which resulted in variation, price escalation and change in design and specification.

Fundamentally, the extent of the problem observed in the cases referred to calls for the importance of giving due attention to the issues and the need for investigating the main factors causing the problem in a wider perspective; in order to be able to substantially minimize their impacts on the upcoming projects all the identified scope changing factors and the related consequences of the changes should be considered and the provided mitigation measures should be adopted to substantially minimize time and cost overrun and to avoid quality problems of the project deliverables.

5.4 Conclusion

Many scholars agree that a change in scope of a project occurs for various reasons to keep the project on track a tight change control process shall be made. Once the changes are made, it is vital to assess changes in the dimensions of the budget plan, the resource plan, and the project schedule and also if extra work is added to the project and it is not self-funding and more budget should be added to cover this increase in workload.

As the project implementation goes further the scope changes will get costly and the financial impact of the change can be quite large to mitigate such enormous impact on the project all the stakeholders shall set project baseline at the planning stage to measure performance against it, verify scope and project execution plan with all stakeholders and shall ensure that the scope of work is well defined and the schedule and the resource plan is focused on the deliverables and how to complete the deliverables described. Any work that is not part of the defined scope should not be included in the project schedule.

Appendix A: Questionnaire

I am currently undertaking a research study on Assessing The Antecedents Scope Change: The Case Of Building Construction Projects in Addis Ababa city, for the fulfillment of my M.A study in project management at Addis Ababa University.

I would like to confirm you that your response will be kept strictly confidential and will be used exclusively for the purpose of this research. I would appreciate if you complete and return it within **one week** of your receipt of same. Please indicate your response by ticking (X or √) the appropriate box (es), and also filling the blank spaces provided as appropriate.

Section 1: General Background Information

1.1 Name of organization: _____

1.2 Type of organization:

Employer ☐ Contractor ☐ Consultant ☐
Other ☐ (Please specify) _____

1.3 Years since establishment:

< 5 years ☐ 5 – 10 years ☐ 10 years ☐

1.4 Your work experience in building related projects

< 5 years ☐ 5 – 10 years ☐ > 10 years ☐

1.5 Your Name, Title and Contact address:

Name (optional): _____

Job Title: _____

Section 2: Assessment of Degree of Impact and Frequency of Occurrence

The following factors for scope change in building construction projects were identified from review of literature, discussion with experienced professionals and personal experience. Please think in terms of your organization's experience and/or your knowledge about the degree of impact and frequency of occurrence of the under listed factors on building projects and respond by ticking (X or ☐) in the column representing your selection. Please note that scope change refers to any change to the original purpose of the building, such as changing the purpose completely, increasing the or decreasing the purpose, in this research refers to schedule overrun refers to time exceeding beyond the original contract period; hence, all extensions of time granted to the original time for completion were considered as delays. Similarly, quality refers to the end feature of the building proposed in the original design and specification included on the contract.

No.	Factors Causing Scope change	Degree of Impact					Frequency			
		Very high	High	Moderate	Neutral	None	High	Medium	Low	Never
	Contractual Scope Change Causes									
1	Original contract duration is too short									
2	Inadequate definition of specification									
3	Proper scope is not done									
4	Lack of stakeholder engagement during scoping									
5	Project schedule change									
6	Scope Creep									
	Market Related Scope Change Causes									
7	Business needs changed									
8	Business benefits changed									
9	Project Resource changes									
10	Changes in project funding									
11	Increasing the scope of the project									
12	Decreasing the scope of the project									
13	Scope change due to new demands for commercial buildings during construction									
14	Budget overrun									

15	Contractual change such as contract conditions & terms, scope of work, requirements										
16	Change in standard of the building										
17	Scope change during construction (major change from the original)										
18	Schedule change by downsizing the original plan during implementation										
	Technical Scope Change Causes										
19	Corrective actions needed to occur during implementation										
20	Unclear and inadequate details in drawings										
21	Complexity of project design										
22	Realized risk										
23	Inadequate investigations by the designer during the design phase										
	Internal scope change causes Contractor Related										
24	New discoveries of construction methods during implementation										
25	New discoveries of needs to be included in the plan during implementation										
26	Poor quality of the project deliverables										
27	Project implementation and complementation delays										
28	Ineffective construction management by the project manager										
29	Improper construction methods implemented by the contractor										
30	Scope modification due to Technical changes										
	Material Related Scope Change Causes										
31	Change in material prices										
32	Shortage of construction materials required										
33	Changes in material types and specifications during construction										

	Equipment Related Scope Change Causes									
34	Equipment breakdowns									
35	Unavailability the of equipment required									
36	Low level of equipment-operator's skill									
	Labor Related Scope Change Causes									
37	Unavailability of technical professionals in the contractor's organization for the project									
38	Unavailability of skill of manpower									
39	Poor qualification of the contractor's technical staff assigned to the project									
	Consultant Related									
40	Poor and incomplete design									
41	Poor qualification of consultant/ engineer's staff assigned to the project									
42	Poor communication between the consultant/ engineer and other parties involved									
43	Poor coordination by the consultant/ engineer with other parties involved									
	External scope change causes									
44	Unforeseen factors during planning									
45	Delay in obtaining permits from different government offices									
46	Severe weather conditions on the job site									
47	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)									
48	Effect of social and cultural factors									
49	Changes in government regulations and laws									
50	Interference by financiers during planning									
51	Market change									

Appendix B: Computation and Analysis

Computation of Severity, Frequency and Importance Indices and Ranking of Variables - Client																
I/No.	Degree of Impact					Total Response	Severity Index (%)	Frequency of Occurrence				Total Response	Frequency Index (%)	Importance Index (%)	Rank	
	Very High 5	High 4	Moderate 3	Neutral 2	None 1			High 4	Medium 3	Low 2	Never 1					
Factors causing scope change																
Contractual Scope Change Causes																
1		3	2			5	72.00	1	4			5	80.00	57.60	39	
2	3		2			4	105.00	3	2			5	90.00	94.50	3	
3	3	1	1			5	88.00	4	1			5	95.00	83.60	13	
4	3	2				5	92.00	4	1			5	95.00	87.40	10	
5	2	2	1			5	84.00	5				5	100.00	84.00	12	
6	1	3	1			5	80.00	3	2			5	90.00	72.00	23	
Market Related Scope Change Causes																
7	3	2				5	92.00	3	2			5	90.00	82.80	14	
8	4	1				5	96.00	3	2			5	90.00	86.40	11	
9	3	2				5	92.00	5				5	100.00	92.00	4	
10	4	1				5	96.00	4	1			5	95.00	91.20	5	
11	3	1	1			5	88.00	2	2	1		5	80.00	70.40	25	
12	3	1	1			5	88.00	2	3			5	85.00	74.80	20	
13	2	3				5	88.00	3	2			5	90.00	79.20	17	
14	4	1				5	96.00	4	1			5	95.00	91.20	6	
15		3	2			5	72.00	1	3	1		5	75.00	54.00	42	
16	2	1	1	1		5	76.00	4	1			5	95.00	72.20	22	
17	5					5	100.00	5				5	100.00	100.00	1	
18	3	1	1			5	88.00	2	2		1	5	75.00	66.00	29	
Technical Scope Change Causes																
19	1	2	1	1		5	72.00	2	3			5	85.00	61.20	33	
20	2	2			1	5	76.00	3	1	1		5	85.00	64.60	30	
21	1	3	1			5	80.00	3	1	1		5	85.00	68.00	28	
22	3	1	1			5	88.00	2	2	1		5	80.00	70.40	26	
23	3	2				5	92.00	3		2		5	80.00	73.60	21	
Internal Scope Change Causes(Contractor related)																
24	1	1	3			5	72.00	1	2	2		5	70.00	50.40	47	
25	2	2	1			5	84.00	3	2			5	90.00	75.60	19	
26		3	2			5	72.00	1	3	1		5	75.00	54.00	44	
27	2	1	2			5	80.00	5				5	100.00	80.00	16	
28	1	2	2			5	76.00	2	3			5	85.00	64.60	31	
29	1	1	3			5	72.00	1	4			5	80.00	57.60	37	
30	1	3	1			5	80.00	3		2		5	80.00	64.00	32	

Material Related Scope Change Causes																	
31	4	1				5	96.00	4	1			5	95.00	91.20		7	
32	4	1				5	96.00	4	1			5	95.00	91.20		8	
33	3	2				5	92.00	3	2			5	90.00	82.80		15	
Equipment Related Scope Change Causes																	
34	1	3	1			5	80.00	1	3	1		5	75.00	60.00		35	
35	2	2	1			5	84.00	2	3			5	85.00	71.40		24	
36	1	1	3			5	72.00		5			5	75.00	54.00		43	
Labor Related Scope Change Causes																	
37	2	2	1			5	84.00		4	1		5	70.00	58.80		36	
38	1	2	2			5	76.00	2	2	1		5	80.00	60.80		34	
39	1	2	2			5	76.00		5			5	75.00	57.00		41	
Consultant Related Scope Change Causes																	
40	3	2				5	92.00	3	1	1		5	85.00	78.20		18	
41		1	1	1		5	36.00	1	1	1	1	1	35.00	12.60		50	
42		2		3			36.00		2		3		36.00	13.00		49	
43	1	1	1	1			35.00		2	1	1	1	28.00	10.00		51	
External delay causes																	
44	4		1			5	92.00	4	1			5	95.00	87.40		9	
45	2		3			5	76.00	4		1		5	90.00	68.40		27	
46		2	1	1	1	5	56.00		2	3		5	60.00	33.60		48	
47	2		2	1		5	72.00	3		2		5	80.00	57.60			
48		3	1		1	5	64.00	2	1	1	1	5	70.00	44.80		47	
49	1	2	2			5	76.00	1	2	2		5	70.00	53.20		46	
50	1	2	1	1		5	72.00	1	2	2		5	70.00	50.40		45	
51	4	1				5	96.00	5				5	100.00	96.00		2	

NB: The shaded boxes indicate the most 20 scope change causes

Weightings Very High = 5

High = 4

Moderate = 3

Neutral = 2

None = 1

1	4	2	3			9	82.22	6	2	1		9	88.89	73.09	18
2	4	4	1			9	86.67	7	2			9	94.44	81.85	7
3	5	4	0	1		9	95.56	7	2			9	94.44	90.25	1
4	6	2	1			9	91.11	7	2			9	94.44	86.05	5
5	1	6	2			9	77.78	6	2	1		9	88.89	69.14	19
6	5	3	1			9	88.89	6	2	1		9	88.89	79.01	12
Market Related Scope Change Causes															
7	6	3				9	93.33	7	2			9	94.44	88.15	3
8	6	1	2			9	88.89	6	2	1		9	88.89	79.01	11
9	5	4				9	91.11	6	1	2		9	86.11	78.46	13
10	4	1	4			9	80.00	3	5	1		9	80.56	64.44	24
11	2	4	3			9	77.78	4	2	2	1	9	75.00	58.33	30
12	1	2	3		1	9	51.11	3	2	3	1	9	69.44	35.49	45
13	4	3	2			9	84.44	5	2	1	1	9	80.56	68.02	20
14	4	1	3	1		9	77.78	5	2	1	1	9	80.56	62.65	26
15	3	3	1	1		9	71.11	4	3		1	9	72.22	51.36	38
16	5	2	2			9	86.67	5	4			9	88.89	77.04	16
17	6	3				9	93.33	7	2			9	94.44	88.15	4
18	2	2	4	1		9	71.11	3	3	2	1	9	72.22	51.36	37
Technical Scope Change Causes															
19	1	5	3			9	75.56	4	2	3		9	77.78	58.77	29
20	5	1	1	2		9	80.00	5	1	3		9	80.56	64.44	25
21	0	1	5	2	1	9	53.33		4	3	2	9	55.56	29.63	49
22	2		3	4		9	60.00	1	2	4	2	9	55.56	33.33	46
23	4	1	2	1	1	9	73.33	4	1	2	2	9	69.44	50.93	39
Internal Scope Change Causes(Contractor related)															
24	0	2	4	1	2	9	53.33	2	2	3	2	9	61.11	32.59	47
25	1	4	1	1	2	9	62.22	5	1	0	3	9	72.22	44.94	41
26	2	5	1	1		9	77.78	4	4	1		9	83.33	64.81	23
27	4	4	1			9	86.67	8	1			9	97.22	84.26	6
28	5	3	1			9	88.89	6	3			9	91.67	81.48	9
29	4	3	2			9	84.44	6	3			9	91.67	77.41	15
30	1	3	5			9	71.11	1	7	1		9	75.00	53.33	34

Material Related Scope Change Causes																	
31	4	1					5	96.00	4	1				5	95.00	91.20	7
32	4	1					5	96.00	4	1				5	95.00	91.20	8
33	3	2					5	92.00	3	2				5	90.00	82.80	15
Equipment Related Scope Change Causes																	
34	1	3	1				5	80.00	1	3	1			5	75.00	60.00	35
35	2	2	1				5	84.00	2	3				5	85.00	71.40	24
36	1	1	3				5	72.00		5				5	75.00	54.00	43
Labor Related Scope Change Causes																	
37	2	2	1				5	84.00		4	1			5	70.00	58.80	36
38	1	2	2				5	76.00	2	2	1			5	80.00	60.80	34
39	1	2	2				5	76.00		5				5	75.00	57.00	41
Consultant Related Scope Change Causes																	
40	3	2					5	92.00	3	1	1			5	85.00	78.20	18
41		1	1	1			5	36.00	1	1	1	1		1	35.00	12.60	50
42		2		3				36.00		2		3			36.00	13.00	49
43	1	1	1	1				35.00		2	1	1		1	28.00	10.00	51
External delay causes																	
44	4		1				5	92.00	4	1				5	95.00	87.40	9
45	2		3				5	76.00	4		1			5	90.00	68.40	27
46		2	1	1	1		5	56.00		2	3			5	60.00	33.60	48
47	2		2	1			5	72.00	3		2			5	80.00	57.60	
48		3	1		1		5	64.00	2	1	1	1		5	70.00	44.80	47
49	1	2	2				5	76.00	1	2	2			5	70.00	53.20	46
50	1	2	1	1			5	72.00	1	2	2			5	70.00	50.40	45
51	4	1					5	96.00	5					5	100.00	96.00	2

NB: The shaded boxes indicate the most 20 scope change causes

Weightings Very High = 5

High = 4

Moderate = 3

Neutral = 2

None = 1

Computation of Severity, Frequency and Importance Indices and Ranking of Variables - contractor

I/No.	Degree of Impact					Total Response	Severity Index (%)	Frequency of Occurrence				Total Response	Frequency Index (%)	Importance Index (%)	Rank
	Very High 5	High 4	Moderate 3	Neutral 2	None 1			High 4	Medium 3	Low 2	Never 1				
Factors causing scope change															
Contractual Scope Change Causes															
1	4	3			1	8	82.50	4	2	1	1	8	78.13	64.45	19
2	5	1	1	1		8	85.00	5	1	2		8	84.38	71.72	9
3	6	1	1			8	92.50	5	2	1		8	87.50	80.94	3
4	5		1	1	1	8	77.50	4	1	2	1	8	75.00	58.13	27
5	3	4	1			8	85.00	5	2	1		8	87.50	74.38	7
6	4	1	1	1	1	8	75.00	4	2	1	1	8	78.13	58.59	26
Market Related Scope Change Causes															
7	3	1	2	2		8	72.50	5	1	2		8	84.38	61.17	23
8	4		3	2		8	82.50	3	2	3		8	75.00	61.88	22
9	3	1	3		1	8	72.50	2	5	1		8	78.13	56.64	28
10	3	1	3	1		8	75.00	2	1	4	1	8	62.50	46.88	38
11	4		2	2		8	75.00	3	1	4		8	71.88	53.91	31
12	3	1	2		2	8	67.50	4		3	1	8	71.88	48.52	33
13	5		1	1		7	85.71	3	2	2		7	78.57	67.35	17
14	6	1		1		8	90.00	6	1	1		8	90.63	81.56	2
15	3	2	2	1		8	77.50	3	1	4		8	71.88	55.70	29
16	4	3	1			8	87.50	5	3			8	90.63	79.30	4
17	5	1	2			8	87.50	5	1	1	1	8	81.25	71.09	11
18	3	1	2	1		8	67.50	2	2	3	1	8	65.63	44.30	40
19	1	2	3	1		7	68.57	1	2	1	3	7	53.57	36.73	45
Technical Scope Change Causes															
20	3	3	2			8	82.50	3	5			8	84.38	69.61	14
21	3	2	1	2		8	75.00	4	2	2		8	81.25	60.94	24
22	1		6	1	1	8	65.00	1	4	2	1	8	65.63	42.66	41
23	4		2		1	8	67.50	4	2		1	8	71.88	48.52	34
24	3	3	2			8	82.50	3	3	2		8	78.13	64.45	21
Internal Scope Change Causes(Contractor related)															
25		3	4		1	8	62.50		1	6	1	8	50.00	31.25	48
26	2	1	3	1	1	8	65.00	1	1	5	1	8	56.25	36.56	46
27	2	1	2	2	1	8	62.50	3		5	1	8	71.88	44.92	39
28	4	2	1	1		8	82.50	5	3			8	90.63	74.77	6
29	1	4	3			8	75.00	5	2	2	1	8	96.88	72.66	8
30		2	4	1	1	8	57.50	1	2	3	2	8	56.25	32.34	47
31	2	2	3		1	8	70.00	3	2	1	2	8	68.75	48.13	36

Material Related Scope Change Causes																	
32	6	1		1		8	90.00	7		1		8	93.75			84.38	1
33	4	1	2	1		8	80.00	5	1	2		8	84.38			67.50	15
34	1	2	3	2		8	65.00	2	1	5		8	65.63			42.66	43
Equipment Related Scope Change Causes																	
35	3	1	3	1		8	75.00	2	4	3		8	81.25			60.94	25
36	3	1	2	2		8	72.50	1	3	4		8	65.63			47.58	37
37	1	3	3	1		8	70.00	1	4	3		8	68.75			48.13	35
Labor Related Scope Change Causes																	
38	3	1	4			8	77.50	2	5	2		8	84.38			65.39	18
39	4	1	3			8	82.50	3	3	2		8	78.13			64.45	20
40	3	1	3		1	8	72.50	3	2	3		8	75.00			54.38	30
Consultant Related Scope Change Causes																	
41	5	1	2		0	8	87.50	5	2	1		8	87.50			76.56	5
External delay causes																	
42	6		2			8	90.00	2	4	2		8	75.00			67.50	16
43	4	2	2			8	85.00	4	3	1		8	84.38			71.72	10
44	1	3		3		8	57.50	2	2	4		8	68.75			39.53	44
45	4	3	1			8	87.50	5		3		8	81.25			71.09	12
46	2	2	3		1	8	70.00		2	3	1	8	40.63			28.44	49
47	3	2	1	2		8	75.00	2	2	4		8	68.75			51.56	32
48	2	3		2	1	8	67.50	2	2	2	2	8	62.50			42.19	42
49	4	2	1	1		8	82.50	5	1	2		8	84.38			69.61	13

NB: The shaded boxes indicate the most 20 scope change causes

Weightings Very High = 5

High = 4

Moderate = 3

Neutral = 2

None = 1

References

1. Assaf Said A., Al-Khalil Mohammed, and Al-Hazim Muhammad (1995) Causes of Delay in Large Building Construction Projects. *Journal of Management in Engineering*. ASCE 11(2), 45 – 50.
2. Ardity, D., Akan, G. T. and Gurdamar, S. (1985) Cost overruns in public projects, *International Journal of Project Management*, 3, pp. 218–225.
3. Amit Sarkar (2010) simple steps to change your project
<http://www.techrepublic.com/article>
4. Birkby G. and Brough P. (2002) *Construction Companion to Extensions of Time*. London; RLBA Enterprises.
5. Bramble, Barry B. and Callahan, Michael T. (1987) *Construction Delay Claims*, Wiley Law Publications, 2nd Edition, U.S.A.
6. Clifford F. and Erik W. *Project Management, The managerial Process*, 3rd edition, pp.141
7. Elise (2009) *the Hand Book of PMP*, CPHIMS
8. Fried et. al (2008) *The Foundation of Project Management, Excellence* 2nd edition, www.wiley.com/go/permission
9. Jahren, Charles T. and Ashe, Andrew M. (1990) Predictors of Cost-Overrun Rates, *Journal of Construction Engineering and Management*, September, Vol. 116, No. 3, pp.54
10. Mochal, T(2006) Poor Scope Management Practices <http://www.techrepublic.com/article>
11. O'Berry, A. Burto, L.Stross and G. Wood (2015) *The Motor*, Volume 109, pp300
12. Rowland, H.J. (1981). *The Causes and Effects of Change Orders on the Construction Process*. Thesis, Georgia Institute of Technology, Atlanta, Georgia, 1981.
13. Roberg ,O.(2017) *Project Scheduling*, Safran Project
14. Shi, Q. (2001) UN Research Institute for Social Development
<http://unrsid.org/unrsid/newsview>
- 15.Tsongas, T.(2011) *scope, time and cost, managing the triple constraints*
<http://programSuccess.wordpress.com>
16. Tucson, MW. (2012) *scope, time and cost, managing the triple constraints*
<http://programSuccess.wordpress.com>
17. S. M. VidalisA, F.T. NajafiB, *Cost and time overrun in highway construction*, Department of Civil and Coastal Engineering, University of Florida, U.S.A. 2002.