Management of Causes and Impacts of Design Changes in Ethiopian Building Projects;

The Case of Arsi Zone Public Building Construction Projects

By

Kassim Kabeto Beriso

A Thesis Submitted to

Department of Civil Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Masters in Civil Engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

September, 2022

Adama, Ethiopia

Management of Causes and Impacts of Design Changes in Ethiopian Building Projects;

The Case of Arsi Zone Public Building Construction Projects

Kassim Kabeto Beriso

Advisor

Dr. Meseret Getnet Mehari

A Thesis Submitted to:

Department of Civil Engineering

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Masters in Civil Engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

September, 2022

Adama, Ethiopia

APPROVAL SHEET

I the advisors of the thesis entitled “Management of Causes and Impacts of Design Changes in Ethiopian Building Projects” and developed by Kassim Kabeto Beriso, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Kassim Kabeto Beriso have read and evaluated the thesis entitled “Management of Causes and Impacts of Design Changes in Ethiopian Building Projects” and examined the candidate during the open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Construction Engineering and Management.

Chairperson	Signature	Date
Internal Examiner	Signature	Date
External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

Department Head	Signature	Date
School Dean	Signature	Date
Office of Postgraduate Studies,	Dean Signature	Date

DECLARATION AND RECOMMENDATION

DECLARATION

I hereby declare that this Master Thesis entitled “Management of Causes and Impacts of Design Changes in Ethiopian Building Projects” is my original work. That is, it has not been submitted for the award of any academic degree, diploma, or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

_____	_____	_____
Name of the Student	Signature	Date

RECOMMENDATION

I the advisor of this thesis, hereby certify that I have read the revised version of the thesis entitled “Management of Causes and Impacts of Design Changes in Ethiopian Building Projects” prepared under my guidance by Kassim Kabeto Beriso submitted in partial fulfillment of the requirements for the degree of Masters of Science in Construction Engineering and Management. Therefore, I recommend the submission of the revised version of the thesis to the department following the applicable procedures.

_____	_____	_____
Advisor	Signature	Date

ACKNOWLEDGEMENT

First of all, I thank the almighty God for what he has done to me till today, blessing my life and giving me the patience and strength to finish this work.

Secondly, I would like to express my sincere gratitude to my advisor, Dr. Meseret Getnet, for all his continuous support, guidance, motivation, and supervision throughout my graduate studies.

Thirdly, I would like to thank all of the Professionals working for clients, consultants, contractors, and regulatory bodies in Arsi zone and Asella town for their contributions in questionnaire response, Case Study and group discussion.

Next, I reserve special thanks to my wife Zemzem Mohammed for her financial support, for her protection of my daughters (Milkiman Kassim and Dineyas Kassim) to protect me from different stress and also for her patiently motivation from start to end of my masters study in any condition.

Finally I would like to thank my Parents Kabeto Beriso and Demitu Beriso for their motivation and advise from start to the end of my study.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURES PAGE

LIST OF ACRONYMS

AWAO	Amigna woreda administration Office
AZAO	Arsi Zone administration Office
AZCA	Arsi Zone Construction authority
AZUDH	Arsi Zone Urban Development and Housing
B/C	benefit-to-cost ratio
BOQ	Bill of Quantity
KMO	Kaiser-Mayer-Olkain
MOWUD	Ministry of Works and Urban Development
NGO	None Governmental Organization
PBCP	Public Building Construction Project
PLC	Private Limited Company
RB	Regulatory Body
RII	Relative Importance Index
SWAO	Sude woreda administration office
SKWAO	Shanan Kolu woreda administration office

ABSTRACT

The purpose of this study is to investigate causes and impacts of design change in public buildings and Management of Causes and Impacts of Design Changes in Arsi Zone. In this study data collection tools were questionnaires, case study and group discussion on sample public building projects. From 64 questionnaires distributed, 58 were responded with response rate of 90.6%. The data were analyzed by using SPSS software version 25 and the Relative Importance Index (RII). The results revealed various factors that lead to design change in public building construction projects, such as; Additions of new works at the request of the client, Poor coordination and communication between parties, Design Errors, Willingness to use alternative materials, The desire of the contractor to improve his financial situation, Inconsistency of the contractual document, Unexpected site conditions and Design change made by consultants. From the results of RII analysis the impacts of design change on overall performance of construction projects, such as Delay of the projects, suspension of the projects and Increase of project cost. The Selected Current Design Change Management practice discussed are involvement of experienced technical personnel, involvement of end users before starting of the construction and ensure sufficient budget for the project also the Result also shows that the parameters used to develop the design change management system flowchart such as Proper supervision, involvement of end users at Design Stage, involving design team in construction process, and developing professional skill of design team were very important to develop the best design change management system flowchart. The study address the management of causes and impacts of design change in public building projects, the researcher creates a management system flowchart as a mitigation measures. The study concludes that paying a serious attention to the major causes of design change will be very important to manage the impacts and finally achieve the goals of project. The researcher recommend that always work to identify major causes of design change and properly manage the impacts of the design change happened at any time. And the researcher recommends studying on the wider area and including more construction projects for further study.

***Keywords**: Design change, Design Change management, Public building projects, Arsi Zone*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

The nature of construction industry is complex and uncertain because of different firms are involved from inception stage to commissioning stage. Design is a process of creating the description of a new facility, usually represented by detailed plans and specifications; construction planning is a process of identifying activities and resources required to make the design a physical reality (Bassa, 2019).

Engineering design changes in reinforced concrete buildings are common in the construction industry; in many cases, these changes lead to excessive claims and disputes. A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions (Mohamad, 2012).

A design change is a form of change that will deviate the way the work was planned, budgeted or scheduled. Almost all building projects undergo various degrees of design changes through the project lifecycle. (Hamzah, 2017) In an integrated system, the planning for both design and construction can proceed almost simultaneously, examining various alternatives which are desirable from both viewpoints and thus eliminating the necessity of extensive revisions under the guise of value engineering. Furthermore, the review of designs with regard to their constructability can be carried out as the project progresses from planning to design. According to Ethiopia Construction industry the lion share of design preparation part goes to consultant firms (Bassa, 2019).

A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions (Abdul-Rahman, 2017).

This research work is required because there is a problem related to design changes happened at many building constructions projects especially in public building projects. Therefore, after generalizing of result analysis the contribution of this research will provide the best design change management frame work for the whole building construction projects in Ethiopia

1.2. Statement of the Problem

The comprehensive literature review was intended to aid the reader in Understanding that some effort has been made in order to investigate cause, effects and design management in Ethiopian building construction industry, especially in public building projects. Bassa, 2019) Investigate the causes and impacts of design change in Three Selected Southern Ethiopia Zones building construction projects. His results also showed that completion schedule delay, increase in project cost, wastage of materials during rework, productivity degradation and working extra hours (overtime) to meet deadlines of the project. (Ambachew, 2018) Assess the design management practices of national consultants focused on building design projects. According to the results of his research, factors contributing to the inconsistent design management are unfamiliarity with defining tasks, ineffective managing and improper evaluation of information flow, inadequate planning, monitoring and controlling for project design process. His results revealed that consultants‟ design controlling process is not integrated with the management and evaluation of information throughout the design process with considering the time constraints. (Beshah, 2015) Assess the causes and cost impact of change orders on road projects in Ethiopia to identifying and analyze the major categories of change orders, the consequential cost impacts of the change orders.

(Ali, 2009) Studies the difficulty to manage design change due uncertainties encountered during project execution phase. But, the problem is till now is existing in the country. For example, according to Arsi Zone quarter year report in 2020 G.C in Arsi Zone, there were many projects were facing problem because of their design change like delay, cost increment of construction projects, project suspension and sometimes result in termination. Besides, some projects were re awarded which is time taking and costly. Many researchers investigate causes and impacts of design changes in foreign countries. Therefore, this research is going to fill the gap by establishing the management system of causes and impacts of design changes for public building projects to minimize completion schedule delay, increase in project cost, and wastage of materials during rework, productivity degradation and working extra hours (overtime) to meet deadlines of the project. So, the Research is done to forward the management system for causes and impacts of design change of public building projects in Arsi Zone.

1.3. The Objective of the Study

1.3.1. General Objective`

The general objective of this study is investigation of management of causes and impacts of design changes in construction of public building projects in Arsi Zone to develop management system.

1.3.2. Specific Objectives

1. To identify the major causes of design changes in public building construction projects in Arsi Zone
2. To investigate the impacts of design changes in public building projects in Arsi Zone
3. To evaluate the current Design Change Management practice and Preventive Measures in Arsi Zone public building projects
4. To develop design change management system for public building projects.

1.4. Research Questions

1. What are the major causes of design changes in public building construction projects in Arsi Zone?
2. What are the impacts of design changes in public building projects in Arsi Zone?
3. What are current Design Change Management practice and Preventive Measures in Arsi Zone public building projects?
4. How to develop design change management System?

1.5. Significance of the Study

From literature review to investigate best understanding on management of causes and impacts of design changes to minimize the problem followed by design change in Arsi Zone public building projects. The most important tool to reduce the risk of disputes of design changes is the best management of the whole process from start to end of the project construction.

1.6. Scope of the Study

The study focused on the 51 randomly selected public building construction projects in Arsi Zone. The rationale behind this delimitation is that construction of public building projects

those their designs are changed are currently under construction in selected area. In this study, the available Consulting organizations, local contractors, Regulatory bodies and Clients were selected, because, they were involved in construction of public building projects in the selected area.

1.7. Limitations of the Study

This research was limited to showing the causes of design changes and the impact of changes on public building project performance and management practices from the perspectives of contractor professionals, client professionals, consultant professionals, and regulatory professionals working in the Arsi zone. During sample selection, it may ignore some relevant samples. Due to the current instability of peace in the country, the study focused on public construction projects in one zone; for this reason, the final findings cannot provide an overall picture of the causes, and effects of changes on public building project performance and management practices. But during the preparation of the target group, attention was paid to the inclusion of the relevant group.

1.8. Organization of the Study

This study is divided into four 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 previously. Chapter three explained the methodology that was implemented to come up with the findings of the study. This chapter also explained the research approach and design, population, sampling and data collection methods used to find out the data needed. Chapter four explained the results and discussion after analyzing the collected data. At the last the findings were summarized under conclusion and finally the study gave recommendations based on the findings.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Change of Design in Construction

The Design change is defined as any change in the design or construction of a project after the contract is awarded and signed. (Asmerom, 2021) A change in a construction project is a deviation from the original plan resulting from unexpected circumstances which can be either positive or negative. A positive change will save the cost and time of the project and may even improve the quality or the scope of the work. A negative change will deteriorate project outcomes. According to (Bassa, 2019), a design change is a design error, a design omission, a different site condition or even a scope change. The main reasons for design changes are the changes in the client's requirements, inadequate experience of the architects and structural engineers and conflicts among them and the of the design process by separating out the design phase from the shop drawing review phase and the construction observation phase (Bassa, 2019).

The design process is a process that is performed in a series of iterative steps to conceive, describe and justify increasingly detailed solutions to meet the needs of the client. In construction projects, a change refers to an alteration or a modification to pre-existing conditions, assumptions and basic information, or requirements. It includes work, time, cost and method of performance (Suleiman & Luvara, 2016). Building design is the process of providing all information necessary for construction of a building that meet its owner's requirements and also satisfy public health, welfare, and safety requirements. Building design may be legally executed only by persons deemed competent to do so by the state in which the building is to be constructed (Suleiman & Luvara, 2016). Design changes may occur in architectural, structural, plumbing and drainage, site works or other aspects of construction.

2.2. Definition of Design Change in the Construction Industry

Project change has been defined by several researchers. "Additions, deletions, or other revision within the general scope of a contract that causes an adjustment to the contract price or contract time," for instance, was how Ibbs (1994) defined project change. Project change, according to Revay (2003), is any event that alters the original scope, execution time, work cost, or quality." any action, incidence, or condition that makes differences to an original plan or what the original plan is reasonably based on," according to Lee (2007), is a project

change. Other studies (Ibbs and Allen, 1995) provide comparable definitions.2007 (Hanna and Swanson). It is important not to confuse project change with a project change order, which is defined as any formal contract modification intended to incorporate a change into the contract (Schwartzkopf, 1995, Lee, 2007; Anastasopoulos, 2010). Change orders can only be used to accommodate changes that management has officially acknowledged through a contract modification. As a result, it's important to remember that approved project changes include project change orders and that change and change orders are two distinct concepts.

A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions (Boon J., Yap, H. Abdul-Rahman, H. & Wang, C. 2016).

Also he noted that these changes are any additions, omissions or adjustments made to the original scope of work after a contract is awarded. It may cause an adjustment to the contract price or contract time, and it occurs regularly on construction projects.
Changes of design in construction can be caused by various sources at different stages of the work, moreover in this context the focus is during construction stage. The cause of design change may arise from external or internal factors that may occur during the construction phases of project. Project changes have obvious impacts on the construction process, not only on the project's schedule and cost but also on the project's performance, e.g., labor efficiency Several studies on causes of delays and cost overruns in construction projects have highlighted design changes as major contributing factor (Valentine, 2016).

Design changes occur when changes are made in the project design or requirements. Design changes are the regular additions, omissions and adjustments to both design and construction work in a construction project that occurs after the award of contract which affects the contract provisions and work conditions that make construction dynamic and unstable (Muhamad M., 2018).

Nearly all projects go through assorted changes from the design stage right through to construction. These various changes have considerable impacts during the lifecycle of a project, which may be minor or major according to the result of the change. However, the impacts are always being underestimated by construction practitioners. Design changes in construction projects will inevitably lead to cost overrun or schedule delay. Overruns in

project schedule and project cost are key principles for a successful project that adversely impacted by design changes (Hamzah, 2017).

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project, and may have considerable negative impacts on items such as costs and schedule delays. A critical change may cause consecutive delays in project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime. Changes, if not resolved through a formalized change management process, can become the major source of contract disputes, which is a severe risk contributing to project failure (Thomas, 2008).

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals. Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle. Managing changes effectively is crucial to the success of a construction project. Change management in construction requires an integrated solution to discipline and coordinate the process, for example, documentation, drawing, process, flow, information, cost, schedule and personnel. The construction industrial needs an effective construction change management process.

A design change is defined as any change in the design or construction of a project after the contract is awarded and signed. Such changes are related not only to matters in accordance with the provision of the contract but also changes to the work conditions (Hamzah, 2017).

The design process is a process that is performed in a series of iterative steps to conceive, describe and justify increasingly detailed solutions to meet the needs of the client. Even though these changes are inevitable to occur as explained by Chronicle in his research but the problem is the frequency and major changes involved that at the end affect the overall performance of building construction projects (Valentine, 2016).

2.3. Causes of Design Changes in a Construction Project

It is difficult for project managers to manage change because the reasons for it vary widely. According to Hanna and Swanson (2007), a variety of factors, including design flaws, design modifications, scope expansions, and unidentified field conditions, can lead to change. Design errors are a frequent cause of change, according to some researchers who examined public highway projects in various nations and regions. However, there are numerous other

causes. Take, for instance, Hsieh et al. (2004) asserted that conventional project procurement methods are more likely to result in change orders due to the fragmentation of design and construction processes. Their research on Taiwan's metropolitan public works revealed that planning and design issues account for the majority of change orders. Additionally, the study suggested a correlation between the reasons for change orders and the type of construction. Wu, 2005) examined highway construction projects as a means of determining the root cause of design modifications and discovered that inadequate geologic surveys frequently account for these modifications. They suggested enhancing site surveys during the feasibility analysis and planning design stages to prevent project-by-project design variations. Anastasopoulos, 2010) argued that so-called "root causes" like design flaws, unexpected site conditions, and weather conditions typically result in change orders. They are also linked to several "intermediate" factors like the size of the project, its type, the amount of the contract, its duration, and the level of bidding competition.

According to (Bassa et al., n.d. 2019) the most five common causes of change orders can be identified as: change of plans by owner, change of project scope by owner (additional-enhancement), problems on site, errors and omission in design (main element), poor design and poor working drawing details (secondary element). (Jeffrey, 2016) Highlight that the causes for delay in construction projects w external causes and internal causes. On the other he categorized the sources of design changes from clients, consultants and contractors whom are the primary parties in building construction projects. Internal factors include; Client related, Design related, Project related and Contractor related. In external-related causes Project outcome is most impacted by the regulation imposed by the government. Change of work rules/regulation by the government agencies, neighborhood communities and coordinating with utility systems.

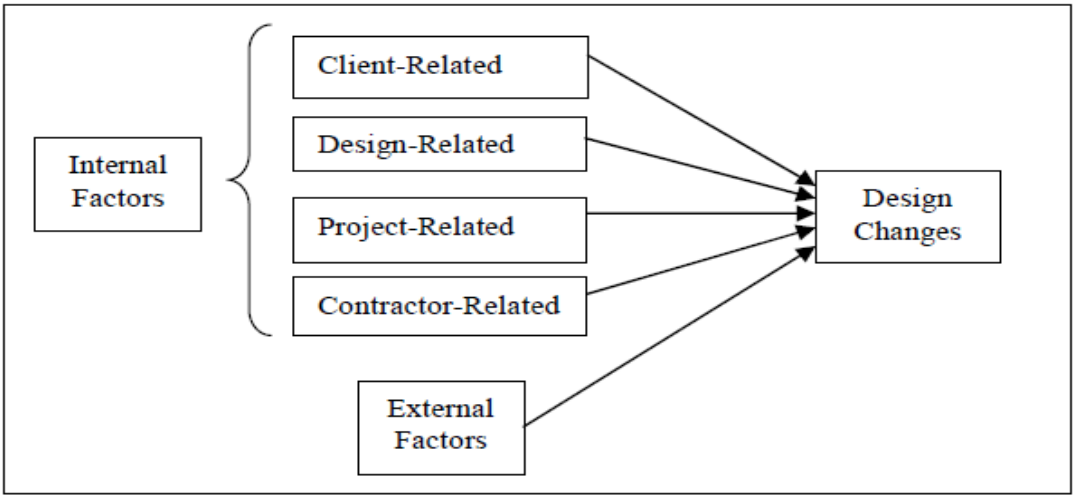


FIGURE 2. 1 Conceptual framework of causing factors influencing design changes

(Source: Adapted from (Jeffrey, 2016)

All the participants of a project, such as owners, designers, and contractors, can be the cause of the changes by requesting any modifications after signing the contracts.

(Muhamad.M., 2018) classified the design changes into seven categories; design change/improvement, design change/construction, design change/ field, design change/owner, design change/process, design change/ fabrication, and design change/ unknown. Similarly, (Peansupap & Cheang, 2015) in their research, assert that classification of changes focuses on the change in construction project that occurs from several originators such as owner/client, designer, and other parties. They found the most of the important change issues leading to conflicts about project cost originate mainly from the owner's side.

(Yana, 2015) investigated several successful projects' requested changes, analyzing historical data as case studies and discovered the reasons of change as follow:

1. Designer's omission in tender documents;
2. Coordination defects in tender documents;
3. Forced upon project from shop drawing coordination;
4. Employer has changed his requirements; or
5. New information on existing site conditions.

According to (Thomas, 2008) the major ranked causes of design change as change of plan by owner, Substitution of materials, change in design by consultant; Errors and omissions in design, the scope of work for a contractor is not well defined, Conflict between contract documents, differing site conditions, change of plan by client; The lack of coordination

between contractor and consultant; The contractor's financial difficulties, owner's financial problems, Workmanship or material is not meeting the specification, Contractor's desire to improve his financial situation; The required labor skills are not available, The required equipment and tools are not available, New government regulations, and Weather conditions.

According to (Thomas, 2008) changes happen due to several predictable and unpredictable causes. They identified four origin agents for the changes in the construction project, including:

1. Owner-related
2. Consultant-related
3. Contractor-related
4. External factors related

Owner-related changes

Owner -related changes are the changes due to Additions of new works/ scopes (not part of original scope), Omission of works/ scopes (reduction on original scopes), Modifications to the original design (changes within the original scope), Unclear initial design brief (e.g., the extent of the scopes, requirements, details etc.), Desire to use alternative material/new technology (may require different details and coordination with suppliers), Desire to use better specification (e.g., to extend the life of the structure or for better performance etc., may require different design detail) and Insufficient background of proposed site (e.g., possibility of underground facilities, previous structures, previous site condition etc. (Mohamad, 2012).

Consultant-related changes

Consultant-related changes are the changes created by the consultants to correct improper design, to correct inconsistent information in drawings, to correct discrepancy between contracts, to correct lack of insufficient geotechnical investigation or wrong interpretation of the findings and to correct insufficient detail of existing site condition (Lokhande, 2015).

Contractor-related changes

Contractor-related changes are the changes created by the contractors to use available material, to use alternative construction methods to save time, to use alternative construction methods to save money, to rectify construction mistakes, to improve the quality of works at site, to improve his financial situation, if the required labor skills are not available, if the required equipment and tools are not available, to apply the new government regulations, and Weather conditions (Mohamad, 2012).

External Factors

According to (Thomas, 2008) External Factors includes; Environmental factors, Third parties and Political and economic factors. Generally, causes of design change as described by different authors summarized as client related (change requirement, new technology, value Engineering, unclear brief), contractor related (request to use available material, alternative construction methodology), site related (location, underground condition) and design related (design error, inconsistent site condition, design omission, unpredictable circumstance during construction, modification to design).

2.4. Type of Design changes in a Construction Project

Change maybe classification in many various habits. Ibbs (1994) demanded that changes contain necessary change and possible change; advantageous change and damaging change. Ibbs, (2007) projected that skilled are mainly five types of change, change in project opportunity, varying location environments, delays, suspensions, and stimulation. Hanna and Swanson (2007) classification adapt helpful change and important change. A helpful change on a project is work acted outside the sphere of the contract still whole is acted "under the contract". A key change restricts as a breach of trust and is occasionally the result of a important departure or many tinier changes from the original contract.

Knowing the type of the change is important in determining which change should receive an action first, and is a way of prioritizing changes in construction projects. According to the engineering, procurement and construction (EPC) contractor, there are two types of changes in detailed design: a "design development" initiated by the engineering team, and a "design change" initiated by the client (Thomas, 2008). (Hunt, 2005) categorized change into three different types:

1. Actual change: any change to the scope of work directed by the owner of the project;
2. Constructive change: any action and/or inaction directed by the owner that modifies the design scope, but the owner does not recognize it as a change; and
3. Cardinal change: it will be recognized in the federal sector of the contract.

(Mirshekarlou, 2012), on the other hand, classified changes into whole other four types:

Beneficial or Detrimental Changes: "beneficial" changes are those that improve the quality of the job, decrease the cost and time, and sometimes the level of complexity in the project design. In contrast, "detrimental" changes are those that decrease owner benefits. However,

sometimes one change can be “beneficial” for the owner but be a “detrimental” change for the contractors, or vice versa. In general, the “beneficial” changes must be supported, and the “detrimental” changes must be avoided. The timing of the change is the only way to help the project team to distinguish the “beneficial” change from “detrimental” change. If a change occurs in the early stage of the project, it might be considered “beneficial.” The same change, when it occurs closer to the end of the project, might be “detrimental,” since it can face the project with an additional cost, time, or both (Behsah, 2015).

Required or Elective changes: “required” change is obligatory due to the nature of the problem and should be evaluated and processed. For instance, matching the design variations with building codes needs an instant action. On the other hand, “elective” changes are not compulsory. When the project team has many alternatives for change management, the change is considered “elective.” These alternatives differ regarding their impacts on the contract cost and time. In order to select the best “elective” change, a benefit-to-cost (B/C) ratio scale is applied.

Compensable, Excusable or Non-excusable changes: the project’s owner in response to its needs or required modifications in the project suggest “Compensable” changes. For example, design changes by the owner caused by market demand. The consultant proposes “Excusable” changes in reply to technical problems or possible document errors. For instance, the implementation of the structure for controlling the landslides is “excusable” change, which has to be paid to the contractor, and there is no payment for a consultant. The “Non excusable” changes are entirely the responsibility of the contractor and there would not be any payment for them. An example of this change would be construction errors that lead to redoing work or demolition.

Controllable or Uncontrollable changes: “Controllable” changes are those where the source of their cause is under the control of the contractor, such as labor productivity or material procurement. The contractor is the only person responsible for “controllable” changes and cannot ask for extra funds. “Uncontrollable” changes are those where the contractor has no effective control of them, such as weather conditions, inflation, and unforeseen ground conditions. This study uses owner-requested actual and elective design changes in order to aid owners to choose the most beneficial design changes to the project, which have the lowest impact on project parameters such as cost, time and productivity.

2.5. Impact of Design Change in a Construction Project

The impact of project changes includes direct impact and cumulative impact The immediate impact of changes can often be predicted and quantified However, the cumulative impact of change is difficult to manage Understanding the impact of changes on construction projects can help develop better change management systems that minimize the negative impact of project changes. Due to the unique nature of each project and the limited resources of time and money available for planning, changes are almost inevitable during the course of the work (Moselhi et al., 1991). Contractors are obligated to comply, but owners typically retain the nearly unilateral right to change work at any stage of completion (Cooper et al., 2004). Numerous studies have shown that change can have negative effects and frequently results in project disruption (Thomas and Raynar, 1997; Jones, 2001). On construction projects, disruption caused by change is a major cause of the damage (Hanna et al., 2002). According to Thomas and Raynar, (1997) definition, disruption is any occurrence that is known to hurt labor productivity. The following definition was provided by AACE (2004): “an action or event which hinders a party from proceeding with the work or some portion of the work as planned or as scheduled,” disruptions are defined as "an action or event. “Most of the time, disruptions are brought on by project change. The absence of materials and information and the necessity to complete the work outside of sequence is the most significant disruptions. And among them, it is thought that the most significant disruption brought on by changes is caused by a lack of materials. The frequency of disruptions increased as more workdays were added, and the inability to rapidly provide materials, tools, equipment and information resulted in efficiency losses.1995, Thomas and Napolitan, 1997, Thomas and Raynar).The construction industry performance measured by three major parameters cost, time and quality. However, the design change affects the whole process of projects. According to (Shamsudeen & Biodun, 2016) the design change affects the whole process of projects and the effects listed below are mostly occurred in Ethiopia Construction industry. increasing of cost of the project (cost overrun), time overrun (delay of the projects), quality problem, increases overhead expenses, wastage of materials due to rework and conflicts between the parties, Productivity degradation due to equipment and material, claim and disputes occur between client and contractor and the most common effects for those projects that change of design took place during construction stage were delay of the projects, Project changes have obvious impacts on the construction process, not only on the project’s schedule and cost but also on the project’s performance, e.g., labor efficiency Several studies on causes of delays

and cost overruns in construction projects have highlighted design changes as major contributing factor (Valentine, 2016)

A change can have impacts on any part of the project and leads to scheduling conflicts, cost overruns, or both at the same time. It can also affect the quality of work, labor productivity, cause legal disputes, and in general affect the overall project performance (Moayeri, 2017).

According (Moayeri, 2017) Changes can have positive or negative impacts on a project, depending on the level of the change, but mostly it has negative effects. The main idea, however, is that these impacts should be known before approving and applying any changes to the project. In current practices, the impact of a change is usually classified as a "direct" or "indirect" impact. According to (Bassa, 2019) the construction industry performance measured by three major parameters cost, time and quality. However, the design change affects the whole process of project and the effects listed below are mostly occurred in Ethiopia Construction industry. According to (Behsah, 2015) Cost overrun, time overrun, quality problem, increases overhead expenses, wastage of materials due to rework, Productivity degradation due to equipment and material, claim and disputes occur between client and contractor. The most common effects for those projects that change of design took place during construction stage were delay of the projects, increasing of cost of the project (cost overrun), abandoning of the project, wastage of materials and conflicts between the parties.

2.5.1. Delay of the projects

It was found that when there is change of the design during construction, project completion period increases. This is because, designing of the new changes of design in structural, services and architectural would require the enough time, approval of the new drawings will use time as well as appraisal of the new materials will need time. Hence at the end the project duration will be increased (Bassa, 2019) .

2.5.2. Change in cost of the projects

According to (Iliyas, 2016,) when design changes occur during construction stage, there is a tendency of the cost of the project to change. The injection of more money will be required if the design changes are complex or increase the project scope. As such, some of the changes require new items that can be more expensive that first proposed ones; also there are some of the extra costs that would be resulted due to extension of the time (Asmerom, 2021).

2.5.3. Wastage of material

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 (Iliyas, 2016,).

2.5.4. Conflict between the parties

Conflicts between the Parties Also changes of the design during construction may result into the conflicts between members of the project. This may happen especially when the design is at fault and the constructor has proposed changes to facilitate constructability. In such a case by any circumstance if such changes increase the cost of construction, the client might wrangle with the consultant for such an incompetent initial design that makes the client incur extra cost and disturb the budget (Iliyas, 2016,). Causes and impacts of design change were summarized by the following digram.

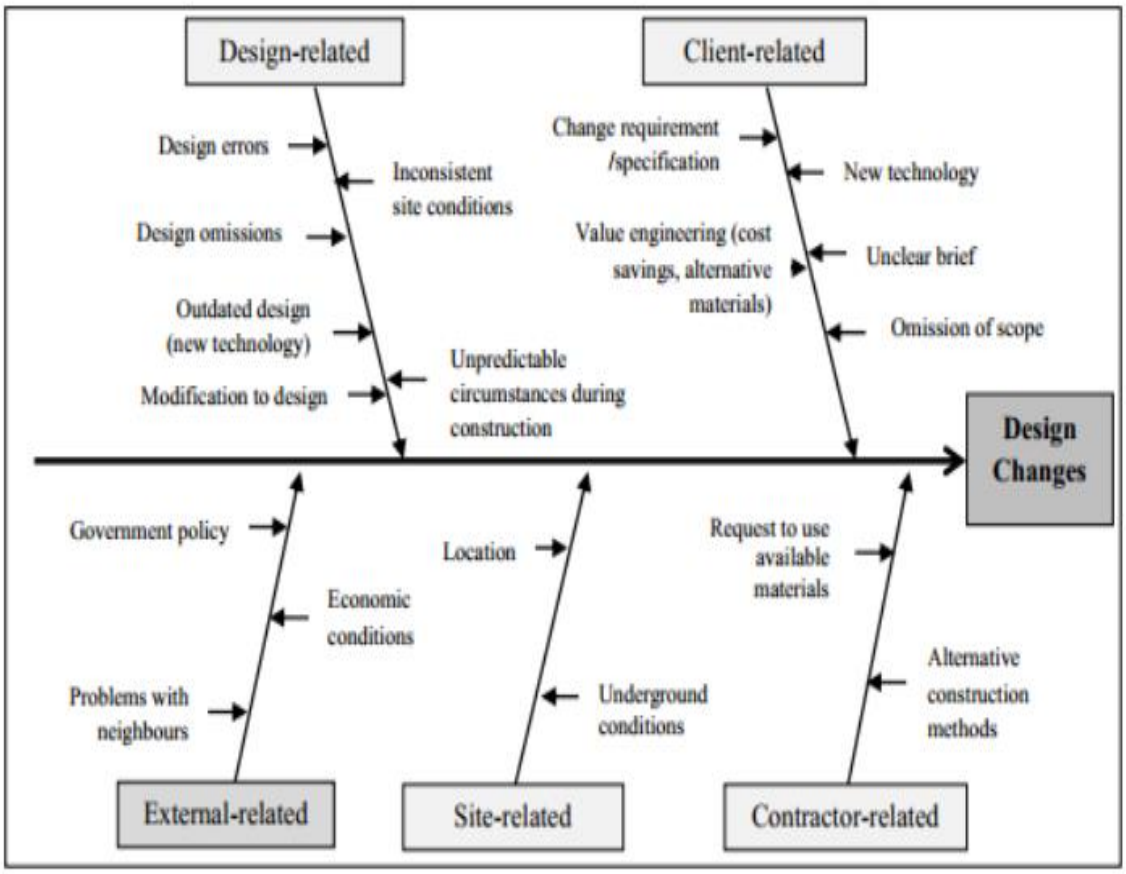


FIGURE 2.2 Generic Cause of design changes

(Source: Asmerom et al., 2021)

2.6. Design Change Management Process

The application of knowledge, skills, tools, and methods to project activities to fulfill project requirements is project management. A crucial and delicate aspect of project management is change management. From project approval to project launch, a change management system attempts to manage and control change. A model for proactive change management is the goal of this study. Therefore, it is essential to examine the current project change management system and determine the knowledge gap. The review of all change requests was defined as the process of change management. Accepting or rejecting modifications; managing modifications to the project management plan, deliverables, organizational process assets, and project documents; and expressing their state of mind. This system reduces project risk, which frequently arises from changes made without taking into account the overall objectives or plans of the project, by allowing documented changes to be considered in an integrated manner.

According to a 1998 study by Voropajev, change management is a process that encompasses all internal and external factors that influence project changes.to anticipate potential changes; to identify changes that have already taken place; to plan effects that prevent problems; to coordinate of all project-wide changes. Due to the unpredictability of many changes, the study also emphasized the need for environmental change forecasting methods and techniques to develop preventive response strategies and tactics. In general, the construction industry did not place sufficient emphasis on project change management, according to a CII research project (Ibbs, 1994). By improving project change management, construction projects can save a lot of money on their total installed costs. Promoting a balanced change culture, recognizing change (when it occurs), evaluating change, implementing change, and continuously improving from lessons learned are the five principles of effective change management that were identified by the study. A prototype change management system in the form of flowcharts with suggested change management procedures for each phase was developed by these guiding principles.

Ibbs et al, (2001) revisited the change management system. They said that anticipating, recognizing, evaluating, resolving, documenting, and learning from conflicts in ways that support the project's overall viability is the central idea of any change management system. Project participants have the ability to promote positive change while minimizing negative change through the use of the project change management system. "Recognize Change" is the

system's second component. Ibbs et al., (2001): emphasized the significance of change prediction as follows: Members of the team are urged to initiate discussion and identify potential modifications in accordance with this principle. The team can better manage change earlier in the project life cycle by identifying changes before they occur. Wu et al, (2005) demonstrated that change identification is the first step in change management. It includes identifying project conditions that could lead to a change event and clarifying who is responsible for the change. A system dynamics model-based change planning and control tool that focuses on effective change management was introduced by Park and Pena-Mora, (2003) for construction projects. The dynamic project model's structure and equations, as well as the feedback procedures triggered by construction change and rework, are all incorporated into the tools various characteristics and behavior patterns of construction change. When it comes to the creation of a project change management system, it is suggested that the model-based approach is efficient. Motawa, 2007) emphasized the importance of taking into account a wide range of project processes and all internal and external factors that influence project changes when developing change management systems. A system dynamics model of the Dynamic Planning and Control Methodology (DPM) and a fuzzy logic-based change prediction model were presented as part of an integrated change management system. By analyzing the available information in the early stages of the project, the fuzzy logic-based change prediction model is used to predict the likelihood of change occurring. Wu et al, 2005) used statistical analysis in multiple case studies to figure out what caused a design change and how it affected a highway project in Taiwan. They discovered that site surveys should be improved during the feasibility analysis and planning design stages to prevent design changes caused by a lack of geologic surveys. This highlights the significance of planning and design throughout the construction engineering life cycle. Additionally, it is discovered that the emphasis placed on geological concerns when investigating and managing them varies according to engineering properties. It's usually hard to stop the owner from making changes. However, planning and design personnel's increased experience with tunnel projects may reduce design changes to some extent. However, it is generally difficult to control design changes brought on by force majeure, such as the weather, hazards, or complaints from civilians.

Anastasopoulos et al, (2010) In order to better understand the factors that are associated with change-order frequency, assess the influence of project type, contract type, project duration, and project cost on the frequency of change orders, and forecast the expected frequency of

change orders for future projects, treated the occurrence of change orders as a count variable and analyzed the frequency of change orders using a variety of count-modeling methods including the negative binomial, Poisson, zero-inflated negative binomial, and zero-inflated Poisson. Change orders tend to increase in frequency with project size, as the project size (contract award amount and contract duration) were found to be significant factors in their study. The relationship between the length of the contract and the number of change orders is linear, whereas the relationship between the amount of the contract and the number of change orders is nonlinear: Change order frequency rises sharply when contract amounts are increased incrementally for small amounts; however, for a substantial contract, small changes in change order frequency result from incremental contract amount increases.

Change management is a pure application-oriented issue and requires engineering innovation to solve the problem (Yana, 2015). Changes in construction cause a serious ethical problems and disputes. So, change management is a pure application-oriented issue and requires engineering innovation to solve those problems (Thomas, 2008). Change management seeks to forecast possible changes; identify changes that have already occurred; plan preventive measures; and coordinate changes across the entire project. Small reworks with minor impacts do not need to go through a formal change process. However, changes with noticeable impacts, either reworks or change orders, all require following a formal process in change management (Thomas, 2008).

Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle so managing changes effectively is crucial to the success of a construction project (Thomas, 2008). According to (Pikas, 2020) Design management has been introduced to address challenges in construction projects.

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals. Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle. Managing changes effectively is crucial to the success of a construction project Thomas, 2008). Change management in construction requires an integrated solution to discipline and coordinate the process, for example, documentation, drawing, process, flow, information, cost, schedule and personnel (Thomas, 2008). The construction industrial needs an effective construction change management process. This paper summarizes various

aspects of the existing construction change management processes and provides a comprehensive literature review as well as some comments on possible future directions.

2.7. Summary of the literatures

Table 2.1 Condensed Summary of the literature Review

No	Issue discussed	Authors
1	Change of Design in Construction	(Asmerom, 2021), (Bassa, Reta, Alyew & Tora), (Suleiman & Luvara, 2019)
2	Definition of Design Change in the Construction Industry	(Boon J., Yap, H. Abdul-Rahman, H. & Wang, C. 2016), (Valentine, 2016), (Muhamad, 2018), (Hamzah, 2017), (Thomas, 2008)
3	Causes of Design Changes in a Construction Project	(Matusala, 2020), (Jeffrey, 2016), (Muhamad & Mohammad, 2018), Peansupap and Cheang, 2015), (Aslam, 2019), (Boon J., Yap, H. Abdul-Rahman, H. & Wang, C. 2016), (Yana, 2015)
4	Impact of Design Change in a Construction Project	(Boon J., Yap, H. Abdul-Rahman, H. & Wang, C. 2016), (Valentine, 2016), (Aslam, 2019), (Bassa, 2019), (Iliyas, 2016,)
5	Design Change Management Process	(Neelamkavil, 2008), (Thomas, 2008), (Pikas, 2020)

2.8. Research Gap

The researcher discovered, after looking through a number of journals and studies on the management of design change's causes and effects that very few studies on the topic have been done anywhere in the world or in Africa. However, research on the topic of design change management is lacking in the Ethiopian context. Feregenet (2019), who demonstrated that no studies on this topic have been carried out in Ethiopia, lends credence to this idea. This is the primary research gap that prompted this study. The other research gap in the study by Matusala (2020) concerned the causes and effects of building design changes in a specific region of the south and Ethiopian nationalities. Because his research was limited to a single subject, it is challenging to apply the concept to the context of Ethiopia. As a result, the researcher was of the opinion that it would be best to conduct the research in a different area. The methodology used in Feregenet's research was the third research gap. The research topic demonstrates a relationship between the variables, but the descriptive methodology used does not demonstrate the relationship. Therefore, the researcher decided to use correlation and regression to demonstrate the relationship between the dependent and independent variables in order to investigate the impact of a design change on project performance. The Arsi Zone context has not been used in this study. Consequently, this study will move one step closer to managing design change's causes and effects to improve project performance.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Introduction

Research is described as the process of gathering, analyzing, and interpreting information to address questions. For the purposes of this thesis, research is defined as practical investigation or exploration to discover new facts or to collect old facts by scientific methods in order to develop an existing theory or apply it to solve real-world problems (Behsah, 2015).

This chapter describes the research methodology and identifies the tools and techniques used in the systematic data collection process. The methodology describes the practical way of organizing the entire research project. An action plan should be developed that shows how the problems will be investigated, what information will be collected by which methods, and how this information will be analyzed to arrive at conclusions and develop recommendations.

Research projects synthesize and analyze existing theory, ideas, and findings from other studies in search of an answer to a specific question or to gain new understanding. This research can be categorized as applied research because the research was started with practical problems to evaluate the causes and effects of design change and their management system of public construction projects in Arsi area.

Most researchers have found in their research that questionnaire surveys are best used to gather the opinions of a large sample of people in a particular industry. The only downside is that opinions may be biased based on their position in the industry. To counter this perceived bias, this study uses recorded data from various public building construction projects as the primary data source.

Once the problem statement has been formulated, it should be clear what data will be needed to study the problem, as well as what type of analysis will be most appropriate for analyzing the data. The problem addressed in this study is the causes of design change, the impact of design change on project performance, an assessment of current design change management practices in public building projects in the Arsi area, and mitigation measures.

3.2. Description of Study Area

This study was includes the 26 woredas location of Arsi zone. The central location of this study area, Asella town was found on a distance of 75 km from Adama town. Since there are many different public construction projects in the selected zone, the researcher was limited to Arsi zone. The image below shows a map of the Arsi area.

FIGURE 3.1 Map of the study area

(Source https://www.bing.com/images/search)

3.3. Research Approach and Design

3.3.1. Research Approach

The purpose of this qualitative type of research is to establish design changes management problem mitigation approaches by developing management system flowchart for the construction of public building projects. To increase the validity of the research findings, a pre-survey was conducted before the questionnaire was distributed to experienced professionals in building construction industry and a case study questions were presented to experienced professionals working in construction industry and corrected according to their technical advises. In general this approach consists of a combination of qualitative and quantitative methods, supported by a literature review.

3.3.2. Research Design

The design of this study was both explanatory and descriptive. The general objective of the study was to investigate managements of causes and impacts of design changes on in construction of public building projects in Arsi Zone and then to develop the management system flowchart. The previous studies related to this study were collected to achieve the research objectives. The researcher reviewed the literature on the drivers of causes of design change, impacts of the design changes on project performance and the management processes in the construction industry. The methods of data collection used to obtain the data required for the study: which are literature review, questionnaires, case studies and Group discussion. The whole process of the study was summarized by the following skeleton diagram.

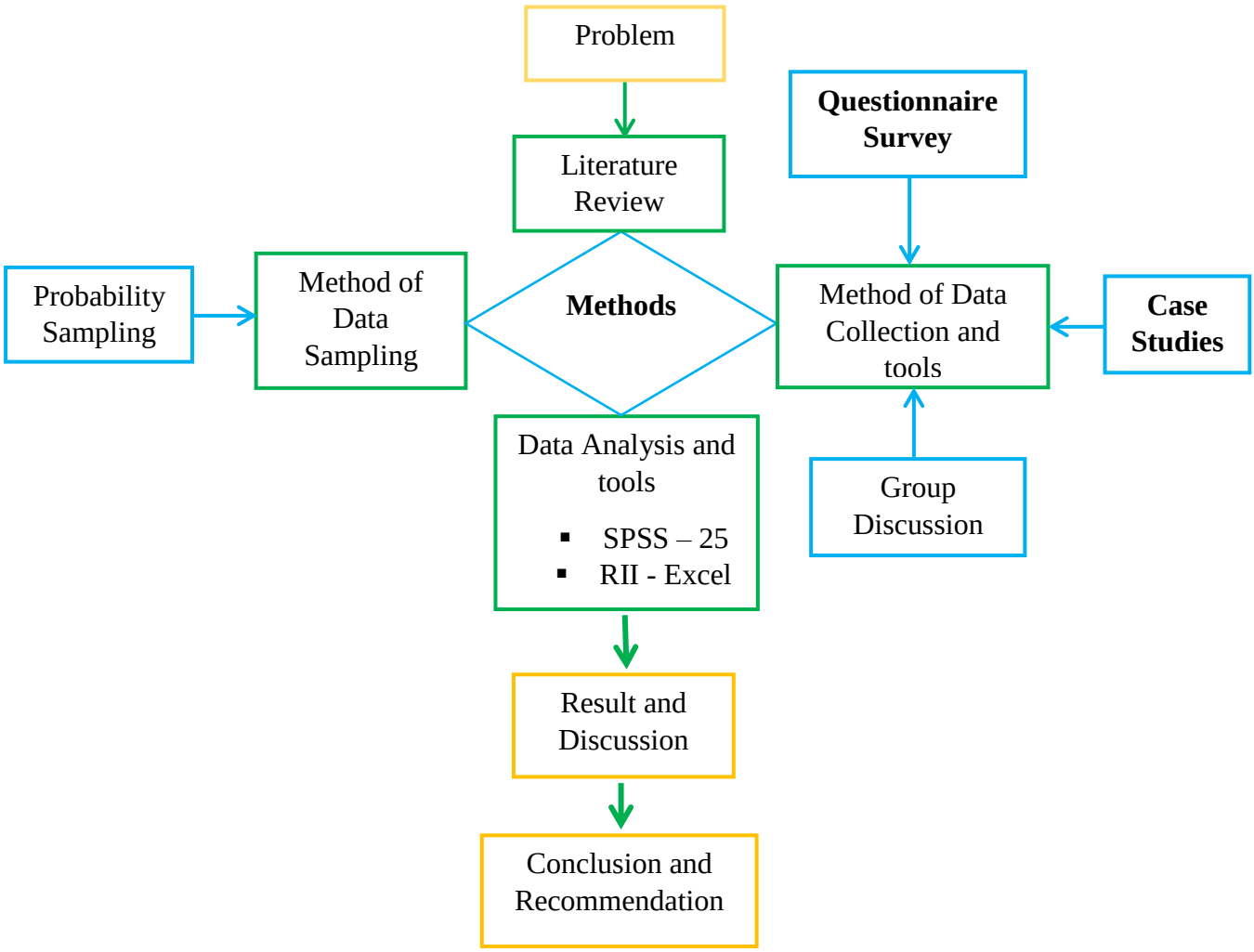


FIGURE 3.2 Skeleton process of the research study

(Source: Researcher Own Work)

3.4. Population, Sample Size, and Sampling Technique

3.4.1. Population

The complete set of cases from which the sample is taken is called the population. Research samples are taken from public building Projects found in 26 woredas of Arsi Zone in which the technical stakeholders of those projects were respondent of the questionnaire. The project stakeholders from which the technical respondents selected from clients, contractors, regulators, and consultants. There are a significant number of public building projects in Arsi Zone; a few of public buildings were randomly selected for the study. This will avoid bias and erroneous conclusions due to uneven population size in the analysis of responses. Clients, regulators, contractors, and consulting companies working for the selected projects were important sources of data for this study. As the main objective of this study is to examine the management of causes and impacts of design change in construction of public building projects in Arsi Zone, representatives of public building under construction were selected for this study.

3.4.2. Sample Size

The samples for this study were the selected public building projects of Arsi Zone found in 26 woredas of the area. Based on the received data from Arsi Zone Construction Authority, the total population of public building projects under construction in Arsi Zone for the year of 2022 was 182 projects. From this it was decided to use a sample of a portion of the population from the total population, this was worked out by calculating the sample size using the Yamane (1967) method. This method applies to known or finite population sizes.

$$n = \frac{N}{1+N(e)2}$$ ----------eq. 3.1

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%)

$$n = \frac{N}{1+N(e)2} \qquad n = \frac{182}{1+182(0.05)2} \quad , \qquad n = \frac{182}{1+182*0.0025}$$

n = **125**

Sample Size Correction

For finite population size if the sample size is ≥ 10% of population size then the sample size need to be corrected. 10% of population size = 182*(10/100) = 18.2.

This implies that 125 ≥ 18.2, Hence, 182 is the finite population, by using the population correction formula as follows:

$nc = \frac{nN}{(N+n-1)}$, ---------- eq. 3.2

Where, 'N' is population size and 'n' is sample size,

Population size (N) =182

Sample size (n) = 125

$$nc = \frac{125 * 182}{(182 + 125 - 1)}$$

$$nc = \frac{22{,}750}{306}$$

$$nc = \mathbf{74}$$

Calculated Sample Size (n) = 125

Corrected Sample Size (n_c) = 74

Reduced Sample Size = 125-74 **= <u>51</u>**

Therefore, the target respondents of the questionnaire were construction professionals who were working in the 51 randomly selected. The inclusion criterion was that the respondents should be professionals in the selected public building construction. This includes project managers, consulting engineers, construction engineers, office engineers, designers, experts, and professionals of regulatory bodies in the Arsi Zone and Asella Town who were directly involved in the construction of public building projects.

3.4.3. Sampling

Sampling is important when it is difficult to survey the entire population when there is a budget deficit and time constraints that prevent the researcher from surveying the entire population. In this study, taking the entire population is difficult due to the above reasons. Therefore, the probability sampling method was used. Probability sampling is often

associated with survey and explanatory research strategies. When conducting a survey, the researcher must select a random sample of people. This allows for more accurate results for a larger number of respondents. This shows that random sampling is compatible with the design of this study. Among the methods of probability sampling, simple random sampling was used because simple random sampling would give each member of the study population an equal chance of being selected.

3.5. Data Sources and Data Collection Tools

3.5.1. Source of Data

This study used both primary and secondary data. Primary data were collected first-hand by the researcher using structured questionnaires distributed for client-side professionals, contractor-side professionals, consultant-side professionals, and regulatory body professionals working on selected 51 construction sites. The secondary data has been obtained from sources that already exist in various sources.

3.5.2. Data Collection Tools

Data collection is the process of gathering and measuring information about variables of interest in a prescribed systematic manner that answers research questions, verifies hypotheses and evaluation of results. The data collection instrument used in the study is questionnaires and case study.

A. Questionnaires

Questionnaires are written forms consisting of a set of questions that will be used to collect the data needed from a sample population. Each item in the questionnaire was designed with the objectives of the study in mind.

The questionnaire was divided into four main parts. Part I is about the factors that cause design change. Part II is about the impact of a design change on project performance. Part III is about design change management practices. Part IV is about parameters used to develop best management system flowchart for design change management process. Respondents were asked to indicate their opinion of the most influential causal factors using a 5-point Likert scale. The ratings used are very low = 1, low = 2, medium = 3, high = 4, and very high = 5.

B. Case Study

In this research study, the researcher selected four public building projects that involved design changes during the construction process. The construction of public buildings, which started recently in the Arsi area, was chosen. These selected projects are Amigna woreda administration office building G+3, Arsi zone administration office building G+4, Sude woreda administration office building G+1 and Shanan Kolu woreda administration office building of G+1. The purpose of the selected case study was to provide in-depth knowledge and a better understanding of the factors and dimensions of the research problem. The methods of data collection in the case study that I used are observation, interview, and review of documents or records.

C. Focused Group Discussion

A focus group discussion involves discussing a particular topic of interest with people from similar backgrounds or experiences. It is a type of qualitative research in which people are questioned about their perceptions, attitudes, convictions, opinions, or ideas. Participants in focus groups are free to interact with other group members; In contrast to other research methods, it encourages participants to talk to each other. It usually involves interviewing a small group of eight to twelve people. A moderator (interviewer) leads a loosely organized discussion of various interesting topics. For this study the Arsi Zone Urban Development and Housing Office and Asella Construction Authority, focus groups were held. In each instance, a group of ten professionals engaged in group discussion. Because technical professionals were chosen for the group discussion, it was simple to lead the discussion.

Because the indicated technical professional experts and others involved in the construction industry contributed their skills, knowledge, and exposure through discussion, the researcher decided to use focused group discussions (FGD) as a data collection tool.

3.6. Complete study of literature

A thorough study of the literature is part of the research process itself, not part of research preparation. Such a literature review demonstrates that the researcher is well versed in the research area, shows how previous research supports current research and generates new research ideas by discovering what others have left behind. The literature reviewed consisted mainly of textbooks, journals, conference proceedings, theses, and dissertations. A comprehensive literature review is the most reliable source of information and is the most cited in scientific reports.

3.7. Data Analysis Technique

To answer the research questions and objectives, descriptive statistics such as frequencies and percentages were used to represent the demographic and educational characteristics of the respondents and rank the most important causes of design change and the effect of a design change on project performance and compare the degree of RII management practice was used. Multiple regression analysis was then also conducted to determine the percentage of the independent variable, i.e. the design change factors, to explain the dependent variable which is project performance. In this context, data were collected, summarized, and analyzed using the Statistical Package for Social Scientists (SPSS) version 25.

After identifying from the literature review, a questionnaire was prepared on 38 factors causing weak design change management, 7 impacts of weak design change management on project performance, and 11 current design change management practices. Responses to 38 factors causing weak design change management were analyzed using SPSS, and 7 impacts of weak design change management on project performance and 11 current design change management practices were ranked according to the Relative Importance Index (RII) method.

$$RII = \frac{\sum PiUi}{N(n)}$$ ----------eq.3.3

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

RII = Relative Importance Index

Pi = respondent's rating

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)

3.8. Reliability

The reliability of the data collected was assessed using the Statistical Package for the Social Sciences (SPSS). A reliability test is performed to check whether each scale item is free of measurement error. If a questionnaire is examined at different times and among different population groups and gives the same results, the questionnaire is considered "reliable". This means relatively strong reliability value. Commonly used methods when using SPSS to assess reliability are Cohen's Kappa coefficient for categorical data and Cronbach's alpha for

continuous data (Likert-type scales). Since data collection was based on a Likert scale, Cronbach's alpha was used to test reliability.

$$\alpha = \frac{K}{K-1}(1 - \frac{\sum S^2 y}{S^2 x}) \quad \text{----------eq.3.4}$$

Where:

K is the number of test item

S^2y is the sum of item variance

S^2x is the variance of total score

3.9. Validity

To increase the validity of this study is a pre-survey was conducted before the questionnaire was distributed to experienced professionals in buildings construction industry and Case Study questions were presented and group discussion was held. Experienced professionals guide which term should be added and which should be deleted. In addition, several data collection and analysis methods were used to collect and process data, and the data obtained from the various sources almost supported each other. To check the validity of the content, first draft questionnaires were distributed to 10 experienced professionals in buildings construction industry. The questionnaires were then modified based on the comments received and distributed to the target population.

3.10. Ethical consideration

Ethical considerations were taken into account throughout the process of conducting this research. The researcher informed all potential participants about the nature and purpose of the study, and their participation was optional. It has been clarified that their answers to the questions offered are for academic research purposes only and will never be disclosed to anyone at all times. When reviewing secondary data from journals, articles, proceedings, and related sources, each source used was noted for both in-text citation and reference.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Introduction

This part of the study deals with the analysis and discussion of the data collected from the questionnaire and the case study. It includes identifying the root causes of design changes, the impact of design changes, current practices for managing design changes in the Arsi area, and mitigating design changes.

The procedure used in the analysis of the results aimed to establish the relative importance of the various factors responsible for the impact of a design change on public building designs. The questionnaire allows each respondent to give their answer to all objectives. As a result, the respondents had to give their responses to the questionnaire according to the questionnaire prepared for each objective. For each variable, the percentages of respondents' responses were ranked for analysis. Based on the ranking of the variables by different groups, it was possible to identify the most important factors that influenced the design change in public building construction projects in the Arsi zone.

The case study selected part of the construction of four public building projects in the Arsi zone. This is the G+3 building of the Aminya Woreda Administration Office; the G+4 building of the Arsi zone administration office, G+1 building of the Sude woreda administration office and G+1 building of the Shanan Kolu woreda administration office were surveyed according to the research objectives. During the case study, documents such as status reports for each project were examined both on-site and from collected documentary files. This helps to understand the reasons for each project's delay due to design changes.

In this chapter, the questionnaire collected from the respondent was analyzed by using SPSS software of version 25 to find the principal component factors causing design change in public building projects in Arsi Zone and MS excel sheet and presented by frequencies, percentages, means, and other descriptive analysis. Under this chapter the researcher used the graphs and charts to display the findings to support analysis and presented descriptively and quantitatively under this chapter.

4.2. Reliability Test

Before the results obtained from the questionnaires received were being analyzed the researcher insured the uniformity of replies by dividing the questionnaires in this research and checked for internal consistency by the Cronbach's Alphas Coefficient. This reliability test was conducted for the four different sections as indicated on the research objectives. The results were represented on the table below.

Table 4.1 Cronbach's Alphas coefficients for reliability

Reliability Statistics			
Design Changes Parameters	Cronbach's Alpha Value	Number of Items	Internal Consistency
Factors Causing Design Changes	0.923	38	Excellent
Impacts of design changes	0.83	7	Good
Current management Practice	0.81	11	Good
Mitigation Factors	0.80	10	Good

Source: SPSS output

The results from the Cronbach Alpha analysis indicate that all the items internal consistency were good because alpha values of the items were from 0.8 up to 0.923. According to Many researchers the value of alpha greater than 0.7 implies the instrument is acceptable. So that, the survey instrument used in this study was reliable and acceptable.

4.3. Questionnaire Response Rate

Detailed questionnaires were developed and distributed to examine the causes and effects of design changes in public building construction projects in the Arsi area and to assess current design change management practices. For this purpose, a total of 64 questionnaires were distributed equally among the specialists of the customer's managers, consulting engineers and specialists of the regulatory bodies. As a result, 58 questionnaires were returned with completed answers to each question. The total number of respondents is given in the table below. The table shows the number of questionnaires distributed to specialists from the client side, specialists from the consultant side, specialists from the contractor side and specialists working as a regulatory body in the selected area.

Table 4.2 Summary of Respondents' Response Rate

No	Professional Respondents	Distributed Questionnaire		Returned Questionnaire		Response Rate in (%)
		No	% (out of 64)	No	% (out of 58)	
1	Client side	16	25	14	24	87.5
2	Consultant side	16	25	15	26	93.75
3	Contractor side	16	25	14	24	87.5
4	Regulatory body	16	25	15	26	93.75
Total or Average		64	100	58	100	**90.63**

Source: own survey (2022)

Respondents were divided into four groups: client specialists, consultant specialists, contractor specialists, and regulatory specialists. The above table shows that 16 questionnaires were distributed for each organization, which means a total of 64 questionnaires. Of the 64 questionnaires, the totally valid responses were 14 for client-side professionals, 15 for consultant-side professionals, 14 for contractor-side professionals, and 15 for regulatory-side professionals. They were used in the analysis, which amounted to 58 respondents, representing a response rate of 90.6%. According to (Asmerom, n.d.), more than 80 percent of all questions that are answered other than refusals are considered as complete answers. Therefore, this response rate was considered good response rate.

4.4. Respondents Characteristics

The purpose of this section was to find out the demographic background of the respondents. This study used demographic information: education, respondent's occupation, respondent organization, educational level, and work experience. All respondents returned the questionnaires with no missing values.

4.4.1. Educational Background of Respondent

Out of all the 58 questionnaires collected, the respondents' education background shows that 25 (43.1%) were in civil engineering, 3 (5.2%) in architectural engineering, 6 (10.3) in surveying engineering, 4 (6.9%) in electrical engineering, 10 (17.2) construction technology and management, 5 (8.6%) hydraulic engineering and 5 (8.6%) urban planning. This means

that all the questionnaires distributed to the necessary professionals were answered according to the purpose of the study.

Table 4.3 Educational Background of Respondents

Educational Background of Respondent		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architectural Engineering	3	5.2	5.2	5.2
	Civil Engineering	25	43.1	43.1	48.3
	Surveying Engineering	6	10.3	10.3	58.6
	Electrical Engineering	4	6.9	6.9	65.5
	Construction Technology and Management	10	17.2	17.2	82.8
	Hydraulic Engineering	5	8.6	8.6	91.4
	Urban Engineering	5	8.6	8.6	100.0
	Total	58	100.0	100.0	

4.4.2. Position of Respondent

From the total number of collected 58 questionnaires, the respondents held professional positions: 4 (6.9%) project managers, 15 (25.9%) Site engineers, 6 (10.3%) Quantity Surveyors, 15 (25.9%) supervisors, 7 (12.1%) consulting engineers, 3(5.2%) architects, 4(6.9%) Structural engineers and 4(6.9%) were electrical engineers. This means that all questionnaires have been completed and answered by professionals directly related to the thesis topic.

Table 4.4 Respondents Working Position

Position of Respondent		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Project Manager	4	6.9	6.9	6.9
	Site Engineer	15	25.9	25.9	32.8
	Quantity Surveyor	6	10.3	10.3	43.1
	Site Supervisor	15	25.9	25.9	69.0
	Consultant Engineer	7	12.1	12.1	81.0
	Architect	3	5.2	5.2	86.2
	Structural Engineer	4	6.9	6.9	93.1
	Electrical Engineer	4	6.9	6.9	100.0
	Total	58	100.0	100.0	

Another question asked in the information by the respondents was about the type of organization that the respondents represent. In this case, of the 58 questionnaires collected, 24.1% were from the client's side, 25.9% from the consultant's side, 24.1% from the contractor's side, and 25.9% from the regulatory body's side. This means that all respondents are stakeholders.

Table 4.5 Type of respondents Organization

Respondent Working Organization		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Client Side	14	24.1	24.1	24.1
	Consultant Side	15	25.9	25.9	50.0
	Contractor Side	14	24.1	24.1	74.1
	Regulatory body Side	15	25.9	25.9	100.0
	Total	58	100.0	100.0	

4.4.3. Education Level of Respondent

Out of all the 58 questionnaires collected, the respondents' education level shows that 4 of the respondents were master's degree holders, 52 of the respondents were first degree holders and 2 of the respondents were diploma holders. This indicates that 6.9% of the respondents were master's degree holders, 89.7% of the respondents were first degree holders and 3.4% of the respondents were diploma holders. Of the total respondent, 89.7% of the respondent was first-degree holders which imply that responses were stronger.

Table 4.6 Education Level of Respondent

Education Level of Respondent		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Levels (I-V) (Diploma)	2	3.4	3.4	3.4
	Fist Degree	52	89.7	89.7	93.1
	Master’s Degree	4	6.9	6.9	100.0
	Total	58	100.0	100.0	

4.4.4. Work Experience of Respondent

Out of the total number of 58 respondents with work experience of 2 years or less, there were 2 (3.4%) respondents, with work experience from 2 to 4 years - 6 (10.3%) respondents, and with work experience from 4 to 6 years - 9 (15.5%) respondents, and 41 (70.7%) respondents had more than 6 years of experience. This means that most questionnaires were answered by professionals with more than 6 years of experience which is good work experience to answer the question reasonably.

Table 4.7 work experience of the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	≤ 2 Years	2	3.4	3.4	3.4
	2 to 4 Years	6	10.3	10.3	13.8
	4 to 6 Years	9	15.5	15.5	29.3
	> 6 Years	41	70.7	70.7	100.0
	Total	58	100.0	100.0	

4.5. Analysis Result for Factors Causing Design Change

This study identified 38 factors that cause design change in public building projects. The factors contributing to the design change of public building construction projects in the Arsi area were analyzed using SPSS version 25 software to find the principal components that cause the design change of public building projects in the Arsi area.

The preliminary factor Analysis of findings is concerned with data screening, hypothesis testing, and sampling adequacy.

Table 4.8 Preliminary factor analysis results

Preliminary Analysis	Result
Descriptive Statics	OK, No missing data is observed
Correlation Matrix	Determinant 1.010>P(0.00001) Ok
KMO	0.590 > 0.5 OK
Factor Extraction	1.4 >1 Eigen Values OK
Total Variance	64.614%>50% OK
Reproduced Correlations	44% <50% OK

4.5.1. KMO and Bartlett's Test of Sphericity

Bartlett's Test of Sphericity

Bartlett's test of sphericity, which compares an "identity matrix" (a matrix with ones along the principal diagonal and zeroes elsewhere) to the observed correlation matrix to determine whether or not the variables inter correlate at all, is the most liberal test. You should not use a factor analysis if this test does not have statistical significance. The statistical significance of Bartlett's test indicates that the observed item correlation matrix is not an identity matrix. However, this merely demonstrates that at least some of the variables are correlated with one another and is not a particularly convincing sign that your dataset is factorable.

KMO Value

A more accurate metric for factorability is the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The KMO tests are used to determine whether the partial correlations in your data are close enough to zero to indicate that at least one latent factor underpins your variables. Before conducting factor analysis, the majority of authors recommend a value of at least 0.60, although 0.50 is the minimum acceptable value. An overall Measure of Sampling

Adequacy (MSA) and an MSA for each item are produced by the KMO function in the psych package. If the overall MSA is too low, you could theoretically look at the MSAs of the items and eliminate those that are too low. Naturally, as with any theoretical or empirical method of item selection, this should be done with caution.

The KMO value for the data that was collected was 0.59, which is a value that is acceptable. This suggests that our planned factor analysis can proceed. The following table provides a general summary of the factor analysis test results from this study's KMO and Bartlett analyses.

Table 4.9 KMO and Bartlett's analysis test results

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.590**
Bartlett's Test of Sphericity	Approx. Chi-Square	1399.195
	df	703
	Sig.	0.000

Total Variance Explained

The eigenvalues can be used to determine the proportion of variance attributed to each factor. By dividing each eigenvalue by the total number of variables in the analysis, we can determine the percentage of variance accounted for because the maximum sum of the eigenvalues will always be the same as the number of variables in the analysis. It is 64.6 in this study. The explanation of the total variance result is shown in the table below.

Table 4.10 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.484	27.589	27.589	10.484	27.589	27.589	3.966	10.437	10.437
2	2.842	7.480	35.069	2.842	7.480	35.069	3.530	9.290	19.727
3	2.380	6.264	41.334	2.380	6.264	41.334	3.420	9.001	28.728
4	2.142	5.637	46.971	2.142	5.637	46.971	3.364	8.852	37.580
5	1.941	5.108	52.078	1.941	5.108	52.078	3.292	8.662	46.242
6	1.743	4.588	56.666	1.743	4.588	56.666	2.800	7.369	53.611
7	1.580	4.159	60.825	1.580	4.159	60.825	2.141	5.635	59.246
8	1.440	3.788	64.614	1.440	3.788	64.614	2.040	5.368	64.614

Extraction Method: Principal Component Analysis.

The Communalities result

The proportion of variance that can be explained by retained factors is referred to as the communality of each variable. For each variable, these are once more the percentages of variance that can be explained by the retained factors. The retained factors should be able to explain more of each variable's variance. The fact that the correlation matrix on which the factor analysis is based has ones along the principal diagonal in principal components analysis and communalities along the principal diagonal in principal axis factor analysis is the primary distinction that should be noted between the two methods. The table that follows displays the extracted communalities results from the analysis results.

Table 4.11 The Communalities result

Communalities			
No	Factors	Initial	Extraction
1	Application of Standard Design sent from higher institution for application	1	0.699
2	Un-experienced technical professionals	1	0.727
3	Design Errors made by designers	1	0.634
4	New interests created by the client	1	0.742
5	Unexpected ground condition of the construction site	1	0.617
6	Instrument imperfection	1	0.404
7	Application of the design prepared for one location for all	1	0.623
8	Design change made by consultant	1	0.59

Extraction Method: Principal Component Analysis.

Screen Plot

In factor analysis, the first decision that needs to be made is how many factors need to be extracted in order to get the factor structure that is the tiniest but still easy to understand. We could use parallel analysis and the scree plot, which are the two most common methods. The simplest approach is the scree plot. Eigenvalues can help us determine the number of factors we need to extract because they are a measure of a factor's contribution to variance. All of our factors' eigenvalues are simply plotted in a scree plot, and then we look for areas where they sharply decrease.

Drawing a straight line through the plotted eigenvalues, beginning with the largest, is the scree plot technique. The idea is that the amount of additional variance explained beyond the point at which the last point falls on this line represents the final factor that you extract. In point of fact, the loose stone that surrounds the mountain's base is referred to as scree. A scree plot essentially aims to assist you in distinguishing between the points that represent a "mountain" and those that represent scree. But this data has a very large first factor, regardless of whether you use principal components or principal axis factor extraction. You would probably conclude that there are only three factors in the dataset if we started our straight line here. But if you started your line at the second point on scree plot, you probably would conclude that the dataset contains five factors. Although this would be the only piece of evidence used in our calculation of the number of factors to extract, we might want to take a look at both of these factor solutions even though the latter interpretation is probably closer to the truth.

The screen plot has two axes: the y-axis, which in this study is represented by the Eigen values from 0 up to 8, is determined from factor analysis, and the X-axis is represented by the component factor numbers from 1 to 38 starting from the lowest Eigen value from 1.440 to 10.484, the values are distributed on the graph. See on the following graph.

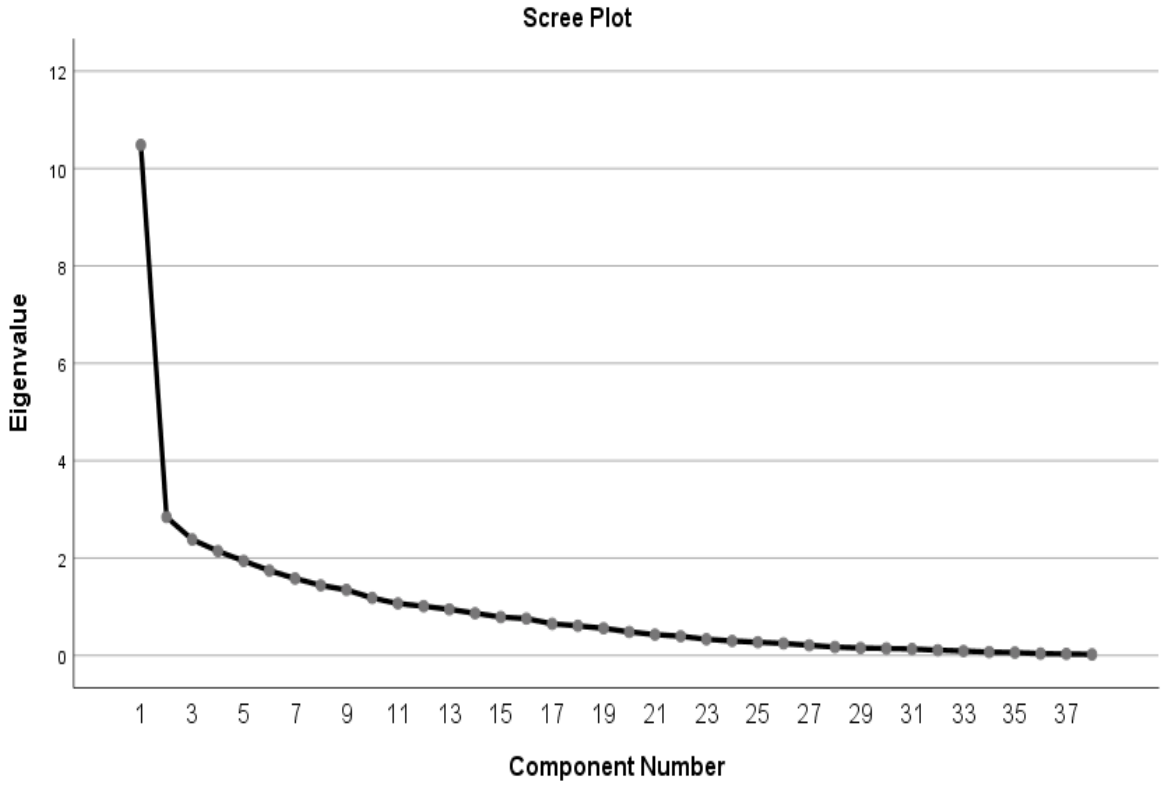


FIGURE 4.3 Scree Plots of component factor and Eigen value

(Source: Researcher Own Work)

4.5.2. Factor Analysis Result Discussion

According to the factor analysis by SPSS result the 8 Principal Factors of Eigen value greater than 1.4 were extracted. Therefore the 8 selected principal factors that cause design change were discussed below.

1. Application of Standard Design

In this study application of standard design means the use of a single design at Federal or Oromia level and sent to many zones of different topography and site condition under that region for application. It is also the reuse of elements, layouts, styles, interactions, and other content by copying and pasting between projects which save time and cost of design for designers. Application of standard design sent from Federal or Oromia level was the first cause of design change. Because the designs were prepared without investigation of feasibility studies, ground condition of the site, topography of the site, Weather condition, soil and underground condition of the site. Therefore by applying the standard design without any investigation, may not match the required site and need to change some part of design to fit the site condition. This problem is always happened in Arsi Zone public building

construction projects like Administration buildings, High school constructions, Health centers, Hospitalities, Elementary Schools, other additional blocks and even some bridge structures. Hence, it is important not to use standard design which is not designed according to the investigation of specific site condition.

2. Un-experienced technical professionals

The second major factor that led to design changes in the construction of public buildings in the Arsi Zone was the involvement of inexperienced technical professionals. Many public building projects were designed by professionals who had just graduated, and a design error made by professionals who had just graduated while investigating the site led to a design change. The design of the finance and administration offices at Shanan Kolu woreda is the best illustration of this case. This issue primarily affected design firms that prepare designs for other government agencies. Arsi zone and Asella town urban development and housing office were these consulting offices.

Hence, the researcher recommend that the consulting office; Arsi zone and Asella town urban development and housing office should invite experienced professionals for the future when they hire other professionals and also they should upgrade the experience of professionals already hired at their office by training them at all levels according to their work positions.

3. Design Errors

Errors in design can have a negative impact on project performance and contribute to failures, accidents, and fatalities. The omission of details on structural drawings and the incorrect description in specifications and drawings are prominent design errors that result in design modifications. His findings revealed that design error and omission were ranked as the third cause of design change. This placed design change as the third causing factor. Lack of instruction in the plans and specifications causes design errors that, if followed by the contractor, will necessitate costly replacement or correction or lead to a construction failure.

It is important to keep in mind that design is the first step in building, and design mistakes have been the root cause of numerous catastrophic accidents that have killed or injured workers and the general public. When mistakes, omissions, and ambiguities in plans and specifications become apparent during construction, they are a major indicator of a project's overall design effectiveness. As a means of lessening the uncertainty brought on by design errors, construction project design errors ought to be investigated and solutions ought to be suggested.

As a result, the findings of this study suggest that the design professionals' failure to produce comprehensive, accurate and coordinated design results is the root cause of the error or omission.

4. New interests created by the client

Changes in the client's interest in a requirement or specification were the most frequently cited reasons for design modifications by previous researchers. For a variety of reasons, the requirements of the client frequently shift during a project. Re-doing the work by the new plans or scope is required when the client initiates a change to the project's plans or scope after the work has been completed. The design team had to rework any changes to the design every time, which affected their fee.

Scopes were then added or removed in response to these causes. This is because the owner did not participate in the design phase or there was insufficient planning at the project definition stage. Projects in which construction begins before the finalization of the design frequently result in design modifications. In addition, design omissions may cause productivity loss and project schedule delays. It is necessary to add, remove, or modify the original plans and specifications by any change orders placed by clients.

The fourth factor causing design change in Arsi Zone public building project was identified as Additions of new works at the request of the client. The factor change requested by the owner includes a change in project scope and modification of project function which came from the client after some or the whole work is completed. This result is supported by other studies related to design change. Design change requested by the owner was ranked 1st and in general design, change was initiated by the client. Design change requested by the owner was the fourth causing principal factor of design changes in public building construction projects as the analysis result of questionnaires responded.

5. Unexpected site conditions

If the consultants' inaccurate representation of the physical conditions in the contract's documentation is a major factor in redesigns, The implementation of large construction projects like highways, dams, and canals is complicated by damages, delays, or claims made by the contractor based on inaccurate contract representations because of factors like different soil conditions, the existence of rock formations, or other reasons. Proper financial planning with contingency funding for unforeseen circumstances and a proper site evaluation before and after the altered conditions for an efficient claims settlement are two methods for

managing the change impacts of an increase in the project's cost and schedule. Because of the culture of using standard designs sent from Federal or Oromia without investigating the ground condition of the site, public building projects in the Arsi zone always face unexpected site conditions. As a result, unanticipated site conditions force the professionals to modify the original design, even if the condition is challenging and causes the project to be suspended or terminated. As a result, designers should design the site's underground condition and conduct careful investigations.

6. Instrument imperfection

The instrument imperfection was identified as one of the primary causes of design modifications in Arsi Zone public building construction projects, according to the analysis's findings. The factors that will determine an in-depth design development are the availability of an adequate instrument and the consultant's adequate operating knowledge. The final design will be accurate if the instrument used for site investigation, topography level measurement, bearing capacity of soil condition, and other investigations are perfect or calibrated. If not, the design cannot be accurate, necessitating a redesign after the projects have begun construction. The consulting offices in the Arsi zone do not have enough instruments, and the instruments that are there were not calibrated. As a result, the public building's professional designers altered its design. As a result, the surveying instruments used by the consulting offices ought to be calibrated within six months.

7. Application of the design prepared for one location for all

In the case of public building projects in the Arsi Zone, one of the eight primary factors that led to design changes was the application of the design that had been prepared for one location to all other locations. Through case study and focused group discussion, this study looks into the possibility that consulting offices in Arsi Zone were distributing a single design to 26 woredas in Arsi Zone. However, each woreda within this Zone has its own topography, soil, weather, underground conditions, and types of material available at query sites, among other things were vastly distinct. Therefore, attempting to implement the design in those various locations may result in difficulties necessitating modification of the initial design.

Delays can be largely attributed to physical conditions that differ from those depicted in contract documentation prepared incorrectly by consultants. The implementation of large construction projects like highways, dams, and canals is complicated by damages, delays, or claims made by the contractor based on inaccurate contract representations because of factors

like different soil conditions, the existence of rock formations, or other reasons. For an efficient claims settlement, proper financial planning with contingency funding for unforeseen circumstances and a proper site evaluation prior to actual construction and after the altered conditions were some of the management methods. Consequently, it is essential to design each woreda in accordance with their site conditions.

8. Design change made by consultant

Design changes related to the structure by an architect consultant or the technical designs changes such as mechanical, electrical, structural and other changes by an engineer consultant is the other cause of design changes. The changes of enhancement in the design, is a regular practice of project design consultants in the construction industry and the frequency with which the changes occur is greater in projects implemented prior to the finalization of the design. There were a design changes made by consultants to increase the quality of projects which is sometimes occurred in construction.

4.6. Impacts of design changes on Project Performance

This study identified 7 effects of design changes on the performance of public building projects. Impacts contributing to the performance reduction of public building construction projects in the Arsi Zone were ranked based on the Relative Importance Index (RII) from the perspective of the contractor, consultant, client, and external factors, and the results of the design impact analysis. Changes are ranked using the RII method in the following table.

Table 4.12 The impacts of design changes

No	Item (Impacts)	Total Respondent (N)	RII	Rank
1	Delay of the projects	58	0.662	1
2	Increase of project cost	58	0.638	2
3	Loss performance of project	58	0.61	3
4	Conflicts between the parties	58	0.607	4
5	Suspension of the projects	58	0.576	5
6	Abandoning of the Project	58	0.521	6
7	Wastage of materials by expiration date of materials	58	0.517	7

Source: Own survey (2022)

The above table shows the impacts of design change. According to the Respondents' responses analyzed by the RII method the top three selected impacts of design change are Delay of the projects, Increase of project cost and less performance of the project.

4.6.1. Discussion of top three Impacts of Design Change

1. Delay of the projects

Clients expect construction projects to be finished in a reasonable amount of time. It is anticipated that projects completed in the shortest amount of time will result in some financial savings. When contractors miss the original project delivery date, they face severe penalties. The penalty is intended to compensate the customer for any losses caused by the extended delivery period. The change that occurred during various phases of construction projects had a negative impact on project costs and completion times. The greater the severity of productivity losses, the more variation orders there are. The amount of output per unit of time is called productivity. As a result, a decrease in productivity means a loss of time and subsequent delays.

It was discovered that the project's completion time increases when the design is altered during construction. This is because it will take time to design the new structural, architectural, and service design changes, approve the new drawings, and evaluate the new materials. As a result, the project's duration will increase at the end. This study found that the

first effect of changing the design of public building projects in the Arsi Zone was a project delay. As a result, respondents ranked "Delay of the project" as the first impact of a design change, giving it an RII value of 0.662, indicating that delays in projects are the first drawback of a design change. This suggests that design changes are a major cause of delays and disruptions. Owners and builders alike agree that change effects are hard to quantify and frequently cause disagreements.

2. Increase of Project Cost

There are well-known phases to construction projects, of which the pre-construction and construction phases are particularly significant. Cost planning is focused on the construction phase because the construction phase typically uses more resources than the pre-construction phase. Customers want to be aware of the total cost of their completed construction projects in advance. Clients want the final construction costs to be the same as what was originally projected in the tender. Sadly, many construction projects overrun their budgets. However, construction costs are not affected by any variation orders. The majority of the times, omissions reduce costs while additions raise them. According to a number of studies, variation orders are a factor in these cost overruns.

This study demonstrates that an increase in project costs was one of the most significant effects of the second-ranked design change. The project's cost is more likely to fluctuate when design changes occur during construction. If the design changes are more complicated or increase the scope of the project, additional funding will be required. If the design changes are complex or increase the project's scope, additional funding will be required. Project cost increase has a relative importance index of 0.61 in this study, which is also supported by a case study on four specific public building projects in the study area.

In general, the following diagram provides a summary of the most important factors that influence design change.

3. Less performance of the project

Project performance can indicate whether a construction project is successful. The degree to which a project achieves its primary objectives to satisfy customers' requirements is referred to as the project's performance. Key performance indicators can be used to gauge how well the project is doing. Time, cost, and quality are generally accepted project performance metrics. The key performance indicators are these three aspects.

This project's performance is evaluated in terms of the expected quality standard, on-time completion, within budget, and client satisfaction. When a construction project is completed on time, within budget, and to the required quality standards, it is considered successful. A project is either unsuccessful or faces performance challenges if it fails to meet the triple constraints or the aforementioned factors. People, cost, time, quality, safety and health, environment, client satisfaction, and communication were the categories used to describe project performance. During the construction phase, there are typically several unanticipated deviations from the original design that cause issues with cost and time performance. The construction of the public building in the Arsi Zone is plagued by numerous issues, many of which are more complicated, such as issues with quality, client satisfaction, cost, and time.

Even though all members of the construction industry support changes to the design, they have an impact on the project's outcome. In building projects, design modifications frequently result in cost and time overruns. As a result, during the design and tender document preparation period, the design consultants and all other parties involved in public building construction projects in the Arsi Zone should conduct in-depth investigations to eliminate frequent design changes, design errors, and unrealistic contract requirements. This would improve the performance of public building construction projects in the Arsi Zone by reducing time and cost overruns.

The following diagram provides a general summary of the major factors that influence design change in Arsi Zone public building projects.

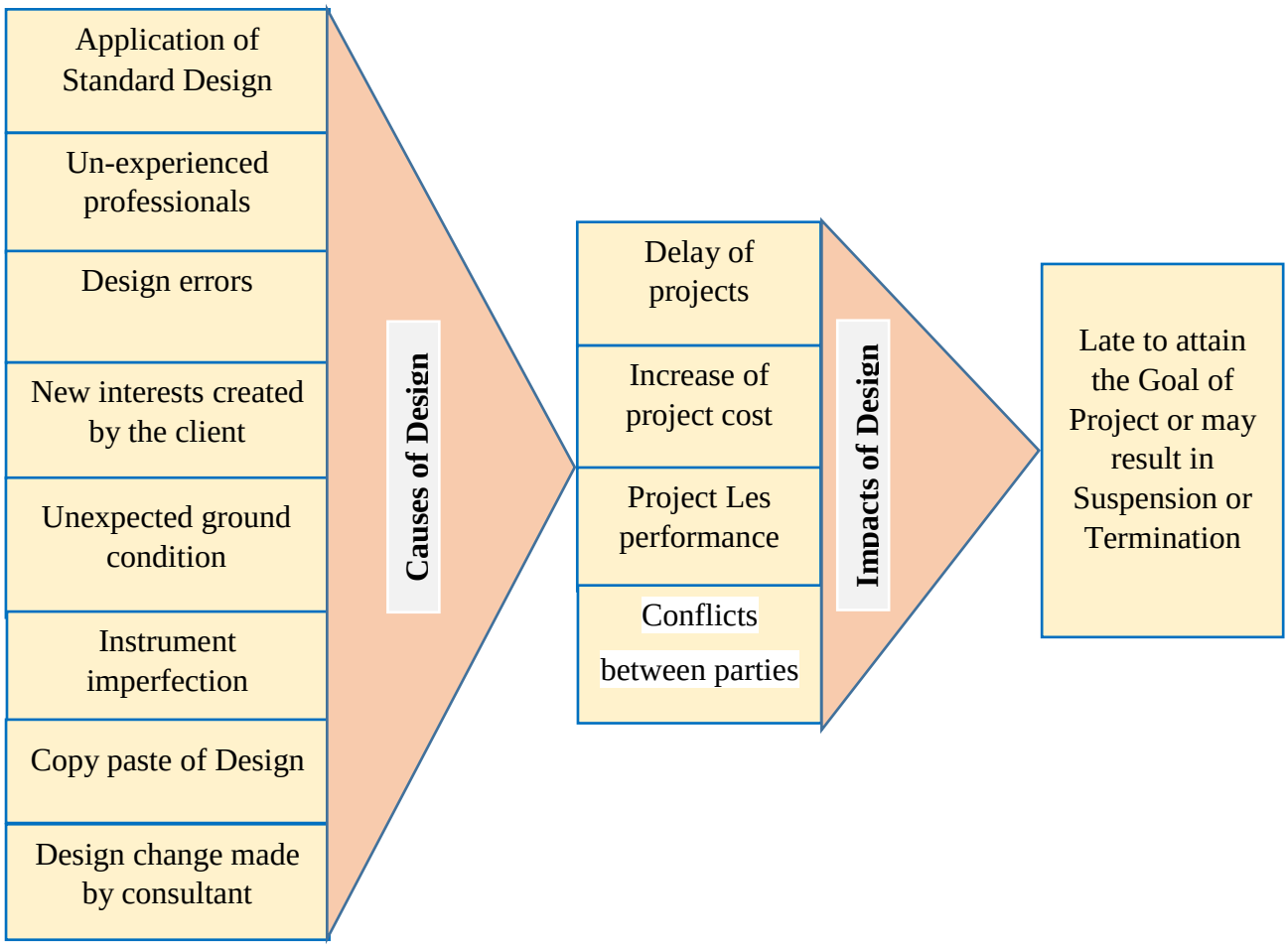


FIGURE 4.4 Factors causing design change and their impacts flowchart

(Source: Researcher Own Work)

4.7. Design Change Management practice and Preventive Measures

The current design change management practice analysis result was presented in the following table in the top three selected current design change management practices with the RII values of 0.672, 0.621 and 0.614. The result is presented in the following table.

Table 4.13 The Current Management practice

No	Item (Current Management practice)	Total Respondent (N)	RII	Rank
1	Decide importance of changes	58	0.672	1
2	Insuring the budget for the change	58	0.621	2
3	Schedule for design change	58	0.614	3
4	Approve the change	58	0.607	4
5	Proper feasibility study for all projects	58	0.597	5
6	Skill up designers	58	0.576	6
7	Involving PLC consultants in design work for high rise buildings	58	0.469	7
8	Participating professionals on their proper position	58	0.445	8
9	Lead the team by technical leaders.	58	0.434	9
10	Provision of clear brief by the client	58	0.397	10
11	Design team should check for perfect design,	58	0.379	11

Source: Own survey (2022)

From the result presented in the above table, the first three current design change management practices were selected for discussion. According to respondents' responses analyzed by the RII method, the top four selected current design change management practices are: Decide importance of changes, insuring the budget for the change and Schedule for design change.

4.7.1. The Top three Design Change Management practice

The primary objective of change management in construction is to ensure that all stakeholders receive clear and concise communication at all times. Information included during this notification may relate to any deviations from already accepted specifications, any impact on agreed timelines and the cost of any changes that need to be made.

Change management in construction requires an integrated solution to discipline and coordinate the process, for example, documentation, drawing, process, flow, information, cost, schedule and personnel. The construction industrial needs an effective construction change management process.

1. Decide importance of changes

The evaluation module calculates all possible time and cost effects of an identified change on other processes and team members using criteria and options. In order to decide whether to precede with any of the change options or carry out additional research, it is necessary to analyze and, if at all possible, optimize them. Again, this stage necessitates a significant effort to model intelligent behaviors that are involved in the decision-making processes. A proposal changes to order or design change that summarizes the change itself and its effects a new, revised action plan, cost, schedule, etc. is the evaluation's result. A formal approval procedure must be followed for each identified change. For a variety of changes and construction contracts, there are predefined approval procedures. To begin, the proposed work change must be approved by all parties involved. A process of change review is used to accomplish this. The proposed change order can then be finalized with the client's approval. This could involve deciding whether to accept, improve, or reject changes. While a change that is accepted changes the contract, a change that is rejected may either be enforced as a construction change directive or become permanently rejected.

2. Ensure sufficient budget for the project

It comes down to money in every project. If you had more money, you probably could get more people to work on your project faster and get more donations. Because of this, you cannot complete a project plan until you establish a budget. The process of determining the bottom line, on the other hand, is always the same, regardless of how big or small your project is or how many resources and activities it requires. Estimating each project's costs in detail is crucial. You incorporate the cost estimate into the budget plan once this is compiled. As work progresses, you can now monitor how this budget affects the project. When you start a project, you frequently have a predetermined idea of how much it will cost and how long it will take. In the area under investigation, it was discovered that clients and consultants were introducing the design change on numerous public building projects without ensuring a sufficient budget for the addition of the works. The projects will be put on hold and the project will take longer to complete if the clients only want to change the project's scope.

As a result, before deciding whether or not to make changes, the parties involved should verify that the budget is adequate and locate the source of funds necessary to finish the project as a whole, including any additional work.

3. Schedule for design change.

The management procedure necessitates a schedule for the design change that has been decided upon by all parties involved to keep records of all pertinent information and additional time to finish the project to put the changes into effect. To ensure that all aspects are up to date, that all parties are informed, and that all activities are carried out correctly and well-coordinated, an operational system is required. To make the change analysis procedures easier in the future, everything recorded is linked to the change cases and each other.

The schedule of the projects in the Arsi Zone public building projects is one of the major issues. There is no record of a client being penalized for a problem that challenges the contractors, nor is there any record of a contractor being penalized for a problem that delayed the project. This suggests that the people of the Arsi Zone were losing out on the opportunity to receive services from the products of numerous public building projects as a result of a lack of care to schedule for design changes and even original projects in public building projects.

As a result, the researcher suggests that everyone involved in construction projects should be aware of the benefits of scheduling to maximize project performance in terms of cost, time, and quality for both the initial work and any additional work required following a design change.

4.8. Case Study

In this research, the four public building projects were selected to increase the validity of the research to provide in-depth knowledge and a better understanding of the factors and dimensions of the research problem. These selected projects were G+3 building of Amigna woreda administration office (AWAO), G+4 building of Arsi Zone administration office (AZAO), G+1 building of Sude woreda administration office (SWAO) and G+1 building of Shanan Kolu woreda administration office (SHKWAO). The data collected in the case study were by observation, interview, and review of documents or records were presented in the above table.

Four case studies are used to demonstrate the negative effects of design changes, particularly in terms of cost and time. The causes and sources for each of the four case studies are listed

in Table 4.16. The extent of the effects of each cause on the project is indicated by the percentage and how frequently it occurs. Table 4.17 shows the precise impact of the design changes on each case study by the end of the project by the percentage of increase in cost and time.

Causes of Design Change

From the data collected by case study; the major causes of design change involved in the four selected projects were: additions of new works at the request of the client, willingness to use alternative material, unexpected site conditions, design change made by consultant and design errors. Additions new works requested by the client involved in all cases, the willingness to use alternative material involved in two cases, unexpected site ground conditions involved in one case, design change made by consultant involved in one case and the design error involved in one case. In general, the result is displayed in the following Table.

Table 4.14 The Factors Causing Design Changes from Case study

No	**Factors Causing Design Changes**	AWAO	AZAO	SWAO	SHKWAO
1	Additions of new works at the request of the client	✓	✓	✓	✓
2	Design errors			✓	✓
3	Willingness to use alternative material	✓		✓	
4	The desire of the contractor to improve his financial situation	✓		✓	✓
5	Inconsistency of the contractual document		✓		
6	Unexpected site conditions		✓		✓
7	Design change made by consultant		✓	✓	

Source: Own survey (2022)

Impacts of design changes

The data collected shows that the major impacts of design changes involved in the selected projects were: Delay of the projects (involved in all cases), Increase of project cost (involved

in all cases) and Termination of the projects (involved in one case). The result of this is also graphically expressed in the following table.

Table 4.15 The impacts of design changes from Case study

No tem	(Impacts)	AWAO	AZAO	SWAO	SHKWAO
1	Delay of the projects	✓	✓	✓	✓
2	Suspension of the projects	✓			✓
3	Increase of project cost	✓	✓	✓	✓
4	Loss performance of project			✓	✓
5	Conflicts between the parties			✓	✓
6	Abandoning of the Project				✓
7	Wastage of materials by expiration date of materials			✓	✓

Source: Own survey (2022)

The data collected shows that the major impacts of design changes involved in the selected projects were: Delay of the projects (involved in all cases), Increase of project cost (involved in all cases) and Termination of the projects (involved in one case). The result of this is also graphically expressed in the following Table.

Table 4.16 Organized delays and Cost increase of four selected projects

Cost increase	**Original Agreement Amount**	**Amount After Design Change**	**Parentage of Cost increment**
AWAO	21,643,162.15	29,660,512.25	37.0 %
AZAO	68,431,596.09	103,182,330.05	50.8 %
SWAO	22,652,158.35	25,821,266.87	14.0 %
SHKWAO	11,652,458.75	17,468,745.25	49.9 %
Time Delay	**Original Agreement Period**	**Delay After Design Change**	**Parentage of Time Delay**
AWAO	720 calendar Days	891calendar Days	>100%
AZAO	510 calendar Days	721 calendar Days	>100%
SWAO	365 calendar Days	420 calendar Days	>100%
SHKWAO	720 calendar Days	1825calendar Days	>100%

Source: Own survey (2022)

4.9. Focused Group Discussion

From focused group discussion held at the Arsi Zone Urban Development and Housing Office and Asella Construction Authority, technical professional experts and others involved in the construction industry contributed their skills, knowledge, and exposure through discussion. The results of the focused group discussion make it abundantly clear that project completion is highly unlikely without modifications to the design. The work's nature and complexity necessitate some adjustments to the design. Professionals believe that projects with repetitive design and detail undergo fewer and fewer significant modifications than projects that are not repetitive. Clients are the most common source of design modifications in public building projects, according to professional discussions. Until they see the proposed works built, many clients are unable to visualize them from detailed drawings.

In addition, the client frequently alters the specifications in the construction industry to enhance the level of performance and the quality of the work. The financial burden is another factor that forces clients to alter the work's scope, use different materials, or construct in different ways.

A lack of coordination among members of the design team may also have an impact on the project's build ability and element conformity. In fast-track projects, it is also thought that an

unclear scope of work frequently leads to design modifications. To save time, construction work may be started prior to the design's completion. The lack of a feasibility study at the proposed location and unexpected site conditions as a result of an inadequate site investigation were two additional reasons cited by professionals who participated in the discussion.

Design changes deviate from these essential goals, despite the efforts of clients, consultants, contractors, and regulatory bodies to complete work on time and within budget. Professionals who were a part of the group cited major delays as an effect of the changes to the design because they redistribute the planning of material, the allocation of resources, and the portions of the project that have been completed. The delay of a design change may also have a significant impact on a project's cost. Productivity, efficiency, and momentum are all affected by design modifications. In addition, professionals want to build strong relationships with one another and work well together to finish a project successfully; Design changes have the potential to make people feel bad, which can enrage professionals and lead to arguments.

Corrective Measures under Group Discussion

Finding the most significant preventative or corrective measure that could be recommended to reduce design changes was one of this study's primary goals. In the group discussion with technical professionals, the majority of the corrective and/or preventative measures that could be taken to reduce design changes were presented. Most of the time, clients don't realize the project's fundamental requirements until they see them during construction or the final design phase. Most of the time, the reason for this issue is that designers don't tell clients how the design work is going and don't talk to them about any technical issues or other ideas that don't fit their needs. In addition, a lot of customers don't get involved much in the design phase because they are too busy or think they don't have enough technical experience; Customers want their ideas implemented quickly and without a lot of discussion. Additionally, there are instances in which construction work begins prior to the design's completion. In such instances, consultants are pressured to quickly provide contractors with working drawings to avoid delaying site progress. Most importantly, consulting engineers should be able to correctly implement their clients' requirements. If consultants have questions, they should ask their clients right away.

In addition, clients should hire consulting engineers with sufficient industry experience to carry out their work professionally. It's possible that unqualified consultants won't be able to

bring their clients' ideas to life or only come up with a limited set of design criteria that don't meet their needs. At the beginning of a project, this information provides alternative options and highlights any technical issues or work-related restrictions with solutions. Additionally, feasibility studies provide an estimate of the work's cost so that clients are aware of the necessary funding. The type and specifics of the underlying soil stratus are important design parameters that are revealed by site investigations. Finally the group summarizes the following:

The major Causes of Design Changes

- Application of Standard Design sent from higher institution for application,
- Un-experienced technical professionals
- Design Errors made by designers examples:
    - When designing the exterior shape, they don't take into account the climate in the area.
    - Not relating the choice of exterior materials to the climate.
    - Inadequate movement provisions;
    - Inadequate foundation design;
    - Exceeding permissible deflection;
    - Ignoring the effects of wind on the structure;
    - Inadequate concrete cover on the reinforcement;
    - Improperly locating pipes and conduits
- New interests created by the client
- Unexpected ground condition of the construction site
- Instrument imperfection
- Application of the design prepared for one location for other woredas

Preventive Measures of Design Changes

- Proper feasibility study for all projects
- Skill up designers
- Involving PLC consultants in design work for high rise buildings
- Participating professionals on their proper position
- Lead the team by technical leaders.

Impacts of Design Changes

- project delay
- project cost increase
- project les performance
- conflicts between parties

Managing Impacts of Design Change

- Decide importance of changes
- Insuring the budget for the change
- Schedule for design change
- Approve the change

4.10. Description of Mitigation System Flowchart

To solve the problem of mismanagement of causes and impacts of design changes in public building projects for selected study area, the researcher creates a flowchart. The mitigation measures investigation were assigned to which dependent variable was appropriate to address the design change management problem. This implies that management at inception of project will reduce the causes of design changes. Hence, causes of design changes reduced the impacts will be reduced and simply managed.

The flowchart implies that the causes of design changes listed like application of standard design sent from federal government or from any other higher institution for application, un-experienced technical professionals, design errors made by designers, new interests created by the client, unexpected ground condition of the construction site and instrument imperfection or absence of checking instruments perfection, fixing their degree of imperfection and application of the design prepared for one location for other woredas as standard design which may not much other location were the major causes of design changes in arsi zone public building construction projects. The preventive measures to minimize the factors causing the design change were: feasibility study for all projects of different site conditions other than using the study prepared for another projects as standards, skill up designers by providing short term training, involve PLC consultants for high rise buildings, using professionals on the proper position according to their educational background and qualification and leading technical professionals by personnel leaders.

The major impacts of design changes investigated in this study were delay of project, increase in cost of the project, les performance of the project and conflicts between parties involved in the construction of the projects. For these impacts the researcher summarizes the managing parameters as; discussion on the importance of changes and draw the final decision, insuring the additional budget required for the change starting from redesign cost to execution cost for the change, schedule for design change and finally approve change by regulatory body to make it legal for all parties. If it is decided that the changes occurred was advantageous and the type of the contract for the certain project is not impossible to manage, termination will be the final decision in the process of management.

To improve the validity of the flowchart developed in the figure below was confirmed by more experienced professionals working in the Arsi Zone Construction Authority, Asela town construction authority, and Arsi Zone Urban Development and Housing Office. The flowchart developed was the total summary of questionnaires, case study and group discussion results.

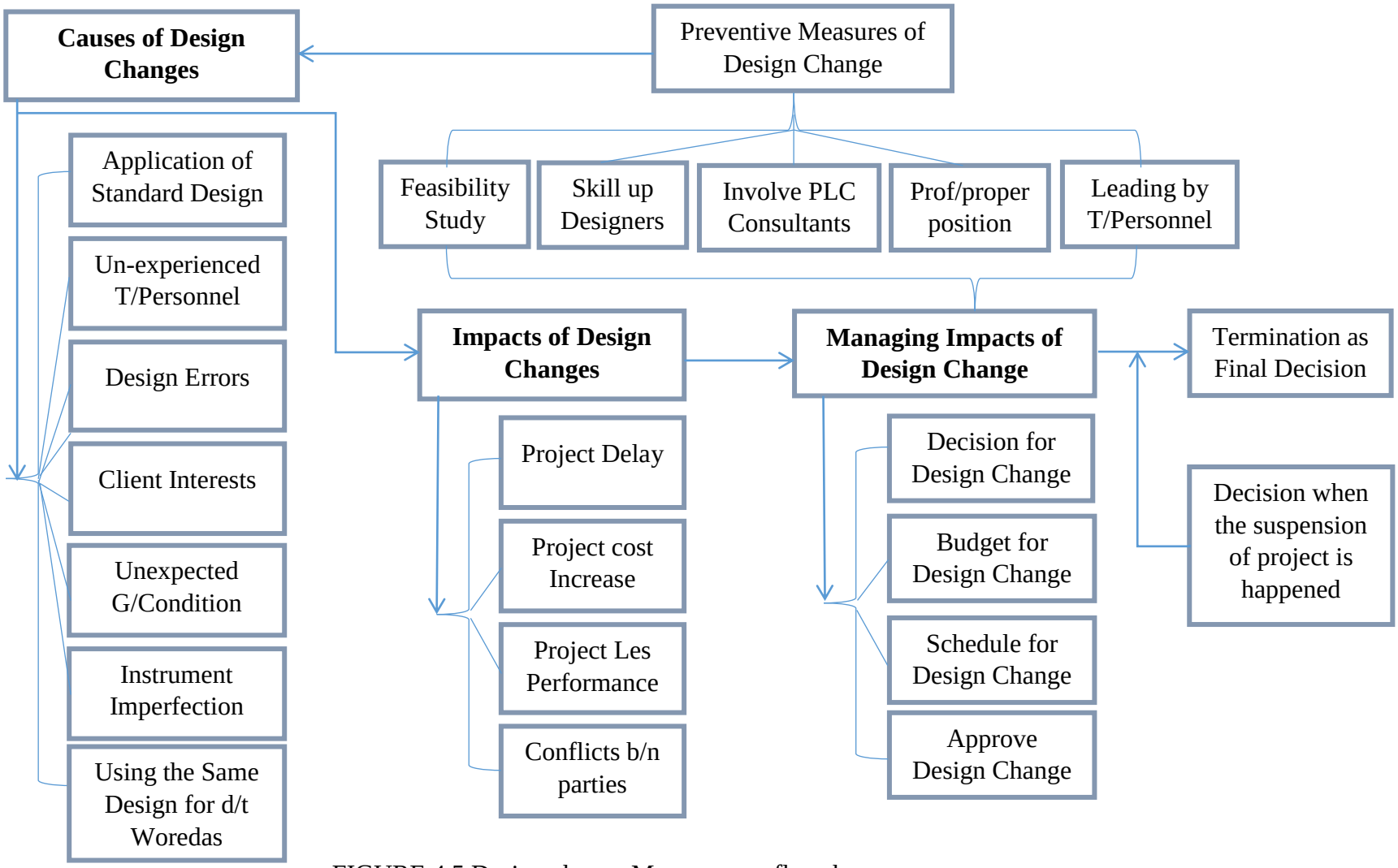


FIGURE 4.5 Design change Management flowchart

(Source: Researcher Own Work)

4.11. Implications of the Study

This study develops the mitigation measures for challenges to manage causes and impacts of design change in public building projects in Arsi Zone. The investigation of mitigation measures contributes to the problem of managing causes and impacts of design change in public building projects. The researcher collected and combined the variables from different ligatures and also some other variables gathered from experienced professionals working for the selected populations so that the study could cover wider perspectives for the selected study area.

In practice, the project clients should request an accurate and complete design brief at an early stage. This will help the client understand the design concept and solve the problem of requesting changes during the construction phase, which will lead to project delays, cost overruns, and rework. Design consultants involved in building construction projects should recommend conducting detailed studies during the preparation of design and tender documents, which will eliminate frequent design changes. The regulatory body should improve effective communication and coordination between the client, consultant, and contractor. This will avoid frequent design changes that lead to time, cost, and rework.

Overall, the findings of the study are largely in line with the expected outcome, which was stated to benefit all construction stakeholders at all levels.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Almost all projects undergo a variety of modifications, both during construction and during the design phase. The main purpose of the study is to investigate the management of causes, and impact of design changes on the construction of public buildings projects in the Arsi Zone to develop the management system. The main factors causing design change in public building construction projects in the Arsi Zone were application of standard design sent from higher institution for application, un-experienced technical professionals, design errors made by designers, new interests created by the client, unexpected ground condition of the construction site, instrument imperfection and application of the design prepared for one location for other woredas.

The results also revealed the major impacts of design changes as project delays, project cost increases, project les performance and conflicts between parties. The preventive measures of design changes at inception stage were: proper feasibility study for all projects, skill up designers, involving PLC consultants in design work for high rise buildings**,** participating professionals on their proper position and lead the team by technical leaders.

To minimize the impacts of design change after it was happened in the project the major parameter for preventing the negative impacts were: decide importance of changes, insuring the budget for the change, schedule for design change and approve the change

Finally, this study can conclude that if we do not pay serious attention to the main factors that cause design change, which significantly affects the performance of the project; it will be very difficult to achieve the goals of the project. The most significant corrective and/or preventive measures that have the potential to establish boundaries and attempt to minimize design changes that could not be avoided were identified in this paper. In addition, professionals involved in reinforced concrete building projects were advised to follow the guidelines.

5.2. Recommendation

Aligned with the above conclusion, the researcher proposes the following recommendations that should be considered by concerned stakeholders to reduce design changes and the impacts of a design change on project performance as follows:

- Clients should ask for a clear and complete design brief at an early stage. This 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. The client should also engage an experienced project coordinator that represents the client to ease the design process and communicate with the design members. If scope change is mandatory, communicate with the design team the design should be modified by the currently constructed structure to avoid undesirable rework, cost overrun, and time overrun. Giving sufficient time for bid documents such as technical specifications, drawings, bill of quantities and designing of the project and revising it in a good way. This is because any discrepancy in bid documents will lead to disputes between project parties and so delay may occur.
- The 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 changes, design errors, and unrealistic contract requirements.
- The regulatory body has to improve effective communication and coordination between Client, consultant and contractor. 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.

In general the clients, consultants, contractors and regulatory body should consider allocating sufficient time at the initial design stage to implement the client's idea properly and to finalize the requirements of the proposed work. The identified cause and effect of design change factors can be used as a checklist to contribute to improving project performance of public building construction projects in Arsi Zone. All the stockholders should always work to properly manage the design change happened at any time.

Further research study can be done by including other construction projects other than public building projects and also conducted for wider areas including more zones, because this study doesn’t include other construction projects other than public building projects in Arsi Zone

because of the peace instability in our country Ethiopia and time limitations. Further quantitative research could be made on the design change management problem on construction projects other than public building projects as well as for wider areas including more zones, the study could also include external factors that were not included in this research.

REFERENCES

Abdul-Rahman, H. (2017). Impacts of design changes on construction project performance. National Huaqiao University.

Ali, A. A. (2009). Methods of Coordination In Design changes.Ambachew, S. (2018). Addis Ababa institute of technology assessment on design management practices of national consultants focused on building design projects Addis Ababa.

Anastasopoulos, P. C., Labi, S., Bhargava, A., Bordat, C., and Mannering, F. L. (2010). Frequency of change orders in highway construction using alternate count-data modeling methods. Journal of Construction Engineering and Management, 136(8), 886-893.

Argaw, T. (2018). Addis Ababa University the causes of project delay: The case of lideta limate primary school building project lideta sub city adminstration construction office.

Aslam, M., Baffoe-Twum, E., & Saleem, F. (2019). Design Changes in Construction Projects – Causes and Impact on the Cost. Civil Engineering Journal, 5(7)

Asmerom, B. n.d. 2021). School of Graduate studies departement of Project Management the effect of design change on building project performance in addis ababa the case of g1contractors, g1 consultants and clients Addis Ababa, Ethiopia.

Association for the Advancement of Cost Engineering (AACE) International, Inc. (2004). Estimating lost labor productivity in construction claims. AACE International Recommended Practice No. 25R-03.

Bassa, M., Reta, A., Alyew, A., & Tora, M. (n.d. 2019). Causes and Effects of Design Change in Building Construction Projects in Three Selected Southern Ethiopia Zones. www.ijert.org

Behsah, m.d. (2015). Assessment of Causes and Cost Impact of Change Orders on Road Projects in Ethiopia

Boon, J., Yap, H., Abdul-Rahman, H., & Wang, C. (n.d. 2016). A Conceptual Framework for Managing Design Changes in Building Construction. https://doi.org/10.1051/00021

Chronicles, F. (. (2001). Changes during Construction. Chronicles, F. (2001), Coping With Changes during construction

Cooper, K. G., Reichelt, K. S., and Moore, J. (2004). Quantifying Disruption through Simulation and Heuristics. AACE International Transactions EST.08.

Eisenhardt, K. M. (2014) Building Theories from Case Study Research, Stanford University, publisher Taylor & Francis, 2015. 14(4), 75-77pp

Hamzah, A. R. (2017). Impacts of Design Changes on Construction Project Performance:

Insights from a Literature Review of Journal of quantity surveying & construction business.

Hanna, A. S., Lotfallah, W. B., and Lee, M. J. (2002). Statistical - fuzzy approach to quantify cumulative impact of change orders, Journal of computing in civil engineering, 16(4)

Hanna, A. S, and Swanson, J. (2007). Risk allocation by law—Cumulative impact of change orders. Journal of Professional Issues in Engineering Education and Practice.

Hsieh, T. Y., Lu, S. T., and Wu, C. H. (2004). Statistical analysis of causes for change orders in metropolitan public works. International Journal of Project Management, 22(8), 679-686.

Ibbs, C. W. (1994). "Project change management." Construction Industry Institute Special Publication 43-1, Austin.

Ibbs, C. W., and Allen, W. E. (1995). Quantitative impacts of project change. Construction Industry Institute, Univ. of Texas.

Ibbs,C. W., Wong, C. K., and Kwak, Y. H. (2001). Project change management system. Journal of Management in Engineering, 17(3), 159-165.

Iliyas, J. S. (2016,). Factors Influencing Change of Design of Building Projects. International Journal of Construction Engineering and Management, 98.

Jeffrey, B. H.-R. (2016). Conceptual framework of causing factors influencing. MATEC Web of Conferences 66, 00021 (p. 3). Lee Kong Chian: IBCC 2016.

Jones, R. M. (2001). Lost productivity: Claims for the cumulative impact of multiple change orders. Public Contract Law Journal, 1-46.

Latortue, X., Minel, S., Pompidou, S., & Perry, N. (2015). Integration of end-user needs into building design projects: use of boundary objects to overcome participatory design challenges. https://hal.archives-ouvertes.fr/hal-01360417

Lee, S. (2007). Understanding and Quantifying the Impact of Changes on Construction Labor Productivity: Integration of Productivity Factors and Quantification Methods.

Le-Hoai, Lee, Y. D et al.(2008). Delay and Cost Overruns in Large Construction Projects: A Comparison with other Selected Countries, Vietnam, KSCE Journal of Civil Engineering, 367–377pp

Lokhande, M. A., Saif, F., & Ahmed, Y. (2015). Assessing Consequences of Change Request Impact in Construction Industry of YEMEN: An Explorative Likert-Scale Based Survey Design. Management, 2015(5), 141–147. https://doi.org/10.5923/j.mm.20150505.01

Lukumon, & Oyedele. (n.d.). Design Factors influencing Quality of Building Projects in Nigeria: Consultants' Perception.

Matusala. (2020). Causes and Effects of Design Change in Building. International Journal of

Engineering and Technical Research V8(12).

Moayeri, V. (2017). Design Change Management in Construction Projects Using Building Information Modeling (BIM) THESIS. Thesis, October.

Mohamad, M. I., Nekooie, M. A., & Al-Harthy, A. B. S. (2012). Design Changes in Residential Reinforced Concrete Buildings. In Journal of Construction in Developing Countries (Vol. 17, Issue 2).

Mughees Aslam, Edmund Baffoe-Twum and Farhan Saleem. (Vol. 5, No. 7, July, 2019). Design Changes in Construction Projects – Causes and Impact on the Cost. Civil Engineering Journal 5(7):1647-1655.

Muhammed. (2018). Impact of Design Changes in Construction Project. Malaysian Journal of Sustainable Environment.

Moselhi, O., Leonard, C., and Fazio, P. (1991). Impact of change orders on construction productivity. Canadian Journal of Civil Engineering, 18(3), 484-492.

Motawa, I. A., Anumba, C. J., Lee, S., and Peña-Mora, F. (2007). An integrated system for change management in construction. Automation in Construction,16(3), 368-377.

Orczyk, J. J. (2002). Skills and knowledge of cost engineering: change management. AACE International's 46th Annual Meeting, Portland, Oregon, June 2002.

Park, M., and Pena-Mora, F. (2003). Dynamic change management for construction: introducing the change cycle into model-based project management. System Dynamics Review, 19(3), 213-242.

Pikas, E., Koskela, L., & Seppänen, O. (2020). Improving building design processes and design management practices: A case study. Sustainability (Switzerland), 12(3).

Qi Hao, Weiming Shen, Joseph Neelamkavil, Russ Thomas (2008). Change Management in Construction Projects, International Conference on Information Technology in Construction

Revay, S. O. (2003). Coping with changes. AACE International Transactions, CDR.25.1-7.

Roben. (2015). Analysis of the Impact of Variation Orders On Project Performance.

Schwartzkopf, W. (1995). Calculating lost labor productivity in construction claims, Wiley, Somerset, N.J.

S, F. (n.d. 2016). Building Design and Construction Hand Book 6 Edition.

Shamsudeen, M., & Biodun, O. (2016). Effects of Design Errors on Construction Projects. International Journal of Scientific & Engineering Research, 7(2), 1099–1114.

Suleiman, I. J., & Luvara, V. G. M. (2016). Factors Influencing Change of Design of Building Projects during Construction Stage in Dar-es-Salaam Tanzania. International Journal of

Construction Engineering and Management,

Thomas, H. R., and Napolitan, C. L. (1995). Quantitative effects of construction changes on labor productivity. Journal of construction engineering and management, 121(3)

Thomas, H. R., and Raynar, K. A. (1997). Scheduled overtime and labor productivity: quantitative analysis. Journal of Construction Engineering and Management, 123(2)

Thomas, J. R. (2008). Change management in construction projects. http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/jsp/nparc

Valentine, G. M. (2016). Factors Influencing Change of Design of Building. International Journal of Construction Engineering and Management.

Voropajev, V. (1998). Change management—A key integrative function of PM in transition economies. International Journal of Project Management, 16(1), 15-19.

Wu, C. H., Hsieh, T. Y., and Cheng, W. L. (2005). Statistical analysis of causes for design change in highway construction on Taiwan. International journal of project management, 23(7)

Yana, A. A. G. A., Rusdhi, H. A., & Wibowo, M. A. (2015). Analysis of factors affecting design changes in construction project with Partial Least Square (PLS). Procedia Engineering, 125, 40–45.

Appendix 1 Questionnaire Survey

This Research Survey is designed for fulfillment of master program in Civil Engineering (Specialization in Construction Engineering and Management) at Adama Science and Technology University. To do the full research on investigation management of causes and impacts of design changes in Ethiopian building projects in Arsi Zone to develop management system the questionnaire is proposed to attain the objectives of the research, which are; to identify the major causes, impacts and existing design changes management practice.

The responses you gave me are very essential to final output of the research. So, I sincerely ask you to complete the entire questionnaire and gave me back you strictly confidential response as much as possible in four to five days.

Thank you for your consideration

Prepared by Kassim Kabeto

Address:

Mobile Number: 0911751319 or 0910953558

E-mail Address: kassim143zkk@gmail.com

If there is doubt in my questionnaire, please call me at any time

Information of Respondent

Please be sure that I will handle your response appropriately. Mark **'X'** in provided box to express your personnel information.

i. Your Educational Background

☐ Architectural Engineering (1) ☐ Civil Engineering (2) ☐ Surveying Engineering (3)

☐ Electrical Engineering (4) ☐ Construction Technology and Management (5)

☐ Hydraulic Engineering (6) ☐ Urban Engineering (7)

Specify if others _____

ii. Your Work Position at organization

☐ Project Manager (1) ☐ Site Engineer (2) ☐ Quantity Surveyor (3)

☐ Site Supervisor (4) ☐ Consultant Engineer (5) ☐ Architect (6)

☐ Structural Engineer (7) ☐ Electrical Engineer (8)

Specify if others _____

iii. Organization or Party in which you are working

☐ Client Side (1) ☐ Contractor Side (3)

☐ Consultant Side (2) ☐ Regulatory body Side (4)

iv. Level of your educational Background

☐ Levels (I-V) (Diploma) (1) ☐ Fist Degree (2) ☐ Master's Degree (3) ☐ PhD (4)

v. Your Work Experience

☐ ≤ 2 Years (1) ☐ 2 to 4 Years (2) ☐ 4 to 6 Years (3)

☐ > 6 Years (4)

1. Questionnaire Related to Objective one

1.1. Factors Causing the Design Changes

This is the comparison of level or degree of factors causing design changes in Arsi zone public building projects. The level of causing factors starts from 0 to 4; in which 0 is to show that the degree of the factor to cause design changes is **very low**, 1 is to show **Low**, 2 is to show **Medium**, 3 is to show **High** and 4 is to show that the degree of the factor to cause design changes is **very high**. So, by marking 'X' under 0 to 4 compare factors selected in the following table.

No	Factors Causing Design Changes	Degree of Causing				
		0	1	2	3	4
1	Application of Standard Design sent from higher institution for application					
2	Un-experienced technical professionals					
3	Design Errors made by designers					
4	New interests created by the client					
5	Unexpected ground condition of the construction site					
6	Instrument imperfection					
7	Application of the design prepared for one location for all					
8	Design change made by consultant					
9	Financial problems of the client					
10	Financial problems of the contractor					
11	Constraints for determining the purpose of the project					
12	Design change due to weather conditions					
13	To correct construction errors					
14	Desire to use the best features					
15	Incorrect information provided by owner					
16	Improper and unbalanced need of the owner					
17	The customer takes a long time to make a decision					
18	Incorrect choice of project contract type					
19	Conclusion of the contract at the lowest price regardless of the quality of services					
20	Lack of involvement of designers at the construction stage					

21	Underestimation of project cost					
22	To save time, use alternative construction methods					
23	To save money, use alternative construction methods					
24	Guide to structural modification for economic purposes					
25	Building Safety Modification Guide					
26	Design Modification Guide for Building Beauty					
27	Long period between bidding and award					
28	Unjustified expectations of the client and the end user					
29	Insufficient detail of the existing state of the site					
30	New government regulations					
31	Inadequate information provided to the designer					
32	Inconsistent design and conflicting information on drawings					
33	Scarcity of resources					
34	Insufficient background of the proposed site					
35	Frequent change of volume by customers					
36	Improve the quality of works at the facility					
37	Designers find it difficult to capture customer needs					
38	Lack of coordination among design team members					

2. Questionnaire Related to Objective Two

2.1. The impacts of design changes on the performance of the project

In this case the Negative Impacts of design changes on the performance of public building projects is considered by the researcher. Therefore**,** do comparison of the degree of impacts that comes from design changes to project performance in Arsi zone public building projects. The degree of impacts ranges from 0 to 5; in which 0 is to show that the degree of the factor **not affect** the project performance, 1 is to show the degree to affect is **very low**, 2 is to show the degree to affect is **Low**, 3 is to show **Medium** 4 is to show that the degree of impact on the project performance is **High** and 5 is to show the degree of affect is **very high** So, by marking 'X' under 0 to 4 compare factors selected in the following table.

No	Impacts of design changes	Level of impact					
		0	**1**	**2**	**3**	**4**	**5**
1	Delay of the projects						
2	Increase of project cost						
3	Loss performance of project						
4	Conflicts between the parties						
5	Suspension of the projects						
6	Abandoning of the Project						
7	Wastage of materials by expiration date of materials						

3. Questionnaire Related to Objective Three

3.1. Existing Current design changes management Practice

Based on your professional experience to express the level of management Practice on public building projects in Arsi zone use the following: to express the level of management Practice mark 'X' under 0 to show not applicable, mark 'X' under 1 to show **Seldom**, mark 'X' under 2 to show **Sometimes**. Mark 'X' under 3 to show **often** and mark 'X' under 4 to show **Always.**

No	**Current** Design Changes **management Practice**	Level of management Practice				
		0	**1**	**2**	**3**	**4**
1	Decide importance of changes					
2	Insuring the budget for the change					
3	Schedule for design change					
4	Approve the change					
5	Proper feasibility study for all projects					
6	Skill up designers					
7	Involving PLC consultants in design work for high rise buildings					
8	Participating professionals on their proper position					
9	Lead the team by technical leaders.					
10	Provision of clear brief by the client					
11	Design team should check for perfect design,					

How to manage the design change? Please write the best management system you think. (Optional)

_____

_____

_____

_____

Appendix 2 Case Study Survey

Case – 1, 2 and 3

G+3 Amigna Woreda Administration Office Building

Information of the Project

Source of Document _____

Name of the Project Client_____

Location of the Project_____

Types of agreement _____

Year of Start_____

Completion Date according to the agreement_____

Current Status of the Project_____

Is there any Delay ☐ Yes ☐ No

Reason for delay list if any

_____

_____

_____

_____

Location of files of this project:

1. _____
2. _____
3. _____
4. _____

4. Questionnaire Related to Objective one

4.1. <u>Factors Causing Design Changes</u>

In case of this project the Factors Causing Design Changes are:-

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

5. Questionnaire Related to Objective Two

5.1. Impacts of Design Changes on this project

In case of this project what are the Impacts of Design Changes?

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

7. Questionnaire Related to Objective Three

a. Management Practice involved in this project

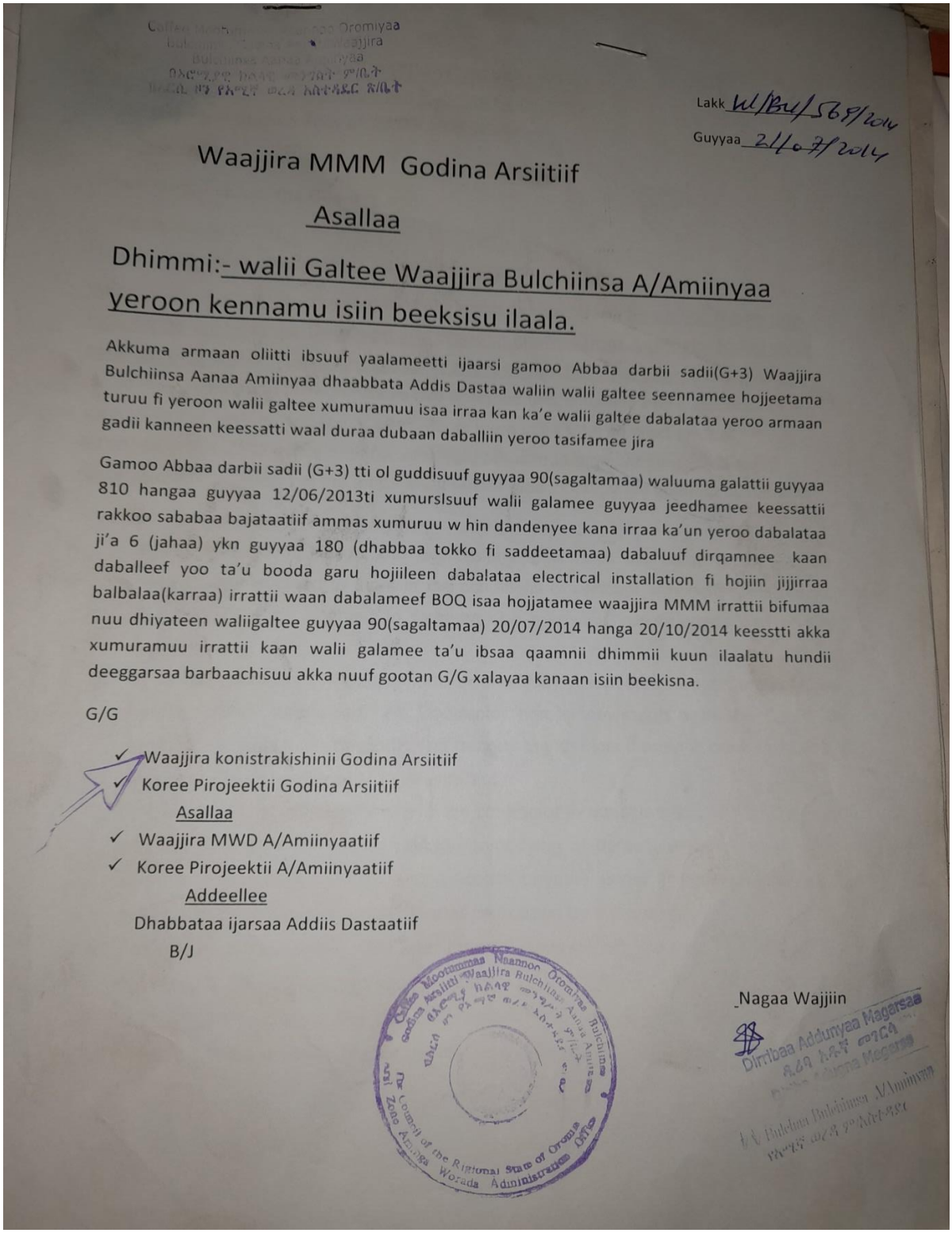
1. Which organization professionals have done the design change of this project?
   ☐ Client ☐ Consultant ☐ Regulatory body decision
2. By which organization professionals have the design change have been approved?
   ☐ Client ☐ Consultant ☐ Regulatory body decision
3. Is there management team in organization that has done the design change of this project?
   ☐ Yes ☐ Yes, but weak ☐ No
4. Is there management team in organization that has approved the design changed of this project?
   ☐ Yes ☐ Yes, but weak ☐ No
5. Is there delay of time in the process of design change of this project?
   ☐ Yes ☐ No
6. Which of the following reason is the **most critical** case behind the delay of this project?
   ☐ Due to weak management team ☐ Due to budget problem
   ☐ Due to approval delay, Specify if other any_____
7. In this project which factor causes is the most critical for the weakness the design change management team?
   - ☐ Improper position of professionals in organization
   - ☐ Interference of political leaders
   - ☐ Periodic change of client leaders
   - ☐ Absence of Scheduled Supervision due to lack of supervision budget; even the budgets are consumed by government leaders.

8. For the design change management in this project which of the following is the most critical party to minimize the negative impacts of design changes?

- ☐ Well Structured Client Organizations
- ☐ Well Structured Contractor Organizations
- ☐ Well Structured Consultant Organizations
- ☐ Well Structured Regulatory body

Appendix 3 Scanned Documents for Case Study

G+3 Amigna Woreda Administration Office Building Agreements



Lakk W/Bu/568/2014

Guyyaa 21/07/2014

Waajjira MMM Godina Arsiitiif

Asallaa

Dhimmi:- walii Galtee Waajjira Bulchiinsa A/Amiinyaa yeroon kennamu isiin beeksisu ilaala.

Akkuma armaan oliitti ibsuuf yaalameetti ijaarsi gamoo Abbaa darbii sadii(G+3) Waajjira Bulchiinsa Aanaa Amiinyaa dhaabbata Addis Dastaa waliin walii galtee seennamee hojjeetama turuu fi yeroon walii galtee xumuramuu isaa irraa kan ka'e walii galtee dabalataa yeroo armaan gadii kanneen keessatti waal duraa dubaan daballiin yeroo tasifamee jira

Gamoo Abbaa darbii sadii (G+3) tti ol guddisuuf guyyaa 90(sagaltamaa) waluuma galattii guyyaa 810 hangaa guyyaa 12/06/2013ti xumursIsuuf walii galamee guyyaa jeedhamee keessattii rakkoo sababaa bajataatiif ammas xumuruu w hin dandenyee kana irraa ka'un yeroo dabalataa ji'a 6 (jahaa) ykn guyyaa 180 (dhabbaa tokko fi saddeetamaa) dabaluuf dirqamnee kaan daballeef yoo ta'u booda garu hojiileen dabalataa electrical installation fi hojiin jijjirraa balbalaa(karraa) irrattii waan dabalameef BOQ isaa hojjatamee waajjira MMM irrattii bifumaa nuu dhiyateen waliigaltee guyyaa 90(sagaltamaa) 20/07/2014 hanga 20/10/2014 keesstti akka xumuramuu irrattii kaan walii galamee ta'u ibsaa qaamnii dhimmii kuun ilaalatu hundii deeggarsaa barbaachisuu akka nuuf gootan G/G xalayaa kanaan isiin beekisna.

G/G

- ✓ Waajjira konistrakishinii Godina Arsiitiif
- ✓ Koree Pirojeektii Godina Arsiitiif

Asallaa

- ✓ Waajjira MWD A/Amiinyaatiif
- ✓ Koree Pirojeektii A/Amiinyaatiif

Addeellee

Dhabbataa ijarsaa Addiis Dastaatiif

B/J

Nagaa Wajjiin

Dirtbaa Addunyaa Magersaa

SUPPLIMENTARY-CONTRACT- AGREEMENT #1
for Amigna Woreda Administration Building Construction

This Agreement made on day of **25/03/ 2022** between:

Amigna Woreda Administration

(Here in after called "**the Client** ") and

Addis Desta GC

Here In after called "**contractor**") of the other part.

Whereas the client is desirous that the contractors to execute the **Electrical Works and Internal door Aluminum Omission and Wooden Internal Door Additions to the main contract of G+2 Administration Building and G+3 one floor variation** (Here in after called "the works") and the contractors has accepted the Execution and completion of such Works and the remedying of and defects there in for total contract price of **5,158,856.68 (Five Milion one hundred fifty eight thousand Eghit hundred fifty Six and 68/100 birr only with Vat)** at the terms and manner prescribed by the contract documents

Now this agreement witness as follows

1. In this agreement, words and expressions shall have the same meanings are respectively assigned to them in the conditions of contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.
2. In Consideration of the payments to be made by the Clients to the Contractor as here in above mentioned, the Contractor hereby covenants with the Client to execute and complete the works and remedy any defects therein in conformity in all respects with the provisions of the contract.
3. The Client her by covenants to pay the contractor in consideration of the execution and completion of the works and the remedying of defects wherein the contract price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.
4. Completion of the works: - No later than 90 days following the signing of contract Agreement, the contractor shall furnish the employer with a time table for completing the works. The completion date shall be **Include in previous** days following the scheduled date for commencement the work.

0911 23 26 39
0912 50 51 57
ADDIS DESTA GENERAL CONTRACTOR

5. Contract Administration: - The Adjudicator is urban & Housing development office and shall be responsible for interpreting and administering the contract in accordance with contract document.

6. *STATUS OF CONTRACT*

It is agreed and under stood that said contract document shall be interpreted according to Ethiopian law and this agreement is deemed to be an administrative contract in Accordance with the civil code of Ethiopia 1960.

In Witness where of the parties to have caused this Agreement to be executed the day and year first before written.

APPENDIX to the Suplementary construction Agreement

1) Project: **G+3 Adminstration Building**
2) Client: **Amigna Woreda Administration**
3) Consultant: **Arsi Zone Urban and Housing Dev. Office**
4) Contractor: **Addis Desta GC**
5) Date of Signing the main agreement: Nov.21/2018
6) Contract time: 720 Calendar days
7) Extension of comletion time for this supplementary works:___720+90_____ calendar days.
8) Total period of completion time:_720+90+180__+__90___calendar days
9) Total amount of main agreement: **21,643,162.15**
10) Amount of Advance for main agreement and previous variations was 20%
11) Total amount of suplementary and varition works so far amended: (3rd floor VARIATION **5,158,856.68 ETB)**
12) This addition of extra one floor amount of (Supplementary of Electric and wooden door works **2,858,493.41ETB)**
13) Amount of Advance of supplementary agreement is 20% of the supplementary agreement
14) Total amount of the project including the supplementary, variation and amount of main agreement is : **29,660,512.25**
15) Reason for this supplementary: Due to clients' interest and astatic value of internal wooden addition by omitting internal aluminum door and missed electrical installation items.

0911 23 26 39
0912 50 51 57
ADDIS DESTA GENERAL CONTRACTOR

For the Client

Abbaas Cinqoo Hiliioo

I/G/Wa/Bul/fi mana maniı Bulchiinsa A/Amiinyaa

Authorized signature

For the Contractor

Addis Desta G/Manager

Authorized signature

WITNESS

	Name	Signature	Date
1.	Mahdi Kayo		Oct 04/2019.
2.	Negessa Fayisa		Oct. 09/19
3.	Afarbet Tesu		Oct. 04/2019

Addis Desta Construction PLC

MAIN- AGREEMENT

This Agreement made at ***Adelle Town*** *day of* November 21/2018 GC *between* ***Amigna Woreda Administration Office*** *(Here in after called "the Employer ") and* ***Addis Desta BC*** *(Hereinafter called "the contractor" of the other part.*

Whereas the contractors is desirous that the Contractors to execute the ***Construction of G+2 Amigna Woreda Administration Office*** *(Here in after called "the works") and the contractors has accepted the Execution and completion of such Works and the remedying of and defects there in for total contract price.* ***Birr 21,643,162.15 (Twenty one Million Six hundred fourty three thousand & one hundred sixty two birr & 15/100 only) with VAT*** *at the terms and manner prescribed by the contract documents*

Now this agreement witness as follows

1. *In this agreement, words and expressions shall have the same meanings are respectively assigned to them in the conditions of contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this agreement.*
2. *In Consideration of the payments to be made by the Employer to the Contractor as herein above mentioned, the Contractor hereby covenants with the Employer to execute and complete the works and remedy any defects therein in conformity in all respects with the provisions of the contract.*
3. *The Employer her by covenants to pay the contractor in consideration of the execution and completion of the works and the remedying of defects wherein the contract price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.*
4. *Completion of the works: - No later than this days following the signing of contract Agreement, the contractor shall furnish the employer with a time table for completing the works. The completion date shall be* ----720---- *days following the scheduled date for commencement the work.*
5. *Contract Administration: - The Adjudicator is urban & Housing development office and shall be responsible for interpreting and administering the contract in accordance with contract document.*

6.STATUS OF CONTRACT

It is agreed and under stood that said contract document shall be interpreted according to Ethiopian law and this agreement is deemed to be an administrative contract in Accordance with the civil code of Ethiopia 1960.

In Witness where of the parties to have caused this Agreement to be executed the day and year first before written

For the Employers	*For Contractor*
Tesfaye Terefe	Addis Desta G/Manager
Authorized signature	*Authorized signature*

WITNESS

	Name	*Signature*
1.	Ibrahim Kaso	
2.	Mengistu Dechasa	
3.	Umer Aliye	
4.	Abdulkerim Tena	

G+4 Arsi Zone Administration office Building Agreements

MAIN- AGREEMENT

This Agreement made on June 24/2012 day of _____ between **Arsi Zone Administration Office** (Here in after called "the Employer ") and **MCG Construction PLC** (Here in after called "the contractor" of the other part.

Whereas the contractors is desirous that the Contractors to execute the **construction of G+4 Arsi Zone Administration Office Building (**Here in after called "the works") and the contractors has accepted the Execution and completion of such Works and the remedying of and defects there in for total contract price. **Eth. birr 68,431,596.09 (Sixty Eight million four hundred thirty one thousand & five hundred nighty six birr & 09/100 with vat.** at the terms and manner prescribed by the contract documents

Now this agreement witness as follows

1. In this agreement, words and expressions shall have the same meanings are respectively assigned to them in the conditions of contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.
2. In Consideration of the payments to be made by the Employer to the Contractor as herein above mentioned, the Contractor hereby covenants with the Employer to execute and complete the works and remedy any defects therein in conformity in all respects with the provisions of the contract.
3. The Employer her by covenants to pay the contractor in consideration of the execution and completion of the works and the remedying of defects wherein the contract price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.
4. Completion of the works: - No later than is days following the signing of contract Agreement, the contractor shall furnish the employer with a time table for completing the works. The completion date shall be **510 Calendar days** following the scheduled date for commencement the work.
5. Contract Administration: - The Adjudicator is urban & Housing development office and shall be responsible for interpreting and administering the contract in accordance with contract document.

6. STATUS OF CONTRACT

It is agreed and under stood that said contract document shall be interpreted according to Ethiopian law and this agreement is deemed to be an administrative contract in Accordance with the civil code of Ethiopia 1960.

In Witness where of the parties to have caused this Agreement to be executed the day and year first before written

For the Employers

Qaasoo Abdurashiid Kadiir
Waajjira Bulchiinsaa Gosaa Arsii
Fi Mana Maree Kaabinee

Authorized signature

for Contractor

Jegena Keneni Hora
Manager

Authorized signature

WITNESS

	Name	Signature	
1.	Mustafa Gelcho		Arsi Zone FECO
2.	Yaaddessa Osmaan		Arsi Zone Admn. O
3.	Eyob Alegashu		Arsi Zone UHDO
4.	Mohammed Aman		

Bulchiinsa Mootummaa Naannoo Oromiyaa
The Oromia Regional State
Arsi Zone Administration Office

MCG CONSTRUCTION PLC

Lakk. BAA/1633/MH·8

Guyyaa 8/4/14

- **Waajjira MWD Godina Arsittiif**
  Asallaa
- **Waajjira Misooma Magaala fi Manneenni Godina Arsittiif**
  Asallaa
- **Waajjira konstraakshini Godina Arsittiif**
  Asallaa
- **Koree Teeknikaa Godina Arsittiif**
  Asallaa

Dhimmi:- Hojjii dabalata(supplementary work) ijaarsa Gamoo waajjira keenya isiin beeksisu ta'a

Akkuma mata duree irratti ibsamuuf yaalameetti waajjirri keenya Ijaarsa Gamoo abbaa darbii 4(G+4) kontiraaktara MCG PLC jedhamuun hojjatama jiraachuun isaa ni beekkama. Haa ta'u malee fedha manajimanti mana keenyatiin haala barbaachisummaa kutaalee irratti hunda'uudhaan;-

1. Kuutaale Gamoo keessaa Darbii 3ffaa irratti kutaa Bulchaa haala ammaayatiin akka hojjatamu
2. Manni waardiya kan G+0 ture gara G+1 tti jijjiramu fi
3. Hojjii dallaa dabalataan akka hojjatamu murteessine akkasumaas waligaltee dhabbata dhuunfa Kontraktara MCG jedhamu waliin gaafa guyyaa *Fulbaana 01/2021 A.L.A* waligala mallaqa *12,193,747.32(Miliyyoon kudha lama fi kuma dhibba tokkoof sagaltami sadi fi dhibba Torbaf Afurtami Torbaa fi santima 32/100)* VAT dabalate waan gooneef,isiniis kanuma akka hubataniif waligaltee keenya fi sanada hojji dabalata kana xalayyaa kana miltoo godhuun isinii erginee jirra.

Nagaa wajiin!.

GG

- Itti gaafatama waajjira keenyattiif

Shigidoo Guddataa Jaal...
ሽግዶ ጉደታ ጃለቶ
MAAG/Waajjira Bul/Godina Arsii

SUPLEMENTERYAGREEMENT FOR AMENDEMENT-1

This Agreement made at ***Asela Town*** *day of* ***September .04...../2021 G.C****between* ***Arsi Zone Administration Office*** *(Here in after called "the Employer ") and* ***MCG Construction*** *(Hereinafter called "the contractor" of the other part.*

Whereas the contractors is desirous that the Contractors to execute the ***Construction Amended Supplimentary Work of G+4 Arsi Zone Administration Office Building*** *(Here in after called "the works") and the contractors has accepted the Execution and completion of such Works and the remedying of and defects there in for total contract price of* ***Birr 12,193,747.32(Twelve Millions one hundred Ninety three thousand Seven hundred Fourty Seven birr &32/100 only) with VAT*** *at the same terms and manner prescribed by the main contract Agreement documents.*

Now this agreement witness as follows

1. *In this agreement, words and expressions shall have the same meanings are respectively assigned to them in the conditions of contracts as in main agreement hereinafter referred to, and they shall be deemed to form and be read and construed as part of this agreement.*
2. *In Consideration of the payments to be made by the Employer to the Contractor as here in above mentioned, the Contractor hereby covenants with the Employer to execute and complete the works and remedy any defects therein in conformity in all respects with the main agreement provisions of the contract.*
3. *The Employer her by covenants to pay the contractor in consideration of the execution and completion of the works and the remedying of defects wherein the contract price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.*
4. *Completion of the works: - No later than this days following the signing of contract Agreement, the contractor shall furnish the employer with a time table for completing the works. The completion date shall be* ___65___ *days following the scheduled date for commencement the work.*
5. *Contract Administration: - The Adjudicator is the client in joint with Arsi Zone urban & Housing development office and shall be responsible for interpreting and administering the contract in accordance with the main contract document.*

6.STATUS OF CONTRACT

It is agreed and under stood that said contract document shall be interpreted according to Ethiopian law and this agreement is deemed to be an administrative contract in Accordance with the civil code of Ethiopia 1960.

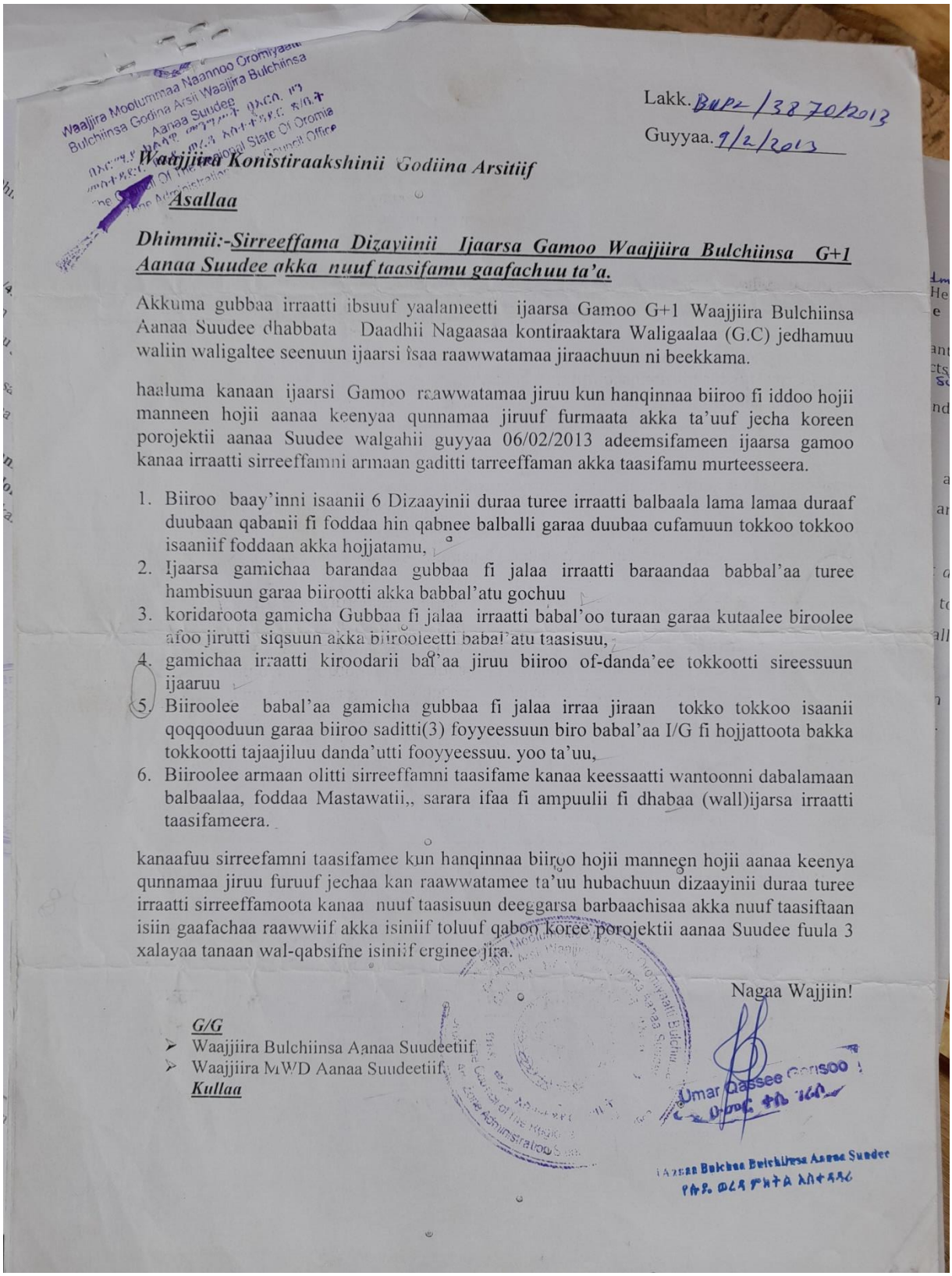
In Witness where of the parties to have caused this Agreement to be executed the day and year first before written

For the Employers	*for Contractor*
Authorized signature	*Authorized signature*

WITNESS

	Name	*Signature*
1.	Fita Bojane	
2.	Guta Zelele	
3.	Mohammed Ameno	
4.		

G+1 Sude woreda Administration office Building Agreements



Waajjira Mooluminnaa Naannoo Oromiyaa
Bulchiinsa Godina Arsii Waajjira Bulchiinsa
Aanaa Suudee
The Council Of The Regional State Of Oromia
The Administration Council Office

Lakk. BUPZ/3870/2013
Guyyaa. 9/2/2013

Waajjiira Konistiraakshinii Godiina Arsitiif

Asallaa

Dhimmii:-Sirreeffama Dizayiinii Ijaarsa Gamoo Waajjiira Bulchiinsa G+1 Aanaa Suudee akka nuuf taasifamu gaafachuu ta'a.

Akkuma gubbaa irraatti ibsuuf yaalameetti ijaarsa Gamoo G+1 Waajjiira Bulchiinsa Aanaa Suudee dhabbata Daadhii Nagaasaa kontiraaktara Waligaalaa (G.C) jedhamuu waliin waligaltee seenuun ijaarsi isaa raawwatamaa jiraachuun ni beekkama.

haaluma kanaan ijaarsi Gamoo raawwatamaa jiruu kun hanqinnaa biiroo fi iddoo hojii manneen hojii aanaa keenyaa qunnamaa jiruuf furmaata akka ta'uuf jecha koreen porojektii aanaa Suudee walgahii guyyaa 06/02/2013 adeemsifameen ijaarsa gamoo kanaa irraatti sirreeffamni armaan gaditti tarreeffaman akka taasifamu murteesseera.

1. Biiroo baay'inni isaanii 6 Dizaayinii duraa turee irraatti balbaala lama lamaa duraaf duubaan qabanii fi foddaa hin qabnee balballi garaa duubaa cufamuun tokkoo tokkoo isaaniif foddaan akka hojjatamu,
2. Ijaarsa gamichaa barandaa gubbaa fi jalaa irraatti baraandaa babbal'aa turee hambisuun garaa biirootti akka babbal'atu gochuu
3. koridaroota gamicha Gubbaa fi jalaa irraatti babal'oo turaan garaa kutaalee biroolee afoo jirutti siqsuun akka biirooleetti babal'atu taasisuu,
4. gamichaa irraatti kiroodarii bal'aa jiruu biiroo of-danda'ee tokkootti sireessuun ijaaruu
5. Biiroolee babal'aa gamicha gubbaa fi jalaa irraa jiraan tokko tokkoo isaanii qoqqooduun garaa biiroo saditti(3) foyyeessuun biro babal'aa I/G fi hojjattoota bakka tokkootti tajaajiluu danda'utti fooyyeessuu. yoo ta'uu,
6. Biiroolee armaan olitti sirreeffamni taasifame kanaa keessaatti wantoonni dabalamaan balbaalaa, foddaa Mastawatii,, sarara ifaa fi ampuulii fi dhabaa (wall)ijarsa irraatti taasifameera.

kanaafuu sirreefamni taasifamee kun hanqinnaa biiroo hojii manneen hojii aanaa keenya qunnamaa jiruu furuuf jechaa kan raawwatamee ta'uu hubachuun dizaayinii duraa turee irraatti sirreeffamoota kanaa nuuf taasisuun deeggarsa barbaachisaa akka nuuf taasiftaan isiin gaafachaa raawwiif akka isiniif toluuf qaboo koree porojektii aanaa Suudee fuula 3 xalayaa tanaan wal-qabsifne isiniif erginee jira.

Nagaa Wajjiin!

G/G
- Waajjiira Bulchiinsa Aanaa Suudeetiif
- Waajjiira MWD Aanaa Suudeetiif

Kullaa

Umar Qassee Gorisoo

Bakkaa Bulchiinsa Aanaa Suudee

SUPLMENTRY- AGREEMENT

This Agreement made on day of 08/09/2014 E.C between Sude Woreda administrati (Here in after called "**the Employer** ") and Dadi Negasa G.C (Here in after called "**the Contractor**" of the other part. Whereas the Consultant is desirous that the Consultants to execute the Arsi zone Urban & house dept office (Here in after called "the works") and the Consultant has accepted the Execution and completion of such Works and the remedying of and defects there in for total contract price 3,169,108.52 (three million one thousand six nine thousand & one hundreds eight 52/100 at the terms and manner prescribed by the contract documents

Now this agreement witness as follows

1. In this agreement, words and expressions shall have the same meanings are respectively assigned to them in the conditions of contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.
2. In Consideration of the payments to be made by the Employer to the Consultant *as* herein above mentioned, the Consultant hereby covenants with the Employer to execute and complete the works and remedy any defects therein in conformity in all respects with the provisions of the contract.
3. The Employer her by covenants to pay the Consultant in consideration of the execution and completion of the works and the remedying of defects wherein the contract price or such other sum as may become payable under the provisions of the contract at the times and in the manner prescribed by the contract.
4. Completion of the works: - No later than is days following the signing of contract Agreement, the Consultant shall furnish the employer with a time table for completing the works. The completion date shall be 90 **days** calendar days following the scheduled date for commencement the work.
5. Contract Administration: - The Adjudicator is Industry and urban development office and shall be responsible for interpreting and administering the contract in accordance with contract document.