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DEPARTEMENT OF PROJECT MANAGEMENT

THE EFFECT OF DESIGN CHANGE ON BUILDING PROJECT PERFORMANCE IN ADDIS ABABA

THE CASE OF G1CONTRACTORS, G1 CONSULTANTS AND CLIENTS

BY

BETHELHEM ASMEROM

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ADDIS ABABA, ETHIOPIA

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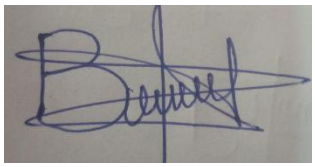
DECLARATION

I, the undersigned, declare that this thesis is my original work; prepared under the guidance of Chalachew Getahun (Ph.D.) all sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.



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ENDORSEMENT

This thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a university advisor.

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LIST OF ACRONYMS AND ABBREVIATIONS

CII	Construction Industry Institute
DB	Design-Build
DBB	Design Bid Build
G1	Grade one
GDP	Gross domestic product
RII	Relative Importance Index
SD	Standard Deviation
SPSS	Statistical Package for Social Science

ABSTRACT

This paper aims to determine the effects of design change on construction project performance located in Addis Ababa. Participants of the study, located in Addis Ababa were G1 contractors, G1 consultants, and clients. To achieve the objective of the study, an explanatory quantitative research design was used. Data was collected using a structured questionnaire. Hypotheses were also tested on a sample of 119 respondents from the client, consultant, and contractor sides. Out of 140 distributed, giving a valid response rate of 85%. Data were analyzed by using Statistical Package for Social Sciences (SPSS) V.20 to conduct descriptive and inferential statistics. For the descriptive statistics frequency, mean, standard deviation, and RII Were performed. For the inferential statistics correlation and multiple regression were performed to answer research objectives. From the descriptive statistics, the top three causes of design change were identified as "change requested by the owner", "poor communication between contracting parties" and "error and omission" were identified. The top three effects identified were "delay in the project", "increase in project cost" and "demolition and rework" were identified. Correlation analysis was conducted to analyze the relationships between variables; the correlation matrix revealed that all coefficients of correlation independent variables were positive and strongly correlates with the dependent variable. In addition to correlation analysis, further regression analysis was also conducted and results revealed that the three independent variables (client related, consultant related and contractor related design change factors) affect project performance. Consultant related factors were identified to be the major factors affecting project performance.

Key words: design, design change; projects; project performance; building construction projects.

CHAPTER ONE

INTRODUCTION

This Chapter presents an overview of the entire study. It includes the background of the study, Statement of the problem, Research questions and Objectives of the study, Significance of the Study, scope and limitation of the study and definition of terms and organization of the study.

1.1 Background of the Study

The construction industry is the main driver of an economy and one of the leading sectors in many countries around the world (Khan, 2008). The construction sector is a key measurement of economic performance in developing countries. The construction sector contributes a significant percentage of the country's gross domestic product (GDP) and offers jobs to a significant proportion of the working population (Mamaru et al., 2017). In the past 10 years, the construction industry shows a yearly growth rate of 12.43 and this shows a share of 5.3% of the country's GDP (The World Bank, 2019).

Despite its important role, the construction industry in developing countries is facing many performance challenges (Tsehaye, 2008). Initially, the goal of any project is to meet project objectives and to complete projects within the specified time, budget, and without having any performance challenge. Though design change doesn't seem among the significant factors which affect project performance, its effect has been very significant especially on project time and cost performance. Various researchers support this idea. According to Burati et al., (1992) frequent design change is one of the major factors which affect project performance. Another study by Qi Hao (2008) states that design change in the construction project is very common and likely to occur at any stage of a project and, In a study conducted by Mughees et al., (2019) design changes are considered the topmost cause of delay in Tanzania construction projects and, its impact on cost overrun varies within the range of 5%-40%. According to research conducted by Han et al. (2013**)** in projects that are even well-managed project cost is affected by design change in a range from 2.1% to 21.5% of total construction cost**.** As stated above design change have a significant impact on project performance, considering this the researcher believes that studying

the effect of design change is very important in preventing frequent design change and solving the problem of performance challenges.

There are few researches conducted on the cause and effect of building project design change across the globe. But, previous research in Ethiopia primarily focused on identifying the factors causing time and cost overruns of construction projects and identified design change as one of the major factors. According to research conducted by Tadele (2018) a case study on Addis Ababa University building projects, design change was identified and ranked 1st for causing cost and time overrun on the project. According to another study conducted by Rahel (2016) on the assessment of cause and the effect of project performance of local contractors, design-related factors were ranked 1st for causing delay and cost overrun. This factor which was identified as one of the major causes for time and cost overrun hasn't been given attention in Ethiopia. According to Fregenet (2019) there are no researches conducted in Ethiopia regarding this topic.

Having the above-mentioned facts in mind, this paper aims to determine the effect of a design change on construction project performance during the construction phase and, to identify the relationship between the three design change factors and project performance by using descriptive and inferential statistics like correlation and regression. This will enable the construction players in developing strategies that can help them in reducing the damaging effects of design changes and improving the performance of the projects. It will also contribute for academic purpose by contributing to literature purpose as there are no researches conducted quantitatively using inferential statistics regarding this topic

1.2 Statement of the Problem

Construction has become the most vital component in Ethiopia's growth. It plays a critical role in the social economy, especially in lowering unemployment. Serious concerns have been expressed about construction projects which have not been delivered in various parts of the country after huge financial mobilizations have been made. There are very large and complex construction projects in Ethiopia currently, especially in Addis Ababa. But those projects have been seen suffering to meet their goals. Various factors could affect the performance of a construction project, but one of these factors is design change Burati (1992). To make sure of the existence of this problem, the researcher conducted a desk study on three building projects in

Addis Ababa. And according to the desk study made it was found that design change affects the project cost in a range of 2-15 % of the total project cost. So this shows the seriousness of the problem and the need to do further research. The negative effect of design change has been identified by different researchers worldwide. According to Mohamad et al., (2012) Design changes have the possibility of creating conflict between client, contractor and consultant because of their effect on cost and time performance. According to Olawale and Sun (2010) Time overrun and cost overruns in building projects are often associated with design changes. According to Undurraga (1996) 20-25% of the construction period is lost as a result of inadequate design. Another study by Burati et al., (1992) found that 79% of rework costs arising in industrial engineering projects were the result of design changes, errors, and omissions. Love (2002) conducted a questionnaire survey on 161Australian construction projects, the author concluded that out of 52% of cost overrun, 26% were directly related to sudden changes in design. According to Kikwasi (2012) a study conducted in Tanzania on the causes and effects of delays and disruptions in Construction Projects, design change was ranked first for causing delay and disruption. Another research conducted by Tadele (2018) a case study on Addis Ababa University building projects, design change was identified and ranked 1st for causing cost and time overrun on the project. According to a study conducted by Rahel (2016) on the assessment of the cause and impact of project performance of local contractors, Design-related factors were ranked 1st for causing delay and cost overrun.

There are many studies conducted on the cause and effect of design change across the globe. But there are limited researches made on the effect of design change on project performance, especially in the Ethiopian context. According to a very recent study conducted on the cause and impact of design change on Bole International Airport Passengers Terminal 1 and 2 Expansion Project, by Feregenet (2019) there is no previous research conducted in Ethiopia regarding design change in building projects. The above-mentioned study is conducted only on Bole International Airport Passengers Terminal 1 and 2 Expansion Project so it is hard to generalize the study result in the Addis Ababa context. This shows the need for further research with adequate sample size and different research method because the above study has limitation that is, the study was carried out using descriptive research design and analyzed using descriptive

statistics using RII analysis tool only. But regression and correlation would be the best tool to show relationship between variables.

Having the above-mentioned facts the researcher believes that, to reduce the adverse effect of design changes during a construction project, evaluating the effect of design change during a construction period is important. And knowing which factor is more responsible for affecting project performance is very significant. The identified effects of building project design change can be used as references to reduce the occurrence of design changes and for the construction players to develop strategies towards managing design change. The researcher believes that this paper contribute one step by identifying the effect of design change on project performance and by showing the relationship between the dependent and independent variables using inferential statistics which was not conducted before in Ethiopian context.

1.3 Research Questions

1. What is the effect of design change on construction project performance in Addis Ababa?
2. What is the relationship between clients related design change factor and building project performance in Addis Ababa?
3. What is the relationship between consultant related design change factor and building project performance in Addis Ababa?
4. What is the relationship between contractor related design change factor and building project performances in Addis Ababa?

1.4 Research Objectives

1.4.1 General Objective

To identify the effect of design change on building project performance in Addis Ababa.

1.4.2 Specific Objectives

- To determine the effect of design change on building project performance in Addis Ababa.
- To identify the relationship between clients related design change factor and building project performance in Addis Ababa.

- To identify the relationship between consultants related design change factor and building project performance in Addis Ababa.
- To identify the relationship between contractors related design change factor and building project performance in Addis Ababa.

1.5 Significance of the Study

The finding in this research will help clients, consultants, and contractors in understanding the effect of these design changes on building construction projects in Addis Ababa. This will enable the construction players in developing the strategies which can help them in reducing the damaging effects of design changes and improving the performance of the projects. It is also vital in reducing the likelihood of conflicts between owners, consultant and contractors because it recommend an appropriate way of managing design change based on the finding of this research.

1.6 Scope of the Study

First, the research is focusing on building projects which are in the execution phase and located in Addis Ababa. The research focused on grade one (G-1), contractors, (G1) consultants and clients which are registered by Addis Ababa city construction bureau.

1.6 Limitation of the Study

This study was limited to show the design change effect in construction phase in the perspective of professionals on contractor's, client and consultant side. In this research internal design change factors were only included because it is difficult to control and manage external design change factors such as political economic, the natural environment, advance of technology, and the third-party.

1.7 Organization of the Study

This thesis is divided into five chapters. Chapter one covers the background of the study, the problem statement, objective of the study, significance, scope and limitation of the study. Chapter two gives a detailed literature review that provides the theoretical basis of the study by

comprehensively evaluating what other scholars had already done on the effect of design change on project performance. Chapter three explained the methodology that was implemented to come up with the findings of the study. Specifically, the chapter explained the research approach and design, population, sampling and data collection methods used to find out the needed data. Chapter four explained the results after analyzing the collected data. In Chapter five key findings were summarized and after that, the chapter conclude the study and gave recommendations based on the findings.

1.9 Definition of Terms

Design of building: - is a process that is performed in a series of steps to conceive, describe and justify increasingly detailed solutions to meet the needs of the client. (Design buildings wiki, 2015)

Design change: - A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. (Burati et al., 1992).

Consultants: - For this study, Consultants will refer to Architectural, Quantity surveying and Project management firms involved in the projects giving advice and developing deigns.

Contractor: - in this study contractor is the party responsible for the completion as well as the construction of the works.

Client: -For this study Client is a person for whom a project is carried out.

CHAPTER TWO

RELATED LITRATURE REVIEW

2.1 Introduction

This chapter provides a detailed review of different works of literature related to the objectives of the study. This chapter starts by giving highlight on the design and Construction process of a building and then discuss about the term change and design change on the point of view of different researchers to come up with an operational definition of the study. Then the review continues with, the factors causing design change in construction industry then it will cover the design change factors affecting project performance.

2.2 Conceptual and Theoretical Literature

2.2.1. The Design and Construction Process of a Building

There are six stages of the construction projects during design and construction.

2.2.2.1 Conceptual Design

Conceptual design is the very first stage of the design process, where drawings and other illustrations or models are used. This is the step where the contractor team performs any site evaluations or surveys that may be required because of the project brief's specific specifications. The design team co-ordinates the preparation of an initial design concept and presents these initial design ideas to the customer. (Design buildings wiki, 2015).

It begins when the client meets the design team and the objectives of the project are defined. It represents a preliminary building design phase, in which the overall system configuration is defined and, schematic drawings and layouts provide early project configuration, architecture type, and formal and functional aspects. It lacks reliable data. (Luis et al.,2014)

2.2.2.2 Schematic Design

Schematic design is intended to turn the project design into physical drawings of space. The project team establishes the locations, physical requirements, and relationships of all the relevant building space. And then the components in schematic design approve or revise the estimated building square footage and, the total project budget as well as the schedule and occupancy dates of the project. The project program and the schematic drawings will be analyzed for possible errors or omissions. (Western Michigan University, n.d.)

2.2.2.3 Design Development

It is the stage in which the architect and the professional consultants prepare design concept documents to further describe the project's size and character. The schematic plans and elevations are modified, updated, and extended in design creation to include all the specifics and requirements necessary for the building. Issues that affect the buildability or are crucial to completing the project plan often come to light, and that may require changes to the project schedule or budget, or both. (Design buildings wiki, 2015)

2.2.2.4 Construction Document

At this stage the plans, specifications and drawings will be prepared by the Design Professional as well as documents for bidding process.

2.2.2.5 Construction Bidding

Bidding is a request from one party to the other, and accepted, to do something according to the Criteria or specifications. Construction bidding is the process of submitting a proposal to undertake, or manage the undertaking of a construction project.

At this point, the ultimate drawings and bidding documents organized during construction documentation stage are utilized in finding the competent contractor. When the contractor is procured, negotiation follows before awarding the contract. (Scott, 2008)

2.2.2.6 Construction Administration

After the design has been finalized, documented and handed off to the winning contractor, construction begins. The client forms a contractual relationship with the contractor, and the architect serves as supervisor of the project to ensure that it is built according to the design documents. (Miracle, 2017).

Even though there are five stages of design process during construction project stages the most influencing factors that affect the construction project performance is the design during the construction stage. Therefore, the study is limited to the construction phase of the project only, although it is understood that the construction process is influenced by decisions made in other stages before the start of the construction phase. It is possible to control Design change during the design stage but it's challenging to control design change during the construction phase. (Talukhaba, 1999)

2.2.2 Delivery of Construction Projects

A. Design-Build (DB)

Design-Build (DB) project delivery systems have increasingly been adopted by many private and public sector organizations worldwide due to its many advantages. However, many Ethiopian building projects are still delivered using the traditional design-bid-build (DBB) project delivery system. In DB method, a single entity signed a single contract with the owner for the performance of design and construction services (Nida Azhara, 2013). The organization could be integrated design company, contractor controlled, designer managed, joint venture or developer led. This method encouraged team collaboration and enable early involvement of contractor to give input and took part in the budgeting, programming, financing, assessed the design for constructability and cost of construction . (Nida Azhara, 2013). In this method, design changes are less likely to happen as the designer and the contractor are one and the same.

B. Design-Bid-Build (DBB)

Design-Bid-Build is the most traditional and most common project delivery method. In the Design, bid and build method, Separate groups perform the completely different but intertwined parts of the process. The Architect and other consultants, after receiving the ideas and requirements from the client/owner, create a set of plans and specifications. These are then provided to several general contractors through a bidding process. (Ibrahim, 2013) The tender will be advertised for prospective bidders once the design was completed.

The contract will be awarded based on the qualification of the firm to provide the design service before the construction phase typically, the lowest bid contractor would be selected to build the project Nida Azhara (2013) in this delivery method design change often have a great impact on the project because there are two separate contracts for the design and construction. There is limited communication between the consultant and contractor and also the contractor doesn't have involvement in the design process, this leads to the problem of design error, omission during the design phase by the consultant which will highly increase project time ,cost quality and scope.in Ethiopia, most projects are delivered through the design bid build delivery method.

2.2.3 Change in the Construction Project

Change is defined as any event which results in an alteration in the original scope of the project, and which may also affect the time, cost and quality of the work of the project (William et al., 2007). Changes to the project may cause in project additions, deletions or modifications resulting in Changes to the amount and time of the contract (Coffman, 1997). And according to CII (2001) changes are any action initiated by the owner, owner's agent or design engineer that results in a project's adjustment. Another study by Hanna et al., (2002) states that change is an event that can change the project's original scope and impact the cost and time of the project.

On the other hand Mokbel (2003) defined the change as an action indicating and aligning a change to the scope of the project that modifies the original time and total cost required to complete the project. According to Osman et al., (2009) defined the change as any deviation from an agreed-upon well-defined scope schedule. Several factors can cause changes in construction projects, and one of the most important factors is the change in design. Many

factors contribute to the changes in project construct such as incomplete information field, incomplete design, design errors, planning and design, underground conditions, security concerns, natural disasters, owner, consultants and contractors, political, economic, natural environment, and third party (Ming et al., 2008).

2.2.4 Design change in Building Construction

Design changes are common in building projects. Design changes are almost unavoidable during the lifecycle of a project; however, design change can be minor or major according to the consequence (Mohamad et al, 2012). The Design change is defined as any change in the design or construction of a project after the contract is awarded and signed. According to Akinsola et al., (1997) design changes are defined as any additions, omissions or adjustments made to the original scope of work after a contract is awarded. According to Abdul-Rahman et al., (2016, p. 33) design change is defined as 'regular additions, omissions and adjustments to both design and construction work in a construction project that arise after the award of project. According to Lu and Issa (2005) design changes and design errors are most frequent and most expensive changes that affect project performance. Mohamad et al., (2012) reported that design changes is a common factors causing claim and dispute in building construction project. As this definition demonstrates, design changes are often perceived to be a damaging and negative influence on construction time–cost, although they can also be proactive in accelerating construction schedule or an alternative cost-saving solution. Design change exist in construction projects and often causes cost overrun or schedule delay (Wu et al,. 2004). Perfect design is impractical due to various constraints and so changes in design are unavoidable.

2.2.5 Factors Influencing Design Change

This section discusses the factors influencing design changes in building construction projects. To gain better insights on the design change dynamics, a strong understanding of causing factors is essential.

2.2.5.1 Classification of Factors Influencing Design Change

Changes in design and construction can be induced at different stages like pre-planning, planning, design, and construction. Moreover, the emphasis in this context is during the construction phase. According to the Research conducted by Chao-hui et al, (2004) states that the cause of design changes is divided into 2 parts due to internal and external factors. Internal factors are the owner, design consultants, and contractors while entering into external factors such as political and economic, natural environment. According to former researches, there are several causes of design change. A study by Love et al., (2002) indicated that project changes may arise due to the effects of both internal and external elements. On the other hand, Mohamad et al. categorized the sources of design changes from clients, consultants, and contractors who are the primary parties in building construction projects. In his study, internal factors includes (1) client-related; (2) design-related; (3) project-related and (4) contractor-related. Figure 1 exhibits the Generic cause-and-effect diagram of design changes.

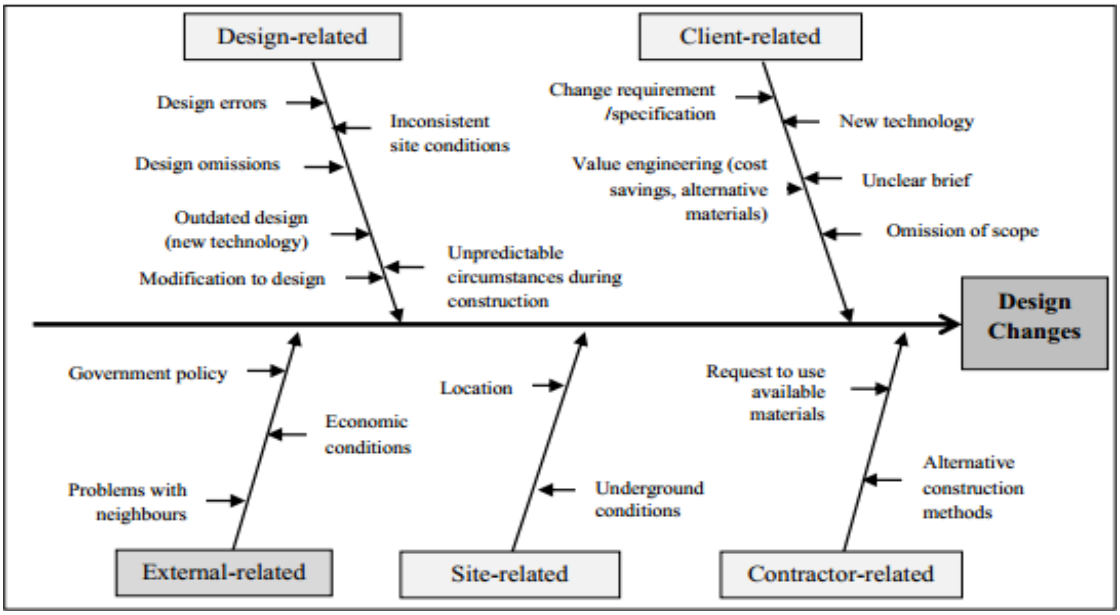

Figure 1 Generic cause-and-effect diagram of design changes

(Source: Adapted from, Love et al., 2012)

The other classification of design change was proposed by Yanna et al., (2015) according to the researcher the root cause of design change was classified as internal and external factors. The internal factor comprises of owner, design consultant, construction management consultant, and contractor, while the external factor contain political and economic, the natural environment, advance of technology, and the third-party.

Table 1 Reference for list of factors causing design change

Factors causing design change	Reference
Client related	Mohamad et al. (2012); Hwang et al. (2014); yana et al., (2015) Yap and skitmor, (2018), Iliyas J, (2016)
Consultant related/design related	Love et al., (2004); Koskela et al., (2002); Thomson et al., (2003) ; Mohamad et al. (2012), Iliyas J, (2016) . Yana, et al., (2015); Yap and skitmor, (2018).
Contractor related	Mohamad et al. (2012), Wu et al. (2005),Sun and Meng (2009) Iliyas et al., (2016) Chang et al. (2011)

Source various journals

After reviewing various journals and literatures about the cause of design change the following design change internal factors were identified and summarized below in table 2.

Table 2 List of factors causing design change.

Category of Design change	Causes of design change
Client/Owner	The owner instruction to modify a design
	The owner failure to make decisions or to review documents at the right time
	The changes of funding scheme from the owner
	Owner instructs additional works
	Addition or omission of scope
	Change requested by the owner
	Owner's needs during the design stage are unclear or not well-defined
Design consultant	Non-compliance with authority requirements
	Unrealistic period to design;
	Failure of a consultant to provide adequate and clear information in the tender documents
	Errors and omission of consultants
	Deficient resources in quality or quantity
	Changes made as a request of a consultant
	Poor coordination and communication between Client and designer as well as designer and contractor
	Consultants who are not familiar with the regulations and construction permits
	Designer noninvolvement/unavailability during construction phase
	Modification to design (improvement)
	No Design checking or 2nd or 3rd party reviews, No system of design checking
	Failure by the consultant to perform design and supervision effectively
	Inadequate investigation of site before the design period
	Material investigation is insufficient. Since certain material items required by the design may be out of stock or inadequate
Contractor	Request to use available materials
	Unrealistic construction's schedule
	Changes initiated by contractors to improve quality and constructability
	Poor communication between contractor and other parties
	The construction budget is too low.
	Shortage of material

2.3 Performance of Building Projects

Construction project success can be indicated by project performance. Salaheldin (2009) has a define performance as the degree to which project fulfills primary objectives in order to meet the needs of customers. The project performance can be measured by key performance indicators (KPIs).The widely accepted performance measurements of a project identified by different scholars are time, cost, and quality. These three factors represent the Key Performance Indicators (KPIs) According to Omran,AbdulRahman & Pakir (2012) project performance success is dependent on its performance. This performance of projects is measured based on expected quality standard, timely completion, within cost estimates and client satisfaction. A construction project is considered successful if it is handed over to the client on time, within the budget and to the required quality standards (Takim and Akintoye, 2003). If a project fail to meet the above mentioned factors or triple constraints the project is failed or it face performance challenge. According to Cheung et al., (2004) project performance were categorized as people, cost, time, quality, safety and health, environment, client satisfaction, and communication. according to the study by Chan and Kumaraswamy (1996) there are a number of unexpected changes from original design arise during the construction phase, leading to problems in cost and time performance. Construction industry in Ethiopia suffers from many problems and complex issues in factors such as time, cost, quality, client satisfaction; productivity and safety.

2.3.1 Effect of Design Changes on Project Performance

Though design changes are widely accepted from all of the participants in the construction industry, the design changes do affect the outcome of the project. Time overrun and cost overruns in building projects are often associated with design changes. Olawale and Sun, (2010). A variety of studies globally has been concerned with identifying the effects of design changes on project performance. The direct effects are rework, schedule delay resulting in longer project duration and cost overruns from the additional resources and wastage involved. Almost all projects go through numerous changes from the design stage to construction stage. These various changes have considerable effect during the lifecycle of a project. According to Olawale & Sun, (2010). The effects of design change are underestimated by construction practitioners. Some effect of design change mentioned by different researchers above are discussed below.

2.3.1.1 Cost Overrun

One of the most common problems that threaten any construction project is cost overrun. Cost overrun in construction arises when the final costs exceeds the expected budget designated for the building. Causes of this overrun originate from a variety of reasons and many are related to the construction and design phase (Hisham et al., 2013). When changes to design occur during construction phase, there is a tendency to change the cost of the project. If the design changes are complicated or increase the scope of the project, infusion of more money will be needed. The effect of design changes on cost in construction projects has been studied and evaluated by different researchers. According to different studies which are carried out by different scholars proved that design change is one of the causes for the arising of cost overrun in the industry. For the sake of comparison, it's important to summarize different researches which are carried out in developed and developing countries.

Yap and Skitmore (2018) conducted a questionnaire survey to establish cost overrun due to design changes and concluded that cost overrun ranges between 5 – 20% of the overall project cost in Malaysia. According to research conducted in United Kingdom by Cox et.,al (2010) four sucessfully executed building projects were analyzed and the cost over run incured in this project was in a range between 5-8%. Another study by Chang (2002) conducted on four sampled projects in California reported that cost increased on average of 24.8%. According to research conducted by Mughees et al.,(2019) design change is one of the predominant factors to cost overrun, and in some cases, may result into cost overrun between 5 and 40% of the project cost. According to research conducted by Chang et al.,(2011) design changes has resulted in an increased in redesign cost of 2.1% to 21.5% and on average 8.5% of the construction change cost. Love (2002) conducted a questionnaire survey on 161Australian construction projects. In this study total 52% of cost overrun, 26% were directly related to sudden changes in design.

According to research conducted in Addis Ababa by Tadele (2018) a case study on Addis Ababa university building projects, design change was identified and ranked 1st for causing cost overrun on the project. So according to the above studies which are carried out in various part of the world show that the cost of design change ranges approximately up to 5%-25% of the total project cost. These figures illustrate the fact that the additional costs due to design change had a considerable adverse effect on project performance.

2.3.1.2 Time Overrun

Time overrun is any delay beyond the baseline construction schedule. Minimizing time and cost is the main goal in managing a construction project. However, time delay frequently occurs in all phases of a construction project and consequently increases the project total duration (Aftab, 2011). And according to Chan (2001) defined time overrun as the difference between the actual completion time and the estimated completion time. The same way, Abubeker (2015) defines time overrun as the inability to complete a project either by the original planned time or budget, or both, ultimately results in project delay.

Time overrun is caused by various reasons Aftab (2014) studied time overrun factor in the construction industry in Malaysia and concluded that the major causative factors contributing to construction time overrun are frequent design changes, change in the scope of the project, financial difficulties of owner, delays in decisions making and unforeseen ground condition. It was found that when there is change of the design during construction, project completion period increases. This is because implementing the new design improvements in structural, service and architectural will require sufficient time, approval of the new designs would take time as well as testing of the new materials would require time. Hence the duration of the project will increase at the end.

The work hours invested by the designers in the changes have been estimated in a 40 to 50% of the total of a project (Koskela, 1992). In Latin American countries, it is estimated that between 20 to 25% of the total construction period is lost as a product of design deficiencies (Undurraga, 1996). Chang (2002) stated that schedule increased on an average of 69% based on four sampled projects in California as a result of design changes.

2.3.1.3 Material Wastage

Waste is one of the serious problems in construction industry. Many researchers and practitioners indicate that there are many wasteful activities during design and construction process. According to research conducted by Sasitharan (2014) among 63 causing factors identified for causing material wastage design change was ranked 1st. Some changes of the design during construction are related to the wastage of materials. This will happen in circumstances where

design changes compel some areas of the already constructed elements of the building structure to be demolished.

2.3.1.4 Conflicts between the Parties Involved

The construction industry is a complex and competitive environment in which participants with different views, talents and levels of knowledge of the construction process work together. In this complex environment, participants from various professions, each has its own goals and each expects to make the most of its own benefits. According to Mohamad et al., (2012) Design changes have the possibility of creating conflict between client and contractor and consultant because of their effect on cost and time performance.

2.3.1.5 Demolition and Rework

Rework was defined as the unnecessary effort of re-doing a process or activity that was wrongly executed at the first time (Love, 2002). A major cause of rework is design changes (Han et al. 2013). According to Li and Taylor (2014) rework in construction project can significantly affect project cost and schedule performance. Rework cost typically ranges from 10% to 15% of the contract sum in a particular building construction project (Sun & Meng, 2010). Love (2002) surveyed the rework costs from 161 Australian construction projects which revealed that rework increased a project's duration by 12.6% and added 20.7% to the project cost. Another study by Burati et al., (1992) found that 79% of rework costs arising in industrial engineering projects were the result of design changes, errors and omissions.

2.4 Empirical Literature Review

According to different studies which are carried out by different scholars proved that design change is one of the causes for the arising of cost overrun in the industry. For the sake of comparison, it's important to summarize different researches which are carried out worldwide.

According to research by Yap and skitmor (2018) 39 design change causing factors were identified through literature review. Data was gathered by giving 12 semi structures interview to construction professionals and through a questionnaire survey of 338 clients, consultants and contractors. The data collected were then analyzed and were used to identify design change

causes and their overall effect. The research reveals that Malaysia's building projects face time cost overruns of 5–20 percent due to changes in design. The identified causes were also categorized under as client-induced, consultant-induced, contractor-induced, and site-induced and external induced. After distributing questionnaire of 39 causes and effects were developed based on culmination of literature review and findings from the semi-structured interviews. The five most important causes that were identified.

The 5 most important causes

(1) Lack of coordination among various professional disciplines/consultants
(2) change of requirement/specification
(3) addition/omission of scopes
(4) erroneous/discrepancies in design documents
(5) unforeseen ground conditions (geotechnical issues)

Of the five most important causes (overall), two are caused by the clients, two with consultants' responsible and one induced by site conditions. The study reveals the three most impactful cause categories are (1) client-induced, (2) contractor-induced and (3) consultant induced.

According to research conducted in Dare selam Tanzania by Iliyas (2016) factors influencing design change were categorized under seven groups which are Factors of consultants, factors of contractor ,client factor , political and economic factors, environmental factors and factors of third parties. The detailed review resulted in the identification of 42 common factors (30 are internal factors and 12 are external factors) Questionnaire and interview were the methods used to gather data for this research. A total of 146 questionnaires were distributed, with 116 returned. This response is 79.5 per cent used in the study to represent the targeted sample. The most important variables under this research for design change were owner's related factors like ''owners instruction to modify design'', ''unclear initial design brief '', and ''owner's change of schedule due to financial problem''. The design consultant factors were ''Failure to provide adequate and clear information in the tender documents'', '' Unrealistic period to design'', ''Unclear and inadequate details in drawings'', ''Underestimation of the cost of the project'', ''Presence of conflicts between contract documents and production'' contractor related factors were ''Lack of contractor's involvement in design'', ''Unrealistic construction's schedule'',

‘‘Changes initiated by contractors improve quality and constructability’’, and ‘‘Rectifying of construction mistakes’’

In this study the internal factors which influence more for the cause of design change during the construction stage were the client factors and design consultant factors. From external factors the environmental factor and third party factors influence design change more. The most common effects that occur in those projects were design change occurred were project delay, project cost increases (cost overrun), project abandonment, waste of materials and disputes between the parties

Another study conducted by Mughees et al., (2019) titled design change in construction project cause and impact on cost. The primary objective of the research was to examine the impact of design changes on project cost and identifying actions responsible for these changes. To achieve the objectives of the study the researcher review past literature published in well-established journals, and contents were analyzed. The researcher identified from literature review that the design change is one of the main factors in causing cost overrun, and may in some cases result in cost overrun between 5 and 40% of the project cost. This study explored many causes of design changes resulting in cost overrun within the perspective of the owner, consultant, and contractors. From the analysis of the study design changes are related to client, designer, contractor and external factors. In this research most of the causes of design change were related to the designer and the contractor as 45.85 percent and 27.1 percent respectively. In this study the impact of these design changes are considerably lesser in comparison to clients and external factors which in the research analysis contributes 10.45% and 16.7% respectively.

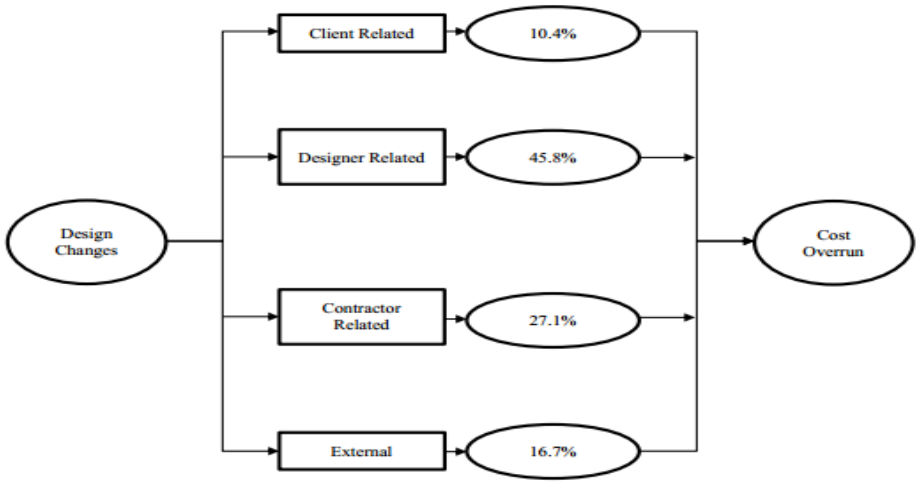

Figure 2 percentage of design factors causing cost overrun

(Source Mughees et al., (2019)

The other study titled Analysis of factors affecting design changes in construction project with Partial Least Square (PLS) was carried out by (Yanna et al., 2015) This study examines the most influential factor that affect design changes in the construction projects. The author classified influential factors of design changes into two groups. The internal factors are owner, design manager, construction management consultant and contractor, while the external factors include political and economic influences, the natural environment, technological development, and third parties. The research method employed a questionnaire survey consisting of 31 questions regarding the frequency of changes in design during project construction which was distributed to the construction project managers. The Partial Least Square (PLS) was used to analyze the data .This study used PLS-SEM because: 1) the model can be built on the basis of a theory that is not very strong, 2) sample size is relatively small, 3) the aims of analysis was to develop a theory or prediction models and 4) the indicators can be shaped reflective and formative. The result shows that the client is the greatest influential factors on the existence of the design changes. The other factors are the design consultant, construction management consultant, political and economic, the natural environment, contractors, third parties, and the advance of technology.

According to research conducted in United Kingdom by Cox et al.,(2010) four sucessfully executed building projects were analyzed and the cost over run because of design change in this project was in a range between 5-8%. Another study conducted on four sampled projects in

California by Chang (2002) stated that cost increased on average of 24.8%. According to research conducted by Mughees et al.,(2019) it was established that the design change is one of the predominant factors to cost overrun, and in some cases, may upshot into cost overrun between 5 and 40% of the project cost. According to research conducted by Chang et al., (2011) Reported that design changes has resulted in an increased in redesign cost of 2.1% to 21.5% and on average 8.5% of the construction change cost. Another study conducted by Burati et al., (1992) on an industrial engineering projects found that 79% of rework costs were the result of design changes, errors and omissions. Love (2002) conducted a questionnaire survey on 161Australian construction projects. The researcher concluded that out of total 52% of cost overrun, 26% were directly related to sudden changes in design. According to research conducted by (Tadele, 2018) a case study on Addis Ababa University building projects, design change was identified and ranked 1st for causing cost overrun on the project. So according to the above studies which are carried out in various part of the world show that the cost of design change ranges approximately up to 5%-25% of the total project cost. These figures illustrate the fact that the additional costs due to design change had a considerable adverse effect on project performance.

2.5 Research Gap or Synthesis

After reviewing various journals about the effect of design change the researcher realize that there are few researches conducted on the effect of design change globally and in Africa. But when we come to Ethiopian context there is lack of research regarding the issue of design change. This idea is supported by Feregenet (2019) who proved that there are no researches conducted in Ethiopia about this topic. This is the major research gap which led to conduct this research. The other research gap in the study made by Feregenet (2019) it was conducted on bole international terminal1 and terminal 2 projects. It only study the topic on specific project so it is difficult to generalize the idea in Addis Ababa context. So the researcher believed that it is best to conduct the research with adequate sample size. The third research gap in Feregenet's research was the methodology used. The research topic show relationship between variables but the methodology used was descriptive and doesn't show the relationship. So the researcher decided to study the effect of design change on project performance by identifying the dependent and

independent variable and then by showing their relationship using correlation and regression. This study haven't been carried out in Ethiopian context. As a result, this study will go one step ahead towards identifying the major effect of design change on project performance which will help to manage its adverse effect on project performance.

2.6 Research Hypothesis

Ha1:- Client related design change has effect on building project performance.

Ha0:- Client related design change has no effect on building project performance.

Ha2:- Consultant related design change has effect on building project performance.

Ha0:- Consultant related design change has no effect on building project performance.

Ha3:- Contractor related design change has effect on building project performance.

Ha0:- Contractor related design change has no effect on building project performance.

2.7 Description of Research Variables

Independent variable is a variable believed to affect the dependent variable (Croswell, 2014). The independent variables in this research are internal factors such as client related, consultant related, contractor related factors causing design change. The independent variable will be measured by using five point Likert scale.

Dependent variable is the variable a researcher is interested in (Croswell, 2014). The dependent variable in this research is effect on project performance.

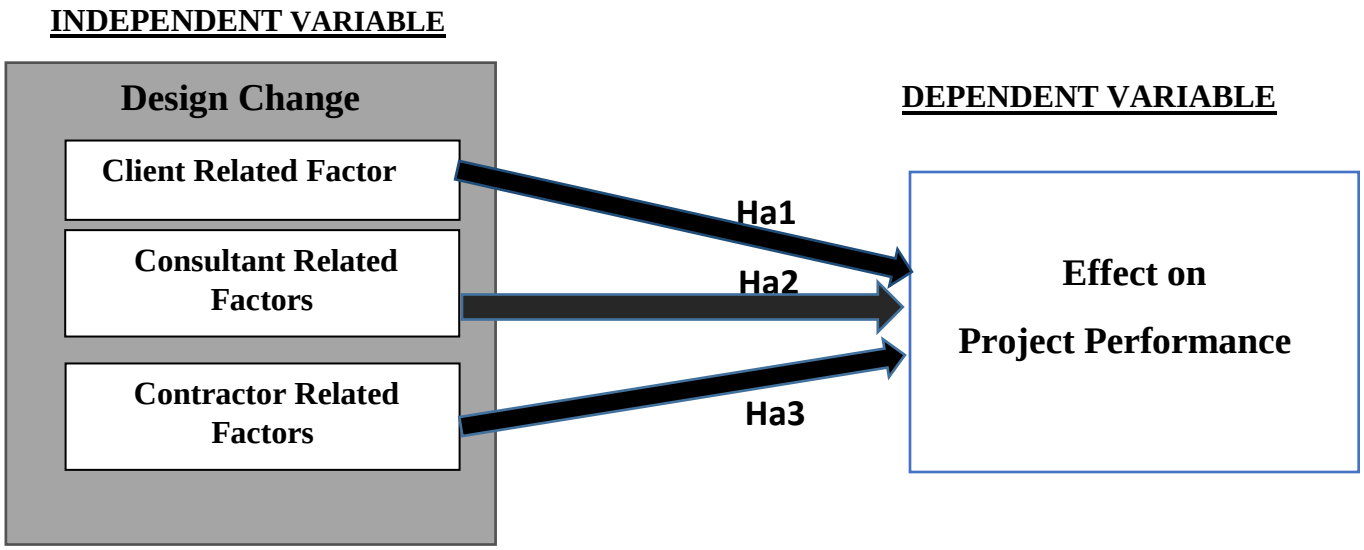

Figure 3 Conceptual frame work

Indicators for the project performance effect

- Time over run
- Cost overrun
- Decrease in quality
- Demolition and Rework
- Decrease in productivity
- Material wastage
- Dispute between parties

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed the research methods used which includes the research approach, the population, sample size, sampling technique, data source, and finally, the data analysis technique was discussed.

3.2 Research Approach and Design

3.2.1 Research Approach

According to Croswell (2014) when selecting a research approach it is very important to consider the research problem because "Certain types of research problems call for specific approaches. Quantitative research approach is best for such studies like the "identification of factors that influence an outcome'' (Croswell 2014:p35) So considering the above mentioned fact the research approach that was used in this research is a quantitative approach. Quantitative research used to examine the relationship among variables. This research contains a dependent and independent variable which was measured numerically by using correlation and regression.

3.2.2 Research Design

The objective of the study was to identify the effect of design change on building project performance in Addis Ababa in the case of G1 contractors, G1 consultants, and clients. Hence, Explanatory and descriptive research was performed as the study establish causal relationships between the dependent variable (effect on project performance) and independent variable (design change factors). According to Kumar (2011) Explanatory research attempts to clarify why and how there is a relationship between two aspects of a situation or phenomenon.

3.3 Population, Sample Size and Sampling Technique

3.3.1 Population

According to Mark (2009) the full set of cases from which a sample is taken is called the population. Clients, contracting, and consulting companies were important data sources for this study. Since the main objective of the research is to identify the effect of design change, the professional construction employee's like project managers, site engineers, quantity surveyors of these two construction companies and the professional-client representatives like supervisors resident engineers were hence in a better position to provide the information required by this study. The population size of the study was 55 G-1 contracting companies, 55 clients who give contracts to the contractors above, and 50 G-1 consultant firms registered under the Addis Ababa construction bureau.

3.3.2 Sample Size

The sample for this study was

- Contracting companies of G1 who are registered by Addis Ababa City Construction Bureau in Addis Ababa, Ethiopia.
- Grade1 consulting companies were selected because of their exhaustive experience and exposure to supervising different projects.
- Clients who gave contract to those G1 contractors

Based on the obtained list of registered contracting and consulting companies from the Addis Ababa Construction Bureau, the total number of registered contracting companies as Grade one contractor 55, Grade one consultant 50 and the clients were 55 so the total population was 160. From this, it's decided to use selecting a portion of the population from the total population this was worked out by calculating the sample size using Yamane (1967) method**.** This method is applicable to a known population size.

$$n = \frac{N}{1 + N(e)^2}$$

Where, n= sample size

N= known population size

e= error level

e= error level (in this case it is 5% with a confidential interval of 95%)

For Building Contractor 1 (GC1)

Total Number of BC1= 55

$$n = \frac{N}{1 + N (e)^2}$$

= 55/ (1+55*0.0025)

= 48

For Grade -1 Consultant

Total Number = 50

$$n = \frac{N}{1 + N (e)^2}$$

= 50/ (1+50*0.0025)

= 44

For clients who hired the above contractors

Total Number of BC1= 55

$$n = \frac{N}{1 + N (e)^2}$$

= 55/ (1+55*0.0025)

= 48

Table 3 Sample size

Organizations	**Number of Population**	**Sample**
G-1 Contractor	55	48
Clients	55	48
G-1 Consultant	50	44
Total	**160**	**140**

Source: Own Survey (2020)

So the targeted respondents of the questionnaire were construction professionals who were working on these construction companies and the client side. The inclusion criteria were the respondents should be construction professionals. This includes project managers, resident engineers, site engineers, office engineers, designers, supervisors, quantity surveyors who were directly related to design change in construction sites. The exclusion criteria were an employee of the company whose job is not directly related to construction and nonprofessional employee of the company like daily labors were not included.

3.3.3 Sampling

According to mark (2009) sampling is important when it is difficult to survey the entire population when there is a shortage of budget and time constraint that prevents the researcher from surveying the entire population. In this research taking the whole population is difficult because of the above mentioned reasons. So probability sampling method was used. According to mark (2009) probability samples the chance, or probability, of each case being selected from the population is known and is usually equal for all cases. Probability sampling is often associated with survey and explanatory research strategies. When conducting survey research, it is important that the researcher samples random people. This allows for more accurate findings across a greater number of respondents. This shows random sampling goes with the research design of this research. Among the probability sampling methods, a simple random sampling was used since the simple random sampling technique will give each member of the study population an equal chance of being selected.

3.4 Data Sources and Data Collection Tools

3.4.1 Data Source

This study used both primary and secondary data. Primary data were collected first hand by the researcher using structured questionnaires to selected clients, contractors, and consultants. While secondary data were obtained from sources already existing in the concerned organizations or by stakeholders of the project to be studied.

3.4.2 Data Collection Tools

The instrument of data collection that was used in the study is Questionnaires. Which is convenient while conducting survey research. Questionnaires a written forms comprising of a set of questions that will be used to gather the data required from a sample population. Each item in the questionnaire was developed to address the research objectives.

3.4.3 Questionnaire

As stated by Mark et al., (2009) a questionnaire is the most widely used method in survey strategy. Survey provide an effective way to collect responses from a large sample before making analysis. To obtain the needed data, a structured questionnaire was used as a data collection tool, due to the sample size and the quantitative approach of the study. The questionnaire was divided into three main parts having a total of 33 questions. Part I solicited general (factual) information about respondents. Part II consisted a total of 23design change cause factors. These design change factors were categorized into three major groups. Seven factors were associated to the client, ten factors were categorized under consultant, and six factors were categorized under contractor. Part III considers a total of seven project performance factors. The respondents were asked to provide their views on the most influencing cause and effect factors using a 5-point Likert scale. The ratings used were: strongly disagree = 1; disagree = 2; Neutral = 3; Agree = 4; and strongly agree = 5.

3.5 Data Analysis Technique

In order to answer research questions and objectives, descriptive and inferential statistics were used. Descriptive statistics such as frequencies and percentages were used to present the demographic and educational characteristics of respondents and to rank the topmost cause and

effect of design change RII was used. Pearson Correlation analysis was conducted to test the existence of a significant relationship between the design change factors and project performance. Then, the multiple regression analyses were also conducted to determine by how much percent the independent variable i.e. design change factors explain the dependent variable which is project performance. In this context, data was collected, summarized and, analyzed using statically Package for Social Scientist (SPSS) version 20.

3.5.1 Reliability

The Reliability of the collected data was assessed using a statistical package for social sciences (SPSS). A reliability test is conducted to check whether each item in the scale is free from error of measurement (Kumar, 2011).If a questionnaire is examined at different times and across different populations, and it produces the same results, the questionnaire is "reliable" (Field, 2009) In this test, Cronbach's alpha values range from 0 (un-reliable) to (reliable) with 0.7 being considered a relatively strong value of reliability. Widely used methods when using SPSS for assessing reliability are Cohen's Kappa Coefficient for categorical data and Cronbach's alpha for continuous data (Likert-type scales). Since the data collection was based on a Likert-scale, Cronbach's alpha method was used to check reliability.

Table 4 Reliability Statistics Cronbach 'Alpha result

Variables	Cronbach' Alpha	No. of item
Client Factors	0.788	7
Consultant Factors	0.717	10
Contractors Factors	0.731	6
Effect On Project Performance	0.703	7
Over all Reliability	**0.878**	**30**

Source: Own Survey (2020)

Therefore, the internal consistency of, 23 design change factors, 7 project performance effects, which constitute a total of 30 variables of Likert Scale questions were verified by calculating "Cronbach's alpha" from the valid responses. The higher the alpha coefficient score, the more reliable the generated scale is. A value of 0.7 is an acceptable coefficient. The result showed an alpha coefficient value of .878 is greater than 0.7 that confirmed the questionnaire reliability by all respondents which measure the same construct.

3.5.2 Validity

The validity, in essence, refers to the appropriateness of the measures used, the accuracy of the analysis of the results and generalizability of the findings" (Mark et al., 2009: p.202). In order to provide supporting evidence that the researcher measure what it intends to measure, a test for content validity was conducted by a pilot study. To check the content validity 15 questionnaires were distributed to experienced professionals in construction projects. After that, the questionnaires were modified based on the received comments and distributed to the targeted populations.

3.5 Ethical consideration

Ethical considerations were taken into account throughout the process of conducting this study. The researcher informed all prospective participants about nature and the objective of the study and their participation was optional. It was clarified that their response to the offered questions was only for the purpose of academic research and would never be disclosed to anyone at all times. When reviewing secondary data from journals, articles, proceedings, and related sources, every source used was acknowledged both in-text citation and referencing.

CHAPTER FOUR

DATA PRESENTATION ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter discussed the data analysis and findings from 119 questionnaires completed by grade one contractors, consultants, and clients in Addis Ababa. The purpose of this study was to identify the effect of design change on project performance in Addis Ababa building projects. The chapter starts with the respondents' profile and is supported by demographic data. Furthermore, inferential analyses such as Pearson's correlation and multiple regression were performed.

4.2 Questionnaire Survey Response Rates

Table 5: Respondents Response Rate

Organization	Sample Size	No. of Respondents	Percentage (%)
Client	48	41	34.5
Consultant	44	37	31
Contractor	48	41	34.5
Total	**140**	**119**	**100**

Source: Own Survey (2020)

Respondents were divided in to three groups, i.e. contractors, consultants and clients. Table 5 shows a total of 140 questionnaires were distributed to respondents. Out of which 48 were contractors and 44 were consultant and 48 were clients. A valid response of 41, 37, and 41 were returned respectively and used in the analysis which constituted 119 respondents and this represented an 83% response rate which is considered as a good response. According to Saunders et.al.,(2016) over 80 percent of all questions answered other than by a refusal or no answer, it is considered as a complete response (Saunders et.al, 2016).

4.3 Demographic Characteristics of Respondents

The purpose of this section was to know the demographic background of respondents. The demographic information used in this research were educational background, profession, type of organization the respondents represent.

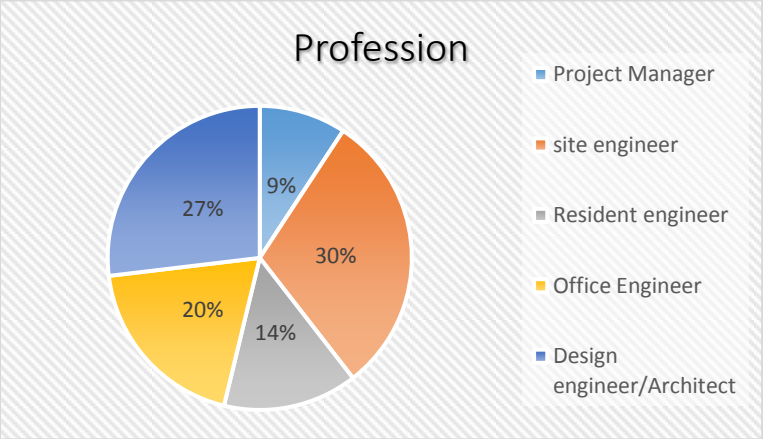

Figure 4 Respondents professional position.

Source: Own Survey (2020)

Of all 119 questionnaires collected the professional position of respondents indicates that 9 % of the respondents were project managers, 27% Architect, 30% site engineers, 14% resident engineers, 20% office engineers. This implies that all the questioners were filled and responded by professionals who are directly related to the thesis topic or design change.

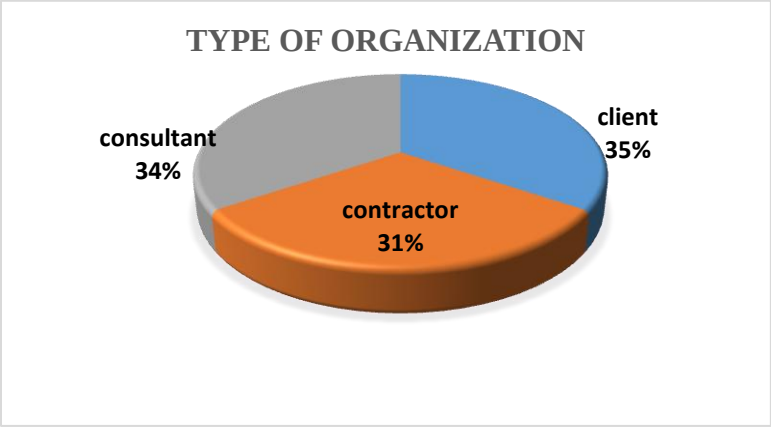

Figure 5 Respondents organization type

Source: Own Survey (2020)

The second question asked in the demographic section was the type of organization the respondents represent. Of all 119 questionnaire collected 35 % were professionals from the client side, 34% from consultant side, and 31% from the contractor side. This implies that all the contracting parties were well represented by the respondents.

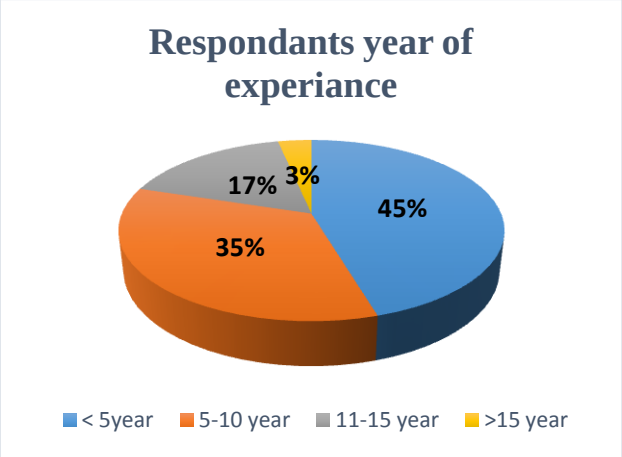

Figure 6 Respondents Year of Experience.

Source: Own Survey (2020)

The above diagram indicates the experience of the respondent, 54 (45%) were less than five years, 41 (35%) were five up to ten years, 20 (17%) of the respondent employees are in the range of eleven up to fifteen years, four (3%) of the respondent was above fifteen years' experience in the industry. Overall 55% of respondent's experience was above 10 years which also supports the idea that they were participated in implementing projects both at operational and design levels. Consequently, it was believed that respondents had some knowledge and understanding of the topic related to design change in general and awareness of the effect of design change on building construction projects in particular. This makes them dependable and credible sources of information which is vital to realize the research objective.

4.4. Descriptive Analysis Result

After identifying from the literature review the different factors that cause design change, the questionnaire was prepared, incorporating 23 factors categorized into 3 groups. And the responses for the internal cause of design change were ranked according to their RII scored.

Relative importance index was calculated using the formula (Sambasivan and Soon, 2007).

$$RII = \frac{\sum PiUi}{N\ (n)} \ldots\ldots$$

$(0 \leq RII \leq 1)$Where,

RII = Relative Importance Index

Pi = respondent's rating of cause and effect of design change (From 1 to 5)

Ui = number of respondents placing identical weighting/rating on cause of design change

N = sample size

n = the highest attainable score on cause and effect of design change (i.e. 5 in this case)

4.4.1 Client Related Factors

Table 6, presents descriptive statistics mean and standard deviation for the client-related factors causing design change and their respective rank according to their mean and RII.

Table 6**:** Client related factors causing design change

No	Item	N	Mean	Stdv	RII	Rank	Over All Rank
1	Owners failure to review document at the right time	119	4.32	0.663	0.86387	**2**	**4**
2	Owner instructs additional work/scope change	119	4.18	0.83	0.83529	**3**	**6**
3	Owner's needs during the design stage are unclear or not well-defined	119	3.88	0.875	0.77647	**4**	**13**
4	Owner's change of schedule due to financial problem	119	3.73	0.945	0.74622	**6**	**18**
5	Changes requested by the owner	119	4.59	0.694	0.91765	**1**	**1**
6	Addition or omission of scope	119	3.74	0.878	0.7479	**5**	**17**
7	Change of funding or budget from the owner	119	3.65	0.798	0.72941	**7**	**20**

Source: own survey (2020)

The above table illustrates the respondent's insight towards client related factors causing design change. Respondents ranked ***"change requested by the owner"*** as the first cause of design change causing factor with a mean value of 4.59 and RII value of 0.917. This design change causing factor is further ranked 1st from the total 23 factors. Based on the responses, ***"owner failure to review the document at the right time"*** was ranked as the second design change causing a factor with mean value of 4.32 and RII value of 0.86. This design change causing factor further ranked as 4th from the total 23 factors. The 3rd ranked factor According to the responses collected was ***"Owner instructs additional work/scope change".***it was identified as the 6th factor with a mean value of 4.18 and RII value of 0.835 from the total 23 factor.

4.4.2 Consultant Factors

A total of ten design change cause factors attributed to the consultant categories were identified. Respondents were asked to indicate their level of agreement on the listed design change causing factors. Based on the received responses the factors were ranked as indicated in the table 7 below. Table 7: Consultant related factors causing design change.

No	Item	N	Mean	Std	RII	Rank	Over All Rank
1	Unrealistic period to design	119	**3.860**	**1.195**	**0.76807**	**9**	**15**
2	Errors and omission in design	119	**4.560**	**0.697**	**0.91261**	**1**	**3**
3	The low consultant fee and poor coordination of design team members	119	**3.200**	**1.375**	**0.64034**	**10**	**22**
4	Changes made as a request of a consultant	119	**4.160**	**0.792**	**0.83193**	**2**	**7**
5	Underestimation of the cost of the project	119	**4.130**	**0.926**	**0.82521**	**3**	**8**
6	Consultants who are not familiar with the regulations and construction permits	119	**3.930**	**0.831**	**0.78655**	**5**	**12**
7	Modification to design (improvement)	119	**3.940**	**0.762**	**0.78824**	**4**	**11**
8	Failure by the consultant to perform design and supervision effectively	119	**3.990**	**0.695**	**0.78487**	**6**	**9**
9	Unclear and inadequate details in drawings,	119	**3.870**	**0.780**	**0.77311**	**7**	**14**
10	Inadequate investigation of site before the design period	119	**3.710**	**0.691**	**0.74286**	**8**	**19**

From the consultant related category Respondents ranked **"Errors and omission in design"** as the first design change causing factor with the mean value of 4.56 and RII value of 0.912. This design change causing factor is also ranked 3rd from the total 23 factors. Design change cause factor ranked second in this category was **"Changes made as a request of a consultant"** with a mean value of 4.16 and RII value of 0.83. This design change causing factor is ranked 7th from the total identified 23 factors. According to the responses collected, **"Underestimation of the cost of the project"** ranked third in the category with a mean value of 4.13 and RII value of 0.82. This cause factor was ranked 8th from the total identified design change cause factors.

4.4.3 Contractor Related Factor

Respondents were asked to indicate their level of agreement on the listed design change causing factors related to the contractor. Based on the received responses the factors were ranked as indicated in the table 8 below.

Table 8**:** Contractor related factors causing design change

No	Item	N	Mean	Std	RII	Rank	Over All Rank
1	Request to use available materials	**119**	**4.210**	**0.700**	**0.84202**	**2**	**5**
2	Unrealistic construction's schedule	**119**	**4.130**	**0.798**	**0.82521**	**3**	**8**
3	Changes initiated by contractors to improve quality and constructability	**119**	**3.970**	**0.952**	**0.79496**	**4**	**10**
4	Poor communication between contractor and other parties	**119**	**4.580**	**0.560**	**0.91597**	**1**	**2**
5	The construction budget is too low.	**119**	**3.760**	**0.892**	**0.75126**	**5**	**16**
6	Shortage of material	**119**	**3.480**	**0.999**	**0.69580**	**6**	**21**

Source own survey (2020)

Based on the results obtained from the survey, respondents ranked **"Poor communication between contractor and other parties"** as the first design change causing factor with a mean value of 4.58 and RII value of 0.915. This design change causing factor is ranked 2nd from the total 23 factors. The design change cause factor ranked second in this category was ***"Request to***

use available materials" with a mean value of 4.21 and RII value of 0.842. This design change causing factor is ranked 5th from the total identified 23 factors. The Design change cause factor ranked 3rd by the respondents in the contractor category was "***Unrealistic construction's schedule***" with a mean value of 4.13 and RII value of 0.798. This factor is ranked 8th among the overall factors.

The following are the top three major design change cause factors from the overall 23 factors. Of all 3 categories, one client factor, one contractor, and one consultant factor were identified as the top three. All the three factors are discussed below.

Table 9: Top three factors causing design change

Design change causing factor	Cause Categories	Mean	SD	RII	Rank
Changes requested by the owner	Client factor	4.59	0.694	0.917	**1st**
Poor communication between contracting parties	Contractor factor	4.58	0.56	0.915	**2nd**
Errors and omission in design	Consultant	4.56	0.697	0.912	**3rd**

Source own survey (2020)

4.5 Discussion of Top three Design Change Cause Factors

1. Changes requested by the owner

The first most factor causing design change in the Addis Ababa building project was identified as change requested by the owner. The factor change requested by the owner includes a change in project scope and/or modification of project function which came from the client after some or the whole work is completed. This result is supported by Studies related to design change. According to Mohamed et al (2012) design change requested by the owner was ranked 1st and in general design change was initiated by the client. Client requested changes throughout the design and construction process can lead to cost and time overruns as well as increased uncertainty for the project delivery team. Another study conducted by Feregenet (2019) on bole international expansion project change requested by the owner was ranked 1st. According to research conducted by Yanaa et al.,(2015) on a study analysis of factors affecting design change in a

construction project with partial list square method the owner was identified as the greatest influential factor on the occurrence of the design changes.

2. Poor Communication between Contracting Parties

The second cause identified based on the responses was ***"poor communication between contracting parties"*** Communication as a whole is vital for any project otherwise the output will be full of changes and errors that will lead to design change. So the coordination of the major stakeholders is very much important for decreasing design change by reducing the occurrence of changes and errors. According to Ahmed Hussien et al., (2018) Poor communication can result in project failure especially in severe cases where the problem is left unsolved. According to Yap and skitmor (2018) lack of communication among various professional disciplines was ranked 1stcause of design change. In another study conducted by Feregenet (2019) poor communication between contracting parties was ranked 2nd factor causing design change. Iliyas et al., (2016) stated failure of communication amongst parties involved as a common factor to design change. The study also concluded that the good performance and success of a building construction project, is determined by the ability and effectiveness of the project team to manage the unnecessary changes during the project.

3. Error and Omission in Design

Design error or omission is caused by the failure of the design professionals to produce complete, accurate, and well-coordinated design results (Waziri, 2016). Design error and omission are among the major contributors to building and engineering infrastructure failures and project time and cost overruns (Sun and Meng, 2009; Love et al., 2009). A design error is caused by lack of instruction in the specifications and plans that, if followed by the contractor, will need replacement or correction at a cost or result in a construction failure. Design errors can adversely affect project performance and can contribute to failures, accidents, and loss of life. Prominent design errors that lead to design change are the omission of details on structural drawings and wrong description in specifications of architectural drawings. According to research by yap and skitmor (2018) 39 design change causing factors were identified through a literature review. Data was gathered by giving 12 semi structures interviews to construction professionals and through a questionnaire survey of 338 clients, consultants, and contractors. From the finding of the research design change on design error and omission was ranked 3rd

cause of design change. According to the study conducted by Feregent (2019) on bole international airport terminal 1 and 2 error and omission was ranked 7th factor among 21 factors identified.

4.6 Effect of Design Change on Project Performance Result and Discussion

Table 10 Effect of design change on project performance

No	Item	RII	Mean	Std	Rank
1	Increase in project cost	**0.89916**	**4.5**	**0.609**	**2**
2	Demolition and rework	**0.85882**	**4.29**	**0.796**	**3**
3	Results dispute among parties	**0.76975**	**3.85**	**1.132**	**4**
4	Decrease in Productivity	**0.72941**	**3.65**	**1.022**	**7**
5	Delay of project	**0.92773**	**4.64**	**0.548**	**1**
6	Wastage of material	**0.7563**	**3.78**	**0.94**	**5**
7	Decrease in quality of work	**0.74622**	**3.73**	**0.918**	**6**

Source own survey (2020)

4.6.1. Delay of Project

Based on the results obtained from the survey, respondents ranked ***"Delay of the project"*** as the first effect caused by the design change factor with the mean value of 4.64 and RII value of 0.92. Different researches support this idea. According to Undurraga, (1996) it is estimated that between 20 to 25% of the total construction period In Latin American countries, is lost as a product of design deficiencies. Another study conducted in Kenya by Ahmed (2013) indicates that delay of project or time overrun is among the very significant factors caused by design change. According to Feregenet (2019) delay of the project was ranked 2nd effect caused by design change. Another researcher Iliyas et al., (2016) identified delay of project as the 2nd most effect of project performance caused by design change. The work hours invested by the

designers in the changes have been estimated in a 40 to 50% of the total of a project (Koskela 1992).

4.6.2. Increase in Project Cost

According to the research finding one of the major effects which ranked 2nd is an increase in project cost. Its mean value is 4.500 and RII value of 0.89. Another study conducted by Mughees et al., (2019) in the research titled design change in construction project cause and impact on cost. Identified contractor and consultant factors as major design change factors causing cost overrun by 27.1% and 48.1% respectively and the cost overrun was measured to be 5-40%. According to Ahmed (2013) increase in project cost was identified as one of the major effects of design change. According to research conducted in the United Kingdom by Cox et al (2010) four sucessfully executed building projects were analyzed and the cost overrun because of design change in this project was in a range between 5-8%. Another study by Chang (2002) reported that cost increased on an average of 24.8% based on four sampled projects in California. Another study supporting the finding of this research was Love (2002) conducted a questionnaire survey on 161Australian construction projects. The author concluded that out of a total 52% of cost overrun, 26% were directly related to sudden changes in design. According to research conducted by Tadele (2018) on Addis Ababa University building projects, design change was identified and ranked 1st for causing cost overrun on the project.

4.6.3. Demolition and Rework

Based on the results obtained from the survey, respondents ranked **"Demolition and rework"** as the 3rd effect caused by the design change factor with the mean value of 4.29 and RII value of 0.85.different scholar's support this idea. According to Han et al. (2013) identified rework as a major cause of design changes. According to Li and Taylor (2014) rework in construction project can significantly affect project cost and schedule performance. Another study by Burati et al. (1992) found that 79% of rework costs arising in industrial engineering projects were the result of design changes, errors and omissions. Rework cost typically ranges from 10% to 15% of the contract sum in a particular building construction project (Sun & Meng, 2010).

4.7 Analysis of Inferential Statistics Result

The major objective of the study is to assess the effect of design change on construction project performance and to assess the existed relationship. For this purpose, inferential statistics of correlation & regression analysis have been used and the result is presented in the below sections.

4.7.1 Correlation Analysis

Correlation is used to test relationships between quantitative variables or categorical variables. In other words, it's a measure of how things are related. A correlation coefficient is a way to put a value to the relationship. (Field, 2009)

Correlation coefficients have a value of between -1 and 1. A "0" means there is **no relationship** between the variables at all, while -1 or 1 means that there is a **perfect negative or positive correlation** (negative or positive correlation here refers to the type of graph the relationship will produce).

Sig (2-tailed) if the value is less than or equal to 0.05 we can conclude that there is a statistically significant correlation between the variables. (Field, 2009)

Table 11 Measures of Association and Descriptive Adjectives

Measure of Association	Descriptive Adjective
> 0.01 to 0.30	Low
> 0.30 to 0.70	Moderate
> 0.70 to 0.90	High
> 0.09 to 1.00	Very high

Source: ((Field, 2009)

Hence the correlation output of dependent and independent variable is interpreted based on table 12

Table 12 Correlations Matrix between the Dependent and Independent Variable

		Client Factors	Consultant Factor	Contractor Factor	Effect on Project Performance
Client factors	Pearson Correlation	1	.687**	.445**	.737**
	Sig. (2-tailed)		.000	.000	.000
	N	119	119	119	119
Consultant factor	Pearson Correlation	.687**	1	.634**	.798**
	Sig. (2-tailed)	.000		.000	.000
	N	119	119	119	119
Contractor factor	Pearson Correlation	.445**	.634**	1	.599**
	Sig. (2-tailed)	.000	.000		.000
	N	119	119	119	119
Effect on Project performance	Pearson Correlation	.737**	.798**	.599**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	119	119	119	119

**. Correlation is significant at the 0.01 level (2-tailed).

Source: own survey result (2020)

Based on the survey result, the correlation between Client factor & its effect on project performance is positive and they are significantly correlated at (R = .737**), (P< 0.01). This shows that an increase in client related design change would lead to an increase in the effect of project performance or it would affect project performance. Similarly, the correlation between contractor factor and its effect on project performance with (R =.599**), (P< 0.01) accordingly, the relationship between the two variables is moderately positive and statistically significant. This shows that an increase in contractor related design change would lead to an increase in the effect of project performance or it would affect project performance. From the survey result, the correlation between consultant factor and its effect on project performance is positive and they are significantly correlated at R =.798**), (P<0.01) which reveals a high relationship of the two variables. This shows that an increase in consultant related design change would lead to an increase in the effect of project performance or it would affect project performance. According to

Field, (2009) a correlation between two variables does not imply that one event causes the second to occur. In order to understand how the dimensions of design change affect project performance and thus to test hypotheses, multiple regression was carried out. But before running the regression the basic assumptions for regression have been analyzed.

4.7.2 Test of Normal Distribution

The P-P Plot of Normality Test is cumulative probability plots of residuals.it is used to judge whether the distribution of variables is consistent with a specified distribution. If the Standardized residuals are normally distributed, the scatters should fall on or tightly close to the normal distribution line. This shows that the scatters of the residuals basically fall straightly on the normal distribution line, indicating a normal distribution of residual. Having this in mind the below diagram shows that the data is normally distributed.

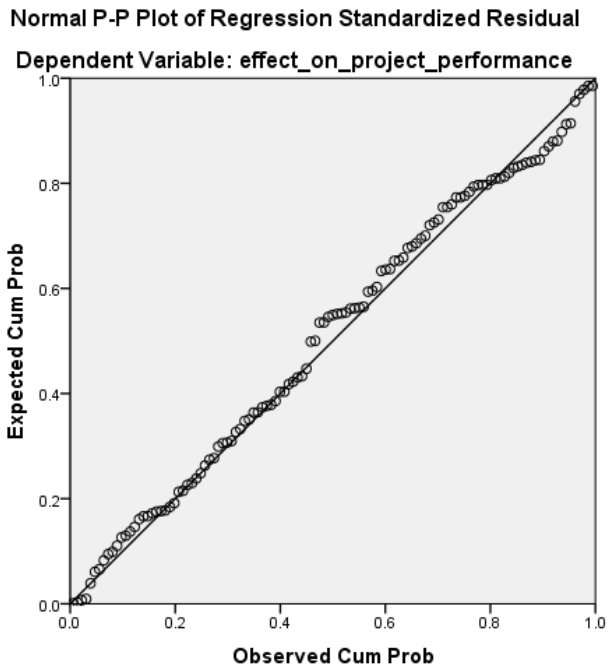

Figure 7 Test of normal distribution

Source own survey result (2020)

4.7.3 Test of Multicollinearity

Multicollinearity is a situation when a high correlation is detected between two or more predictor variables. It can be detected with tolerance values and Variance Inflation Factor (VIF).According to Pallant (2005) tolerance is an indicator of how much of the variability of the specified independent is not explained by the other independent variables in the model. If the value is very small (less than 0.10) it indicates that the multiple correlation with the other variable is high and it suggests the possibility of multicollinearity. The other is the variance inflation factor (VIF) which is the inverse of the tolerance value. If VIF values range between 1and 10 then there is no multicollinearity. If the VIF is <1and >10, then there is multicollinearity. As shown in the table 13 below. The tolerance and VIF of the variables show there is no multicollinearity. VIF value for Client factor is 1.896, consultant factor 2.544 and Contractor factor is 1.673 so it fits the requirement and multicollinearity is not a problem.

Table 13 Multicollinearity Table

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	**Collinearity Statistics**	
		B	Std. Error	Beta			**Tolerance**	**VIF**
1	(Constant)	.120	.236		.510	.611		
	Client factors	.345	.066	.356	5.221	.000	.527	1.896
	Consultant factor	.501	.087	.457	5.786	.000	.393	2.544
	Contractor factor	.146	.062	.151	2.351	.020	.598	1.673

Source own survey result (2020)

4.7.4 Multiple Regression Analysis

Since descriptive analysis does not determine any significant results in predicting the effect of various design change factors on project performance, further analysis using advanced statistical methods such as multiple linear regression is required. Multiple regression analysis is widely used method in research to explore the correlation between one dependent (target) variable and more than two independent (predictors) variables. In this study, the overall effect on project performance as a dependent variable is correlated with owner related design change, contractor

related design change, and consultant related design change, as independent variables by using the technique of standard multiple regressions in SPSS. The result of multiple regression is the development of a regression equation (line of best fit) between the dependent and independent variables. The following tables show the regression analysis for the variables, results are discussed and interpreted based on the table below.

Table 14 Model Summary Effect on Project Performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.847[a]	.718	.710	.282376

a. Predictors: (Constant), Contractor factor, Client factors, Consultant factor

b. Dependent Variable: Effect on Project Performance

Source own survey result (2020)

As the above table depicted, the adjusted R^2 value of the model is 0.710, indicating that 71. % of the variation in project performance is explained by client related factors, consultant related factors, and contractor related factors. In other words, 29. % of the variation in project performance in the Addis Ababa building project cannot be explained by the study variables and there are other factors that can influence project performance.

Table 15 ANOVA of effect on Project Performance

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	23.305	3	7.768	97.427	.000[b]
	Residual	9.170	115	.080		
	Total	32.475	118			

a. Dependent Variable: Effect on project performance

b. Predictors: (Constant), Consultant factor, Client factor, Contractor factor

Source: own survey result (2020)

The F-ratio in the ANOVA table 15 above tests whether the overall regression model is a good fit for the data. The table shows that the independent variables statistically significantly predict

the dependent variable, F (3, 115) = 97.429, p < .005 (i.e., the regression model is a good fit of the data).

Table 16 Regression coefficient

Model		**Unstandardized Coefficients**		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.120	.236		.510	.611		
	Client factors	.345	.066	.356	5.221	.000	.527	1.896
	Consultant factor	.501	.087	.457	5.786	.000	.393	2.544
	Contractor factor	.146	.062	.151	2.351	.020	.598	1.673

a. Dependent Variable effect on project performance
Source own survey result (2020)

The values of the unstandardized Beta Coefficients (β) indicate the effects of each independent variable on the dependent variable. Furthermore, the values of the unstandardized Beta Coefficients in the Beta column of the Table16 above, indicate which independent variable (determinants of design change) makes the strongest contribution to explain the dependent variable (effect on project performance) when the variance explained by all other independent variables in the models controlled. The *t* value and the sig (*p*) value indicate whether the independent variable is significantly contributing to the prediction of the dependent variable. The findings of the regression analysis showed that client related factors, consultant related factors and contractor have major effect on project performance with β coefficient as (0.345), (0.501) and (0.146), respectively After processing of multiple regressions, the following regression model has been resulted: Overall effect on Project Performance = .120+.345(Owner Related factor) +.501(Consultant Related Factors) +.146(Contractor Related Delays) +e

Y =0.120 + 0.345 X1 + 0.501 X2 + 0.146X3+e

Where Y =Effect on Project Performance
X1 = client related factor
X2 = consultant related factor
X3 = contractor related factor
e = sampling error

4.8 Hypothesis Testing

Hypothesis 1: Client related design change has effect on project performance.

The results of multiple regressions, as presented in Table 16 above, revealed that client related design change had effect on project performance with ($\beta = 0.345$, $t = 5.221$ & $p < 0.05$).Thus, the proposed hypothesis was accepted. In this case, the beta coefficient describe that keeping the other variables constant, in this model a one % change in the overall client related design change affect project performance by 34.5 %. Therefore, client related design change had a significant effect on project performance.

Hypothesis 2: Consultant related design change has effect on project performance.

The results of multiple regressions, as presented in Table 16 above, revealed that consultant related design change had a significant effect on project performance with values ($\beta = 0.501$, $t = 5.786$, $p < 0.01$). Thus, the proposed hypothesis was accepted. In this case, the beta coefficient describe that keeping the other variables constant, in this model a one % change in the overall consultant related design change affect project performance by 50 %. Therefore, consultant related design change had a significant effect on project performance.

Hypothesis 3: Contractor related design change has effect on project performance.

The results of multiple regressions, as presented in Table 16 above, revealed that contractor related design change had a significant effect on project performance with values ($\beta = 0.146$, $t = 2.351$, $p < 0.01$). Thus, the proposed hypothesis was accepted. In this case, the beta coefficient describe that keeping the other variables constant, in this model a one % change in the overall contractor related design change affect project performance by 14.6 %. Therefore, contractor related design change had a significant effect on project performance.

Table 17 Summary of hypothesis testing for regression

Hypothesis	Tool	Outcome
Ha1: Client related design change has effect on project performance.	Multiple Regression	**Accepted**
Ha2: Consultant related design change has effect on project performance.	Multiple Regression	**Accepted**
Ha3: Contractor related design change has effect on project performance.	Multiple Regression	**Accepted**

Source: Own Survey (2020)

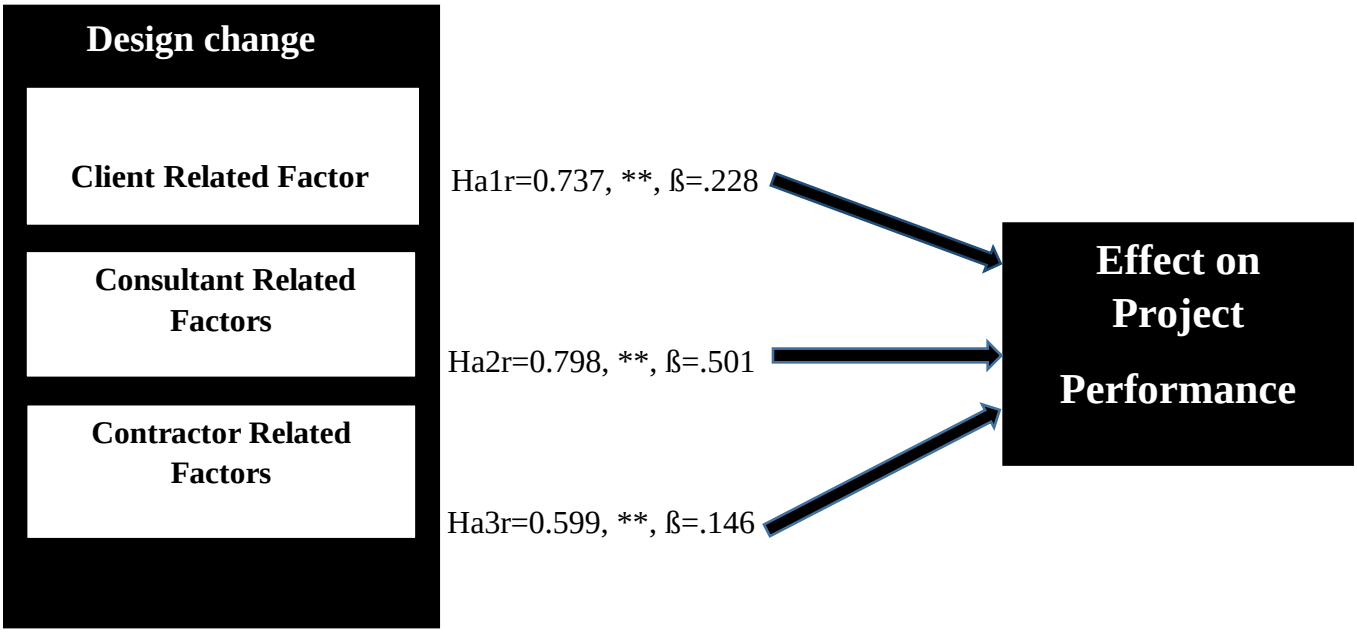

Figure 7 project performance model

As there are no researches conducted about this topic using regression and correlation analysis it was difficult to compare the inferential statistics output with other researchers. But in general it was found that design change affect project performance. 71% of the variation in project performance is explained by client related factors, consultant related factors, and contractor related factors. In other words, 29 % of the variation in project performance in the Addis Ababa building project cannot be explained by the study variables and there are other factors that can influence project performance. Several researchers support the idea that design change is a major factor affecting project performance. According to Olawale & Sun, (2010) Design changes in construction projects lead to cost overrun or schedule delay. Cost and time are among the major project performance indicators. Kaming et al. (1997) support the conclusion that design change affect project performance. On their study which identify thirty one factors on high-rise project in Indonesia found that design changes is one of the most important factors causing time overrun. According to Burati et al., (1992) frequent design change is one of the major factor which affect project performance. The above mentioned researches support the idea that design change affect project performance. Which support the idea and conclusion of this study.

CHAPER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter has three subdivisions. The first subdivision presents summary of the main findings: the second subdivision presents conclusion of the study resulting from findings. The third subdivision deals with the recommendation that is made on the basis of findings.

The following three research questions guided this study:

- What is the effect of design change on construction project performance in A.A?
- What is the relationship between the client related design change factor and construction project performance in A.A?
- What is the relationship between consultant related design change factor and construction project performance A.A?
- What is the relationship between contractor related design change factor and construction project performance A.A?

5.1 Summary of Major Findings

The main objective of this study was to identify the effect of design change on project performance in Addis Ababa building projects. This study used a quantitative research approach and due to the purpose, an explanatory research design was used. The target population for this study was G1 contractors, G1 consultants, and clients. Based on the research objective, questionnaires were prepared and distributed to 140 professionals. From this, the researcher collects 119 (85%) from the sample through email and google form. The collected data were analyzed using a statistical package for social science software (SPSS). Multiple Regression analyses were employed for testing the hypotheses. Prior to applying regression analysis, reliability, and correlation analysis tests required to perform regression were performed. With regard to reliability, the results showed that all measures used in this study had an acceptable level of reliability. Descriptive statistics like frequency, percentage, mean, and standard deviation were employed to analyze the background information of respondents. A relative importance index was used to rank the top three causes and effects of design change.

From the RII value conducted for the cause of design change, three topmost factors were identified. The first ranked cause was a change requested by the owner the 2nd ranked factor was poor communication between contracting parties. The 3rd ranked factor causing design change was demolition and rework. Those three factors were identified and ranked the same by different researchers like Feregenet (2019); Mohamed et al., (2016); Iliyas J et al, (2016). RII ranking was also done for the effect of design change.The top 3 effects of design change were identified as delay of the project, cost overrun, and demolition and rework respectively.

Next, the result of the correlation analysis was made. In this regard Table 12 shows that all the independent variables client, consultant, and contractor related factors are positively and significantly correlated with the dependent variable (effect on project performance)

Finally, a multiple regression analysis was conducted to test the hypothesis. In this regard, the result shows that the model tested is significant ($p < 0.000$) with R square 0.71. This value indicates that project performance was affected by design change factors client, consultant, and contractor by 71. %. Regarding the hypothesis as Table 17 illustrated, since the beta coefficients were found significant, the three alternative hypothesis in the study were accepted. Moreover, the findings revealed that**,** the consultant factor is found to be the most dominant factor in determining the effect of project performance in Addis Ababa building projects.

5.2 Conclusion

The conclusions of the whole study were made through a comparison of the project objectives and the end results. The main objective of the research was to identify the effects of design change in Addis Ababa building projects. But before conducting correlation and regression analysis to show the relationship between design change factors and project performance top causes of design change and its effect were identified by using the relative importance index. The study identifies change requested by the owner, poor communication between contracting parties and error and omission were the topmost cause factors of design change. The top three identified effects include delay of the project, increase in project cost, demolition and rework. This was supported by (Feregenet 2019; Mohamed et al, 2016; Iliyas J et al, 2016).

The next three ojective of this study were to identify if there was any relationship between client,consultant,and contractor factor with its project performance effect.

In this study, it was found that all design change factors client related, consultant related, and contractor related factors have a significant relationship with effect on project performance. Which means that there exists a positive and significant relationship between design change and effect on project performance. This implies that when design change increase effect on project performance will increase. The study result show that project performance was affected by design change factors client, consultant, and contractor by 71. % which is very significant. We can conclude that if serious attention is not given to this design change factor which significantly affect the project performance it will be very difficult to achieve project objectives.

5.3 Recommendation

Aligned with the above conclusion, the researcher proposes the following recommendations that should be considered by concerned stakeholders in order to reduce the effect of design change on project performance. These include:

Recommendation for consultant

- The design consultants involved in Building construction projects are recommended to make detailed investigations during the design and tender document preparation period which will eliminate frequent design change, design errors, and unrealistic contract requirements. This would help in reducing time overrun and cost overrun which affect the project performance.
- Consultants should perform and schedule realistic project duration using detailed work break down structure and by using various modern software's like MS project and primavera which will help in making detail and well organized project schedule to avoid exaggerated time and cost deviation.
- Consultants should give a brief explanation of the design document with the respective professional appointed by the client. And giving awareness about the consequence of design change in the construction phase.

Recommendation for client

- Clients should ask for a clear and complete design brief at an early stage. Which would help the client to understand the design concept and solve the problem of requesting

change during the construction stage which will result in a delay in the project, cost overrun, and rework.

- Client should engage an experienced project coordinator that represent the client in order to eases the design process and communication with the design members.
- If scope change is mandatory, communicating with the design team the design should be modified in accordance with the currently constructed structure in order to avoid undesirable rework, cost overrun and time overrun.

Recommendation for Contractor

- The contractor has to improve communication and coordination between stakeholders. By having constant and fixed meeting schedules where the parties could discuss the current design and actual work on site. This will avoid frequent design change that results in time overrun, cost overrun and rework.
- Instead of asking to use available material to increase their profit it is better if they increase their profit margin and execute the project with the given and approved material by the consultant.

General recommendation

- The clients, consultants and contractors should considered allocating sufficient time at the initial design stage to implement the client's idea properly and to finalize the requirements of the proposed work.
- Identified cause and effect of design change factors can be used as a check list to contribute for improving project performance of building construction projects in Addis Ababa.

Suggested further research

Similar study can be done by including construction organizations G2-G9, contractors and consultant because this study doesn't include this organizations because of time limitation. Further quantitative research could be made on the effect of design change on each project performance factors like time, cost, quality, and each effect could be quantified in percent. The study could also include external factors that were not included in this research.

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APPENDIX A

Questionnaire

St. Mary's University
Project Management Department
M.A thesis on Project Management

Dear Respondent,

I am kindly requesting your willingness to participate in this research "**the effect of design change on projects performance in Addis Ababa".** The questioner is designed for partial fulfillment of MA in project management. The research result could be used as an input for clients, contractor and consultants, academician or other interested groups.

It is believed that your participation in this research will contribute in achieving objective of the research. Thus the quality of your response towards the question item determine the quality of the research result. Therefore please answer the question as objectively and honestly as possible and according to the instruction contained in body of the questionnaire. Finally, I want to assure you that all information provided in this survey will be treated with strict confidentiality and allowed to serve for the purpose of the research under consideration. If you have any question please feel free to contact me through the provided addresses.

Thank you in advance for your cooperation!!

Contact Address

Bethelhem Asmerom

E-mail: betyasmerom@gmail.com

Phone No: 0913569578

Part 1: Demographic profile of respondents

Please put a tick mark **"√"** the one that represents you most appropriately.

1. What is your title/position?

[1] Project Manager ☐ [4] Office Engineer ☐

[2] Resident Engineer ☐ [5] Site Engineer ☐

[3] Architect /design engineer ☐

2. Type of organization you are working for?

[1] Client ☐

[2] Consultant ☐

[3] Contractor ☐

3. How many years of experience do you have in construction industry

[1] 1-5 years ☐ [3] 11-15 years ☐

[2] 6-10 years ☐ [4] >15 years ☐

PART II: Factors influencing design change (Measure of independent variable)

Below are list of factors influencing design change. From your experience, please express your opinion on which factors influence design change (which factor causes design change) in Addis Ababa building projects? Please put a tick mark **"√"**in the appropriate column according to the degree of rank.

Measures of Independent Variables		Rating Scale				
A. Factors related to client		**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
1.	Owners failure to review document at the right time					
2.	Owner instructs additional work/scope change					
3.	Owner's needs during the design stage are unclear or not well-defined					
4.	Owner's change of schedule due to financial problem					
5.	Changes requested by the owner					
6.	Addition or omission of scope					
7.	Change of funding or budget from the owner					

B. Factors related to Consultant		Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	Unrealistic period to design;					
2.	Errors and omission in design					
3.	The low consultant fee and poor coordination of design team members					
4.	changes made as a request of a consultant					
5.	underestimation of the cost of the project					
6.	consultants who are not familiar with the regulations and construction permits					
7.	Modification to design (improvement)					
8.	Failure by the consultant to perform design and supervision effectively					
9.	Unclear and inadequate details in drawings,					
10	Inadequate investigation of site before the design period					
C. Factors Related to Contractor		**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
1.	Request to use available materials					
2.	Unrealistic construction's schedule					
3.	Changes initiated by contractors to improve quality and constructability					
4.	Poor communication between contractor and other parties					
5	The construction budget is too low.					
6	Shortage of material					

PART III: EFFECT OF DESIGN CHANGE ON PROJECT PERFORMANCE (Measure of dependent variable)

The following are identified effect of design change on project performance. Please indicate the level of their influence on affecting the project performance.

C. Effect of Design change on project performance		**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
1.	Increase in project cost					
2.	Demolition and rework					
3.	Results dispute among parties					
4.	Decrease in Productivity					
5	Delay of project					
6	Wastage of material					
7	Decrease in quality of work					

APPENDIX B

Case Processing Summary

		N	%
Cases	Valid	119	100.0
	Excluded[a]	0	.0
	Total	119	100.0

a. List wise deletion based on all variables in the procedure.

Client related factors

Reliability Statistics

Cronbach's Alpha	N of Items
.788	7

Consultant Related Factors

Reliability Statistics

Cronbach's Alpha	N of Items
.717	10

Contractor related factors

Reliability Statistics

Cronbach's Alpha	N of Items
.731	6

Project performance

Reliability Statistics

Cronbach's Alpha	N of Items
.703	7

Over all Reliability

Reliability Statistics

Cronbach's Alpha	N of Items
.878	4

APPENDIX C

Descriptive statistics of client factor

No	Item	Frequency					Total	RII	Mean	Stdv	Over All Rank
		SD	D	N	A	SA					
1	Owners failure to review document at the right time	0	0	13	55	51	**595**	0.86387	4.320	0.663	**2**
		0	0	39	220	255	**514**				
2	Owner instructs additional work/scope change	1	0	26	42	50	**595**	0.83529	4.180	0.83	**3**
		1	0	78	168	250	**497**				
3	Owner's needs during the design stage are unclear or not well-defined	1	4	35	47	32	**595**	0.77647	3.880	0.875	**4**
		1	8	105	188	160	**462**				
4	Owner's change of schedule due to financial problem	2	4	49	33	31	**595**	0.74622	3.730	0.945	**6**
		2	8	147	132	155	**444**				
5	Changes requested by the owner	0	4	2	33	80	**595**	0.91765	4.590	0.694	**1**
		0	8	6	132	400	**546**				
6	Poor communication of client with the other parties	1	3	50	37	28	**595**	0.74790	3.740	0.878	**5**
		1	6	150	148	140	**445**				
7	Change of funding or budget from the owner	1	0	60	37	21	**595**	0.72941	3.650	0.798	**7**
		1	0	180	148	105	**434**				

Descriptive statistics of consultant factor

No	Item	Frequency									Over All Rank
		SD	D	N	A	SA	Total	RII	Mean	Std	
1	Unrealistic period to design	8	13	11	45	42	**595**	**0.76807**	**3.860**	**1.195**	**2**
		8	26	33	180	210	**457**				
2	Failure of a consultant to provide adequate and clear information in the design documents	1	1	5	35	77	**595**	**0.91261**	**4.560**	**0.697**	**3**
		1	2	15	140	385	**543**				
3	The low consultant fee and poor coordination of design team members	17	26	17	34	25	**595**	**0.64034**	**3.200**	**1.375**	**4**
		17	52	51	136	125	**381**				
4	Changes made as a request of a consultant	0	3	20	51	45	**595**	**0.83193**	**4.160**	**0.792**	**6**
		0	6	60	204	225	**495**				
5	Underestimation of the cost of the project	1	7	17	45	49	**595**	**0.82521**	**4.130**	**0.926**	**1**
		1	14	51	180	245	**491**				
6	Consultants who are not familiar with the regulations and construction permits	0	1	42	40	36	**595**	**0.78655**	**3.930**	**0.831**	**5**
		0	2	126	160	180	**468**				
7	Modification to design (improvement)	0	0	38	50	31	**595**	**0.78824**	**3.940**	**0.762**	**5**
		0	0	114	200	155	**469**				
8	Failure by the consultant to perform design and supervision effectively	0	0	29	60	28	**595**	**0.78487**	**3.990**	**0.695**	**5**
		0	0	87	240	140	**467**				
9	Unclear and inadequate details in drawings,	0	5	30	60	24	**595**	**0.77311**	**3.870**	**0.780**	**5**
		0	10	90	240	120	**460**				
10	Inadequate investigation of site before the design period	1	0	44	61	13	**595**	**0.74286**	**3.710**	**0.691**	**5**
		1	0	132	244	65	**442**				

Descriptive statistics for contractor related factors

No	Item	Frequency					Total	RII	Mean	Std	Over All Rank
		SD	D	N	A	SA					
1	Request to use available materials	0	0	19	56	44	**595**	**0.84202**			**2**
		0	0	57	224	220	**501**		**4.210**	**0.700**	
2	Unrealistic construction's schedule	1	2	19	56	41	**595**	**0.82521**			**3**
		1	4	57	224	205	**491**		**4.130**	**0.798**	
3	Changes initiated by contractors to improve quality and constructability	4	5	16	59	35	**595**	**0.79496**			**4**
		4	10	48	236	175	**473**		**3.970**	**0.952**	
4	Late approvals of design	0	0	4	42	73	**595**	**0.91597**			**6**
		0	0	12	168	365	**545**		**4.580**	**0.560**	
5	The construction budget is too low.	1	9	32	53	24	**595**	**0.75126**			**1**
		1	18	96	212	120	**447**		**3.760**	**0.892**	
	Shortage of material	8	7	37	54	13	**595**	**0.69580**			**5**
		8	14	111	216	65	**414**		**3.480**	**0.999**	