SCHOOL OF COMMERCE

DEPARTMENT OF PROJECT MANAGEMENT

Factors affecting design change in construction projects in Addis Ababa.

A case of Bole Ayat one project

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Factors affecting design change in construction projects in Addis Ababa.
A case of Bole Ayat one project

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A Project work Submitted to the Addis Ababa University in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Project Management (MPM)

March/2024
ADDIS ABABA, ETHIOPIA

DECLARATION

I, Natnael Agonafer, conducted an independent research study on the Factors affecting design change in construction projects in Addis Ababa, A case of Bole Ayat one project as part of the master's program in project management, with the advice and support of the research advisor. This research is my original work, which has not been submitted for any degree or diploma program at this or any other university/institutions.

Declared by: Natnael Agonafer

Signature:

Date

ENDORSEMENT

This is to certify that Natnael Agonafer has carried out his research work on the topic entitled "Factors affecting design change in construction projects in Addis Ababa, A case of Bole Ayat one project". The work is original in nature and is suitable for submission for the reward of the Master's Degree in Project Management.

Supervisor: Solomon Markos (Ph.D.)

Signature:

Date

CERTIFICATION

The Undersigned certify that they have read and hereby recommend to Addis Ababa University to accept the Project work submitted by Natnael Agonafer and entitled Factors affecting design change in construction projects in Addis Ababa in partial fulfillment of the requirements for the award of Master's Project management.

Submitted by:

Full Name: Natnael Agonafer Signature: _____ Date _____

Approved by:

Supervisor/Advisor: _____Signature: _____Date_____

Internal Examiner: _____Signature: _____Date_____

External Examiner: _____Signature: _____Date_____

Head of Department: _____Signature: _____Date _____

ACKNOWLEDGEMENT

First and foremost, I thank the Almighty Lord for making this work possible. My deepest gratitude goes to my Advisor, Solomon Markos (Ph.D.) for his critical professional comment, constructive criticism, regular follow up; suggestion and useful advice have been invaluable inputs that have improved the quality of my work.

Further, I would also like to thank all of those who helped me during the research by responding to my questionnaires and who assisted directly or indirectly to acquire the necessary data.

It gives me a great pleasure to take this special opportunity to express my sincere and warmest gratitude to all my family members for contributing everything in my path, my friends for unlimited support and their indispensable material and moral shore up in my graduate program.

Above all Glory is to God for his unspeakable gifts!

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Abstract

The construction sector is an important part of every country's economy since it creates jobs and wealth. However, many initiatives in underdeveloped nations had poor results in terms of time and money. Design change, among other variables, is one of the causes of this poor performance. This is because design changes might impact project costs and timelines. With this background, the goal of this study is to determine the existence and prevalence of design changes, to identify the causes of these design changes and their impact, to determine which contracting party is more responsible for initiating these design changes, and to determine who is most affected as a result of these causes. The research is conducted on a project located at Addis Ababa which is owned by Addis Ababa Housing Development Corporation. Among different projects that are undertaken by AAHDC this research is focused on one project, The Bole Ayat One Project, which consists of three building construction sites under it. The study finds that Client related factors, Design related factors, Managing consultant-related and Site – related were found significant in causing design changes the study concludes that design change as one major problem in building projects in Addis Ababa city on the project of Bole Ayat One.

Key Words: Change of design, Client related, consultant related, contractor related, Design related, building project

CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Design is the process of developing an outline of a new facility, which is generally represented by comprehensive drawings and specifications; construction planning is the process of determining the activities and resources needed to make the design a physical reality. In the context of project management in construction projects, design changes refer to any modifications or alterations made to the original plans or specifications of a project after initial approval. These changes can impact various aspects of the project, including timelines, costs, and overall project delivery.

In an integrated system, design and construction planning may occur virtually concurrently, exploring many possibilities that are beneficial from both perspectives and therefore minimizing the need for costly adjustments under the pretext of value engineering. Moreover, as the project advances from planning to design, the design may be reviewed to ensure that it becomes a reality.

According to the Ethiopia Construction business, consultancy companies receive the vast majority of the design preparation section. According to the following literature evaluations, design modification is a rather prevalent problem that has an impact on overall project construction performance. The design change is initiated from one of the following parties‟ such as, owner, consultant, consultant construction management, politics and economics, natural environment, contractors, third party, and advances in technology.

Owner-requested design adjustments include additions, deletions, and/or alterations to the initial scope of work (Moayeri, 2017). According to the first Ethiopian condition of contract (BATCODA), the Consultant will produce as-built final drawings and documentation of the works to provide information on both obvious and concealed work in order for the financier to execute potential modifications in design or modification of works with simplicity and without evaluation and inquiry. These records must include all modified dates and information up to the start of the Service Period.

According to a study conducted by (Cox et al 1999), design changes regularly have a significant impact on client goals in construction projects, where the cost of post-contract award design adjustments typically equates to about five to eight percent of the total cost of the contract. Furthermore, (Burati et al. 1992) revealed that design changes, faults, and omissions accounted for 79% of rework costs in industrial engineering projects.

A study undertook by Yap and Skitmore (Yap and Skitmore 2018) categorize the 39 factors into those linked to the project client, consultant, contractor, site, and external factors. The three most major reasons noted include inadequate coordination among multiple expert advisors, differences in the specification, and frequent modifications to scope requirements.

1.2. STATEMENT OF THE PROBLEM

Change is a vital component of every project, and a design change is a type of modification that deviates from the original plan. Change is an integral component of every project, and a design change is one type of modification that deviates from how the work was planned, budgeted, or scheduled. Throughout the project lifespan, most building projects undergo varying degrees of design modification. Design modifications are prevalent in building construction projects (Mohamad et al., 2012), and in many cases, these changes result in excessive claims and conflicts (Howick et al., 2009).

Numerous variables contribute to project delays, and numerous researchers' findings indicated that design modification is one of these reasons. For example, according to the research conducted by (Kikwasi, 2013) on assessing the causes and effects of delays and disruptions in Tanzanian construction projects, design change was one of the major causes affecting performance and causing disruptions in Tanzanian construction projects.

Ahmed et al. (Ahmed 2003) evaluated the primary causes of delays in the Florida building construction industries. The primary purpose of this research is to ascertain various stakeholders' perspectives on the reasons for delays, the distribution of responsibilities, and the various types of delays. It was revealed that consultants have an important role in design-related delays given that they control the design process in partnership with the project owner.

Al-Momani (Al-Momani 2000) investigated the reasons for delays in 130 Jordanian state projects in the year 2000. The whole project showed that poor design and the owner's

carelessness, modification orders, weather conditions, site challenges, late delivery, economic conditions, and an increase in quantities were the key causes of delay. When it comes to contractual specificity, the availability of these factors affects the effective implementation of projects.

(Assaf et al. 2006) performed study on construction project delays in several types of projects in Saudi Arabia. It was determined that 70% of projects had time overruns. The study was done with the participation of 23 contractors, 19 consultants, and 15 owners. Seventy-three causes of delay were identified and classified into nine categories. A change order is the result of the survey that was agreed upon by all three parties according to the study.

In the case of the Bole Ayat 1 project, the construction is delayed due to many factors. Such as construction material escalation, poor planning, insufficient stakeholder cooperation, and design change given from what‟s observed from statements made for the causes that led to design change. So this study focuses on one of the factor which is design change that contributes its share to the delay. One reason is not communicating in time with other stakeholders such as EELPA (Ethiopian Electric Light and Power Authority), AAWSA (Addis Ababa Water Sewerage Authority) and AACRA (Addis Ababa City Road Authority), insufficient budget, and poor cost estimation that does not consider future economic fluctuation.

For instance one factor that caused design change on this project happens on site. The design of one block did not account a water utility line that passes on its side road so when constructing the building terrace it rests up on it. As a result the terrace structure had to be modified. This happens due to lack of communication between two organizations that are important stakeholder in the project.

Other factors noticed on this project are design change of car entrance ramps. On one block the car entrance ramp design is changed because the original design level has too much elevation deference with the road that is constructed after the building. This type of factors could’ve been avoided if there was accurate data information gathered in the beginning of the project.

Not accounting efficiently other infrastructure works during planning stage played significant role for the change. If all stakeholders on the project, no matter how small roll they contribute, were involved or notified in the planning and decision making stage, works that forces another work to change design would have been avoided.

Clients, however, demand three common aspects in the implementation of each project, public or private: cost, time, and quality requirements. Deviations from these goals nearly invariably lead to project delays and increased costs for the project's implementing agency. The goal of this research is to determine what the factors and repercussions of design change are, and how to minimize them. As a result, research to fill these gaps is required.

1.3. RESEARCH QUESTION

This study attempts to answer the following questions;

- ✓ What are the factors and impacts of design changes on building projects in Addis Ababa housing development corporation bole ayat 1 40/60 building project?
- ✓ How frequent is the change of design in building projects in Addis Ababa housing development corporation bole ayat 1 40/60 building project?
- ✓ Which contracting party/parties are more responsible for initiating the majority of these causes and which are most affected?

1.4. OBJECTIVE OF THE RESEARCH

1.4.1 General Objective

The general objective of this study is to analyze the determinants and impacts of a design change on building projects in Addis Ababa.

1.4.2 Specific Objective

Specifically, this research project addresses the following points:

- ✓ To analyze the determinants of design change in building projects in Addis Ababa housing development corporation bole ayat 1 40/60 building project
- ✓ To examine the impacts of design change in building projects in Addis Ababa housing development corporation bole ayat 1 40/60 building project
- ✓ To determine the frequency of design changes and the parties responsible for design changes

1.5 SCOPE OF THE STUDY

The ongoing and planned condominium construction projects in Addis Ababa are much greater than in other cities. Therefore, for this study Addis Ababa condominium construction projects undertaken by the government; in particular 40/60 condominiums of Bole Ayat one project are considered.

Total buildings on Bole Ayat one project

- Site 1- 14 buildings (G+8) 5 contractors
- Site 2- 38 buildings (20 G+8, 18 G+10) 10 contractors
- Site 3- 41 buildings (32 G+8, 9 G+10) 12 contractors
- Meri site- 14 buildings (G+13) 4 contractors

Many variables influence design revisions, including client-related factors, contractor- related factors, consultant-related ones, and so on. As a result, it is critical to identify both the determinants based on their incidence and influence on Addis Abeba development projects, as well as the primary imitators of these causes and the most impacted parties. The research includes client-side professionals involved in construction design and execution, as well as certain additional stakeholders such as consultants and contractors. The research employed various project papers to examine the project's drivers, variables, and impacts on design revisions. Furthermore, questionnaires are utilized to obtain the necessary data.

1.6 SIGNIFICANCE OF THE STUDY

As indicated in the study's issue statement, relatively little research has been undertaken in Ethiopia on the reasons and implications of design change. Because there have been few studies in the field, it gives a complete starting point for future research on design change difficulties. Second, the research findings may help to prevent/minimize frequent design modifications in future building projects.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1. Theoretical Literature Review

A detailed literature analysis focused on identifying the factors of design change and its implications was done to obtain a better understanding of the research goal.

2.1.1. Basics of Building Design and Construction Projects

2.1.1.1. Define Building Design

Structure design, according to (Jonathan T. and Frederick S. 2001), is the process of supplying all information required for the construction of a structure that fits the needs of its owner while also meeting public health, welfare, and safety standards. The process of combining elements to produce a structure is known as building construction (Jonathan T. and Frederick S. 2001).

2.1.1.2. Building Design Stages

In building projects, there are six design and construction stages (Alison, N. 2008). However, for some projects, some of these processes may be merged or added. The stages are as follows:

Conceptual Design

It is the initial step in which the client/employer and the architects meet to discuss the project's needs. For example, how many rooms are required and what the functions of the spaces are assessed, as well as the match between the owner's demands, wishes, and budget (Alison, N.2008).

Schematic Design

The architects offer visual forms to the owner's program at this stage. Because the initial design suggestions submitted by the architects are rarely approved by the owner, it goes through multiple adjustments. The architects provide the owner with the design concept, which includes plans, elevations, sections, freehand sketches, and three-dimensional visuals (Mehta et al., 2009).

Design Development

During this stage, the architect and thus the specialty consultants prepare design development documents to further define the dimensions and character of the project, including architectural, civil, structural, mechanical, electrical, and other project components that can be used as a basis for working drawing development (Jonathan T. and Frederick S. 2001).

Construction Documentation

At this stage, inclusion includes preparing construction papers such as drawings and specifications, as well as paperwork for the bidding process (Jonathan T. and Frederick S, 2001).

Construction Bidding

The final plans and bidding materials organized during the construction documentation stage are used to locate the competent contractor at this stage. When a contractor is found, negotiations begin before the contract is awarded (Scott, J. 2008).

Construction Administration

It is the way through which the Construction Manager/contractor, in general, works alongside the architect who acts as the client/employer's representative to monitor construction to ensure adherence to construction plans, specifications, and standards (Scott, J. 2008). Even though there are five phases before construction begins, changes in design during construction have been seen to alter the overall performance of building projects.

2.1.2. Design Change

2.1.2.1. Define Design Change

A design change, according to (Burati et al., 1992), is any modification in the design or construction of a project after the contract has been granted and signed. Such modifications are connected to contract provisions as well as changes in working circumstances. Similarly, Akinsola et al. (1997) said that these alterations include any additions, omissions, or revisions made to the initial scope of work after a contract has been granted. It is common on construction projects and may result in a change in contract price or contract duration (Ibbs, 2012). A design change is any deviation from the way work is planned, budgeted, or scheduled (Wang, & Yap, 2016).

2.1.2.2. Determinants of Design Change

Quality deviation/failure, non-conformance, and defects/mistakes are all phrases that frequently result in design modification (Burati et al., 1992). A solid grasp of the causative elements is required to acquire deeper insights into the design change dynamics. Many factors impact design modification throughout the construction stage, some of which produce issues with overall building performance. Design changes in construction projects can occur for a variety of reasons and at various phases; however, in this context, the emphasis is on the building stage. The source of the change might be external or internal challenges that arise during the project's development phases, i.e. from basic design to construction (Gharaee M., 2012).

2.1.2.2.1. Internal Factors

Internal variables are caused by persons directly involved in a building project, such as the owners, design consultants, managing consultants, and contractors (Iliyas et al., 2016). The following are internal elements that contribute to a design modification during the building stage:

Client Related Factors

Clients are significantly involved in design revisions, according to a study by (Mohamad et al, 2012). "Modifications to the original design," "addition of new work/scope," and "unclear initial design brief" was mentioned as three major causes for design changes ascribed to clients. Other key factors include a "desire to use better specifications," a "desire to use alternative materials/new technology," and a "omission of works/scopes." Client-related factors include "change of plans or scope by the client," "inadequate/incomplete project objectives by the client," "change in specification by the client," "financial problems faced by the client," "impediment in prompting decision making by the client," "replacement of materials by the client," "change in specification by the client," and "obstinate nature of the client," according to (Hwang, Zhao, and Goh, 2014). As a result, customer values are vital and should be completely grasped early in the project (Thyssen et al., 2010).

Design Related / Consultant's Factors

Mendelsohn (1997) estimates that around 75% of construction issues or reworks arise during the design phase. Due to a lack of communication among design consultants, mistakes and oversights in project documentation may arise. In many projects, the design and delivery teams misinterpret the client's requirements (Koskela et al., 2002; Thomson et al., 2003).

According to (Mohamad et al, 2012), the following factors led to design changes in residential reinforced concrete buildings: inconsistency in drawing information, lack of geotechnical investigation/incorrect interpretation of findings and insufficient detail of existing site condition, improper design/part of design improvement, contract discrepancy. Similarly, (Iliyas et al., 2016) stated the lack of engineering permits for engineers, an absurd timetable for design, a consultant's inability to provide sufficient detailed information in the tender documents, mistakes and inaccuracies by consultants, alterations made by a consultant's request, consultants who are not acquainted with the rules and regulations, and construction permits.

Low consultation costs and a lack of interaction between members of the design team and the owner, The consultant's grasp of accessible materials and equipment is inadequate, The project's budget was understated, Drawings with ambiguous or inadequate information There is a lack of accurate and timely decisions, and there are no thoroughly validated and correct planning papers and Improper contractor supervision is a factor leading to design modifications in construction projects.

Site-Relate Factors

Location circumstances and subterranean conditions are examples of project-specific dynamics (Hsieh, Lu, & Wu, 2004; Mohamad et al., 2012; Sambasivan & Yau, 2007). A project's intrinsic site circumstances will have an impact on its performance (Frimpong et al., 2003).

Contractor's Factors

According to (Mohamad et al, 2012), design changes caused by the contractor are "due to the contractor's demand to use the accessible material," "to address construction mistakes," "to use alternative construction methods to preserve time," "to use alternative construction methods to save more money," and "to improve the standard of work at the site." Furthermore, (Wu et al, 2005) cite construction technique alterations to fit current site conditions, contractor demands for original construction methods to be updated in a new approach, and improper construction or human errors leading to on-site maintenance.

Sun and Meng (2009), on the other hand, identified "poor site/project leadership abilities," "delays in assigning subcontractors," "delay of subcontractors' work," "weak workmanship," "low productivity," and "poor logistic control" as key issues. Contractors have factors such as an unattainable schedule for construction and a construction expenditure that is too low; lack of contractor participation in design; contractor's desired revenues, cost escalation, and financial problem; contractor's requests for modification for easier operations, higher income, and within the allowable limits for the project; Coordination issues among design team members.

2.1.2.2.2. External Factors

External influences, according to (Iliyas et al., 2016), are variables or parties that are not directly engaged in a building project but effect design modifications, such as political and economic problems, the natural environment, technological improvements, and third parties. The following are external elements that cause a design modification during the building stage:

Political and Economic Factors

The regulation enforced by the government has the greatest influence on the project's outcome. External issues mentioned by (Hsieh et al. 2004) include "changes in work rules/regulation by government agencies," "neighborhood communities," and "coordination with utility systems." On the other hand, (Sun and Meng 2009), (Chang et al. 2011), (Wu et al. 2005), and (Chang 2002) identified change orders as a major external element in their studies. (Alaghbari et al. 2007) expanded the elements to include "market materials," "market equipment and tools," "economic conditions," "law and regulation," and "external works due to public agencies (roads, utilities, and public services)." Smallwood and Shakantu (2011) define components in their analysis as "physical environmental conditions," "economic policy," and "socio-political conditions." According to Iliyas et al., (2016), political and economic matters include factors such as changes in policies and regulations; person in charge changes and the impact of inflation and price; material unavailability/shortage; and fluctuating market demand for the planned application.

Environmental Factors

Weather conditions, natural calamities, geological circumstances, and unanticipated ground conditions are all elements in the environment (Iliyas et al., 2016).

Third Parties' Factors

According to (Doloi et al. 2012), a lack of contact with local authorities will have an impact on project performance. Third-party considerations include neighborhood objections, revisions made in response to a request from an end-user/regulator body, and a request from an investor who arrived after construction began (Iliyas et al., 2016).

2.1.3. Impacts of Design Change

Exceeds in project time and cost are key principles for an effective project that are negatively influenced by design modifications (Chan & Kumaraswamy, 1996; Frimpong et al., 2003). Many experts have discovered that modifications in the design of building projects have an impact on building construction. For example, according to the research conducted by (Kikwasi, G.J. 2013) on assessing the roots and consequences of complications and delays in construction projects in Tanzania, design change was one of the most common causes affecting performance and causing disruptions in construction projects in Tanzania. The following are the consequences of a design modification during the building stage:

Delay of the Projects

Design modifications have been identified as a critical concern in studies on the causes of delay and cost overruns (e.g. Assaf & Al-Hejji, 2006; Kaming et al, 1997). (Iliyas et al., 2016) discovered that when the design is changed during construction, the project the conclusion period increases because the designing of the latest modifications in structural, services, and architectural design, along with the authorization for the new drawings and appraisal of the new materials, will require time. (Memon et al. 2014) classified delay reasons into two categories: excusable delays and non-excusable delays. Excusable delays were caused by the client or consultant, and non-excusable delays were caused by the contractor. Excusable delays were identified as a result of design changes in particular.

Change of Cost of the Project

(Burati et al., 1992) discovered that design and construction caused the most variance in construction costs. The variance was 12.4% of the total project cost. They estimated that design modifications accounted for 78% of total variance, 79% of cost deviation, and 9.5% of total construction cost. They also discovered that two-thirds of the variances are the result of a design modification. According to (Iliyas et al., 2016), when design modifications occur during the building stage, the cost of the project is likely to alter. More money will be needed if the design revisions are difficult or expand the project scope. As a result, some of the adjustments necessitate the purchase of new things, which may be more expensive than the original proposals; also, there may be some additional costs as a result of the time extension. According to another research (Cheng, 2014), the most significant drivers for cost overruns are an unclear and poorly specified project scope, repeated changes to the scope, and imprecise drawings/guidelines/regulations. These variables cause design modifications at any stage of a project, resulting in some reworks that influence not just the cost but also the morale of employees. Also, (Ibbs 2005) stressed the significant loss of worker efficiency as a result of design modifications, resulting in cost overruns and delays.

Wastage of Materials

Some design alterations during construction are related with material waste. This occurs when design modifications necessitate the demolition of certain previously created sections of the building structure (Iliyas et al., 2016).

Conflicts between the Parties

Changes in design during construction may also cause disagreements among project participants. This is especially likely if the design is flawed and the constructor has recommended adjustments to improve constructability. If such revisions raise the cost of construction, the client may argue with the consultant for such an incompetent original design that causes the customer to spend extra expenditures and disrupt the budget (Iliyas et al., 2016).

Demolition and Rework

Previous research has also shown that design modifications cause considerable rework in construction (Love et al., 1999; Love, Mandal, Smith, & Georgiou, 2000; Love, Edwards, & Irani, 2008; Sommerville, 2007). In addition, (Burati et al. 1992) discovered that 79% of rework expenses incurred in industrial engineering projects were the consequence of design revisions, mistakes, and omissions. According to (Hwang et al. 2009), about $75 billion in direct expenditures were lost as a result of rework in 2004 alone, inflicting a significant strain on the construction sector in the United States. Another study done in Singapore found that the average cost overrun was 7.1% when data from 381 projects was analyzed. These were largely owner-induced alterations that need rework.

2.2. Empirical Literature Review

(Yap and Skitmore 2018) investigate the many causes of design adjustments in Malaysian building projects. They combed through the literature to identify the 39 factors as project-related (1) client, (2) consultant, (3) contractor, (4) location, and (5) external. The three most important causes cited are insufficient coordination among different expert advisers, variances in the requirements, and frequent changes to scope requirements.

Cost overruns or timetable delays in construction projects are unavoidable (ElRazek, et al, 1995; Kaming et al, 1997; Le-Hoai et al, 2008; Owalabi et al, 2014). Exceeds in the project schedule and cost are fundamental principles for an effective project that are harmed by design modifications (Chan & Kumaraswamy, 1996; Frimpong et al., 2003). Rework has become a common part of the building procurement process, resulting in schedule and cost overruns (Josephson et al., 2002). Previous research has also found that considerable rework in construction is caused by design revisions (Love et al., 1999).

According to a study conducted by (Cox, Morris, Rogerson, and Jared 1999), design changes can frequently have a major effect on client objectives in construction projects, where the cost of post-contract award design adjustments typically equates to approximately five to eight percent of the contract value. According to (Chang et al. 2011), design changes increased redesign costs by 2.1% to 21.5%, with an average of 8.5% of the construction modification cost. In addition, (Burati et al. 1992) discovered that 79% of rework expenses in industrial engineering projects were the consequence of design revisions, mistakes, and omissions.

According to Williams, Eden, Ackermann, and (Tait 1995), design revisions and delays in design approval would have caused a delay in the project. Design modifications are undoubtedly continuing issues that continue to cause worry in the building sector. Furthermore, (Burati et al. 1992) revealed that design changes, errors, and omissions accounted for 79% of rework costs in industrial engineering projects. Design adjustments and delays in approval of the design, according to Williams, Eden, Ackermann, and (Tait 1995), would have caused a project lag. Design changes are undeniably ongoing challenges that continue to generate concern in the construction industry.

2.3. Conceptual Framework

Causes are grouped into two groups in this paper: internal (client-related, design/consultants-related, contractors-related, and site-related aspects) and external (political and economic, other parties and environmental issues). The literature suggests, good communication fosters team cooperation, which promotes project learning and, as a result, enhances expert judgment in decision-making. With this in mind, efficient interaction is included to the conceptual framework as an adjustment factor to help in controlling of design change.

An efficient communication method facilitates informed decision-making capabilities, which tends to strengthen the expert judgment of project team members. Greater information interchange and experience sharing are encouraged within a cohesive team and collaborative working culture enabled by project communication management. As a consequence, avoidable design modifications are reduced, while unavoidable design changes are effectively handled. Furthermore, the consequences can be anticipated at an early stage or at the moment of the design modification request to reduce the project's risk of potential claims and disputes at the conclusion of the project.

Design modifications Induced reworks have a substantial impact on soft aspects such as employee motivation and job productivity. These intangibles are essential to project timelines and costs. Unwanted consequences will eventually lead to excessive claims and conflicts in the project's later stages. This framework gives a comprehensive picture of the link between design modifications and project time and cost performance. According to (Ahiaga-Dagbui et al. 2015), the primary capacity in comprehending time and expense overruns is not the ability to itemize or categorize contributing elements, but rather the ability to comprehend linkages and the dynamics between the various sources. As a result, this approach solves the

methodological shortcoming and is consistent with the paradigm shift promoted by (Ahiaga-Dagbui et al. 2015). The framework is used to explore the problem of design modifications in building construction projects by providing a foundation for the creation of system dynamics or causal loop mapping.

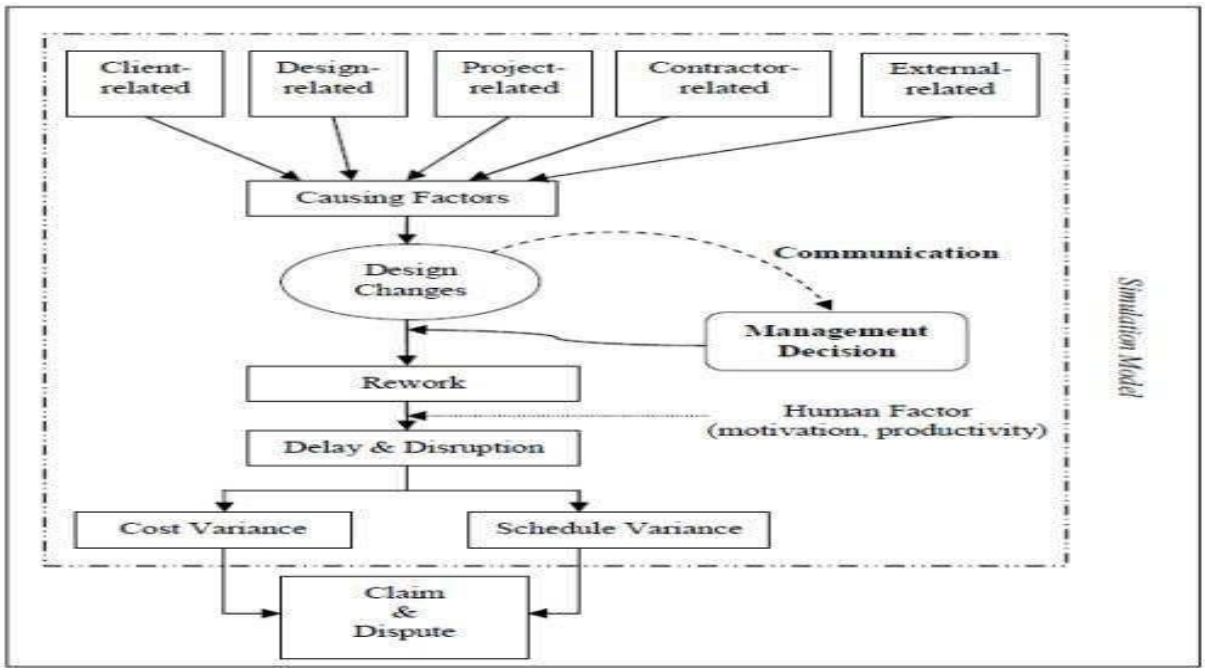

Figure 1 Critical Frame Work

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Research Design

The technique used in this study began with issue identification, which was accomplished by an unstructured literature review, archival research, and informal discussions with specialists in the area, and then the research design was developed. The data and information sources were chosen depending on the research strategy.

The research questions in this study are geared at examining the status and incidence of design change in construction projects at Addis Ababa Housing Development Corporation. So, the research design for this study is casual/explanatory, because the research focuses on real-world initiatives to identify and describe the presence and frequency of design change, factors, and impacts through determining the rate of occurrence and displaying main catalysts and most affected parties as a result of the impact.

Finally, after questionnaire is prepared and delivered to customers, contractors, and consultants to solicit their feedback based on their experience. The data is evaluated in order to extract the information gleaned from the whole study project. This is followed by in-depth talks to reach a conclusion and provide suggestions based on the study's results.

3.1. Research Approach

The suitable research technique would be guided by the research problem as well as the philosophy of research methodology. Creswell and Borrego (2013) defined three research strategies: qualitative, quantitative, and hybrid techniques. Based on the nature of the research questions, this study employed a mixed research strategy, which entails gathering and analyzing both qualitative and quantitative data to gain a greater knowledge of the research topic than either alone.

3.2. Data Types, Source and Method of Data Collection

Since the target population is small, census survey is used and to generate data for addressing the research objectives, Primary data were used. Primary data are acquired firsthand by the researcher for the specific purpose of study, primary data is gathered by delivering open-ended and closed-ended structured questionnaires to a chosen group of clients, contractors, and consultants.

3.2.1. Sources of Data

The research relied on primary data. The Primary is comprised of first-hand data gathered from Bole Ayat One client personnel, consultants, and contractors who participated in the target project via surveys and interviews.

3.2.2. Target Population

The target population of this research for the data collection using the questionnaires consists of client professionals, construction supervision consultants, and construction contractors. Professionals included in this study are those that have direct involvement in the construction process of the project. The client professionals involved in this study include process leaders and construction supervisors. Constructions contractors included in this research are selected based on their performance were professionals including project managers and site Engineers. On the construction supervisor's side, the survey includes coordinators, resident engineers, and site supervisors.

The construction sites selected for this study are 40/60 condominium housing construction sites which are under the branch two bole Ayat one project. Currently, Addis Ababa City Administration Saving Houses Development Corporation has formed an independent office responsible for this specific project. Professionals involved in this project are:-

Table 1 Target population

No of contractor	31
project managers	31
site engineer	31
client supervisor	8
Consultant	3*5= 15
Total	**116**

3.3. Method of Data Analysis

Data analysis and discussion conducted by using Both Qualitative and Quantitative analysis methods. A quantitative approach may apply to identify the determinants and impacts of design changes on building projects. A qualitative approach by interviewing is conducted for

analyzing the major challenges of a design change on bole Ayat One building project.

The descriptive technique is used in the data analysis for this project. The Statistical tool for Social Science (SPSS) tool is used to analyze the data acquired for this study. The questionnaire data was coded and fed into the software to generate the relevant statistics, including the mean. On the basis of frequency of occurrence, the mean score method of analysis was used to rank the causes and implications of design modifications on construction projects in Bole Ayat 1.

3.4.1 Definitions of Variables and Hypotheses

The variables in this study are both dependent and independent factors. The dependent variable is design change, while the independent variables are design change factors. As previously stated, the causes or drivers of design change can be both internal and external. Internal variables arise as a result of client-related, design-related/consultant-related, site- related, and contractor-related issues. External variables can also be caused by political and economic considerations, environmental factors, and third-party causes.

3.4.1.1. Dependent variables

Any change in the design or construction of a project after the contract has been granted and signed is considered a design change. Such changes are related not just to contract provisions, but also to changes in working conditions. In this study, design change is defined as a binary variable content relating to a change in a building project, where Yes denotes the existence of design change and No denotes the lack of design change in the project.

3.4.1.2. Independent variables

Client-related factors: These are factors that may arise due to a lack of technical expertise in order to understand and envision the project, less advice and assistance available to Clients by technical personnel, frequent scope changes by Clients, a lengthy period taken by the Client to make a decision, Clients altering financial and business circumstances that necessitate scope changes, and an incorrect choice of project contract structure (unit price, lump sum, etc.).

Design related/consultant factor: - are factors that might arise as a result of designer’s failure to propose commercially oriented solutions and their lack of trust in pre-planning for design work. Designers have challenges in both capturing customers' demands and communicating conceptual design possibilities to them. Poor collaboration and interaction between the client and the designer, as well as between the designer and the contractor, a lack

of exchange of data among parties, no design verifying or 2nd and 3rd party reviews, no design checking system, unjust client and end user expectations, inefficient use of automation, limited time, and designer unavailability during construction are all factors.

Contractor-related factors:- are factors that can occur as a result of not enough pre-construction investigation and examination of design documents by contractors, taking into account the exotic and complex characteristics of the design, granting contract to the lowest price despite the quality of services, lack of familiarity with new construction technologies, lack of interaction and collaboration between various project teams, information problems, poor project organizational structure.

External related factors:- are variables that may develop as a result of varying site circumstances, bad economic situations, extreme weather conditions, unanticipated changes in material availability, government difficulties, labor shortages, and undiscovered below ground utilities.

3.4.1.3. Hypotheses

A hypothesis is an assumption or concept offered for the purpose of debate and testing. It is a specific, testable description of the researchers' predictions for the study's outcome. For this project work our hypothesis is: - "Design changes in construction projects are influenced by various factors, including client-related factors, contractor-related factors, site-related factors, managing consultant-related factors, design-related factors, and political factors. It is hypothesized that the combination of these independent variables will have a significant impact on the frequency and nature of design changes in construction projects."

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Introduction

The acquired data has been analyzed and evaluated in this chapter. The chapter includes an introduction, demographic profiles of respondents, and an assessment of variables influencing design modifications in Addis Abeba building projects: An example of a Bole Ayat project. Issues on the standard of service were rated using a five-point scale ranging from 1: No occurrence, 2: Low occurrence, 3: Medium occurrence, 4: High occurrence, and 5: Certain occurrence. In addition, demographic information on the respondents is gathered.

4.2. Reliability of the questionnaire

Table 2 Reliability results

Sub scales	**Number of items**	**Cronbach's Alpha**
Client related factors	5	0.902
Design related factors	8	0.873
Managing consultant-related	3	0.731
Contractor – related	4	0.818
Site – related	1	0.815
Political and economic factors	5	0.767
Environmental factors	3	0.931
Third parties' factors	3	0.836
Impacts of design change	5	0.723
Entire scale	**37**	**0.852**

Cronbach's coefficient alpha was determined for each field of the questionnaire as well as the complete questionnaire, as shown in the table above. Cronbach's Alpha scores ranged from 0.7 to 0.99, indicating that all of the results were more than acceptable. The resultant range is regarded high since it assures the dependability of every component of the questionnaire. Furthermore, Cronbach's Alpha for the full questionnaire is 0.852, which is outstanding and demonstrates the overall dependability of the questionnaire. As a consequence of the test, the findings for the items are dependable and acceptable.

4.3. Demographic Characteristics of Respondents

A research was created to examine the variables influencing design modifications in building projects in Addis Abeba, and a questionnaire survey was distributed to the organization's personnel. The research summarized the respondents' profiles in terms of age, gender, academic achievement, and experience in this part. The following frequencies and percentage distributions were used to analyze these replies.

Table 3 Demographic Characteristics

Characteristics		Frequency	Percentages
Sex	Male	75	80.6%
	Female	18	19.4%
Age	20 – 30	35	37.6%
	31 - 40	48	51.6%
	41 – 50	7	7.5%
	above 50	3	3.2%
Educational background	Certificate and below	3	3.2%
	Diploma	1	1.1%
	First Degree	74	79.6%
	Second Degree and above	15	16.1%
Experience in the industry	less than 5 years	2	2.2%
	5 - 10 years	68	73.1%
	11 - 15 years	18	19.4%
	above 15 years	5	5.4%
Total		**93**	**100%**

Regarding the sex of respondents the majority of them 80.6% were male while the remaining 19.4% were female respondents. This reflects the dominance of male employees in construction projects in Addis Ababa in terms of consultant, client contractor and other stakeholders.

With respect to age composition of respondents, more than half 51.6% were in the age range between 31 to 41 years. While remaining 37.6% of respondents were in the age of 20 to 30 years. Lastly, it's a remaining 7.5% and 3.2% of the respondents were in the age range of 41 to 50 and above 50 years of age. This result indicates that the majority nearly 90% of this research respondents where the under the age of 40 years. This relatively reflects age

composition of the construction industry in Addis Ababa. Regarding the educational background of respondents, the great majority of them 79.6% were degree holders followed by 16.1% Master‟s degree holders. On the other hand, certificate and below as well as diploma holders make up 1.1% of the total responses each. This result reflects the presence of highly educated employee respondents from the construction industry and validates responses obtained from such sources will be reliable while measuring factors affecting design changes in construction projects in Addis Ababa.

Lastly with respect to experiences of respondents, the majority 73.1% of them had 5 to 10 years of work experience. 19.4% of the respondents had 11 to 15 years of experience in the construction industry followed by 5.4% of respondents who had above 15 years of experiences. Only 2.2% of the respondents had less than 5 years of experience. This result indicates more than 90% of the respondents off this research had more than 5 years of experience in the construction industry in general which will greatly help the respondents to understand the industry as well as factors affecting design changes in construction projects in Addis Ababa.

4.4. Descriptive Analysis

In this section, descriptive data in the form of mean and standard deviation were offered to demonstrate the respondents' level of agreement with the company's conclusions. The respondents' replies on the characteristics listed below were graded on a five-point scale: 1: No occurrence, 2: Low occurrence, 3: Medium occurrence, 4: High occurrence, 5: Certain occurrence. However, to make the interpretation of the mean results easier and clearer, the scales were reallocated as follows.

With 5 point scales, the interval for breaking the range in measuring each variable is computed as 51/5= 0.8 (Vichea, 2005). It indicates that items with scores ranging from 4.20 to 5.00 are regarded certain occurrences; 3.40 to 4.09 are considered high occurrences; 2.60 to 3.39 are considered medium occurrences; 1.08 to 2.59 are considered low occurrences; and 1.00 to 1.79 are considered no occurrences.

The SPSS software was used to analyze questionnaire data in terms of frequency, mean, and standard deviation (Descriptive statistics).

4.4.1. Client related factors

This study has previously shown that design adjustments are frequently requested by clients. The inclusion of extra work or scope, an unclear initial design brief, and customer adjustments to the original design were mentioned as the three main sources of design alterations. The desire to employ higher specifications, the desire to use alternative materials or new technologies, and the omission of works or scopes are some additional important causes.

Accordingly, the following section presents design changes in construction projects in Addis Ababa that emanates from clients. The results are presented in a descriptive statistics using mean and standard deviations.

Table 4 summary of client related factors

Factors	N	Minimum	Maximum	Mean	Std. Deviation
Changes requested by the owner	93	1.00	5.00	3.4409	1.54260
Owner's change of schedule due to financial Problem	93	1.00	5.00	3.6452	1.39600
Owner fails to review document at the right Time	93	1.00	5.00	3.5161	1.44923
Incorrect/unclear information given at initial stage of design	93	1.00	5.00	3.8172	1.24190
Obstinate nature of client (not considering others constructive idea)	93	1.00	5.00	3.9892	1.20230

Based on the results shown on the above table, all the factors related with clients fall in the mean range of 3.40 – 4.09 which can be viewed as high occurrence for each items. According to this, the owner's requests for changes, the owner's change in schedule due to financial difficulties, the owner's failure to review documents at the appropriate time, the owner's provision of incorrect or unclear information at the initial stage of design, and the client's obstinate nature (not taking into account other constructive ideas) are the main client-related factors that lead to design changes in construction projects in Addis Abeba, particularly in the case of the Bole Ayat one project.

Consistent with these research findings, (Mohamad et al, 2012) discovered that design revisions are largely initiated by clients. The clients were blamed for three key reasons of design changes: "modifications to the original design," "addition to the existing work/scope," and "unclear initial design brief." Other key factors are "want to use better specifications," "want to use different materials/new technology," and "omission of works/scopes."

Furthermore, Hwang, Zhao, and Goh (2014) argued that client-related factors include "change of strategies or scope by the client", "inadequate/incomprehensive goals for the project by the client", "change in requirements by the client", "financial issues faced by the client", "impediment in causing the decision making by the client", "replacement of resources by the client", "change in specification by the client", and "obstinate nature of the client". Client objectives are so vital and should be well known from the beginning of the project (Thyssen et al., 2010).

4.4.2. Design Related Factors

Consultation costs and a lack of communication between the owner and the design team Disputes involving contract documents The consultant's inadequate knowledge of accessible tools and materials Cost of the project was understated, drawings with a lack of detail and clarity There is a lack of accurate and timely judgements, the production of structural detail does not match that of architectural detail, and there are no properly validated and accurate planning documents. Inadequate oversight of the contractor's work as a contributing cause to design modifications in construction projects were the factors that originate from design related factors.

As a result, the design modifications made by design related factors in Addis Ababa construction projects are presented in the following section. With the help of the mean and standard deviations, the data are presented in descriptive statistics.

Table 5 Design Related Factors

Factors	N	Minimum	Maximum	Mean	Std. Deviation
The unrealistic period to design	93	1.00	5.00	3.9892	1.28955
Inadequate information in the tender documents; errors and omission.	93	1.00	5.00	3.6022	1.45318
Conflicts between contract document (drawing Vs. specification)	93	1.00	5.00	3.8172	1.20638
Poor design quality, design error	93	1.00	5.00	3.6559	1.29795
Poor communication among design Team & with client	93	1.00	5.00	4.0215	1.10314
Lack of knowledge	93	1.00	5.00	3.7849	1.38194
Lack available resources	93	1.00	5.00	3.5269	1.63914
Lack of geotechnical investigation	93	1.00	5.00	3.8280	1.61261

As depicted in the above table, all the factors related with design fall in the mean range of 3.40 – 4.09 which can be considered as high occurrence for each items. These factors include an unattainable time frame for design, insufficient details in the bid documents, errors and omissions, disputes between contract documents (drawing vs. specification), low design quality, design error, insufficient interaction among design team members and with the client, a lack of expertise, a lack of readily accessible assets, and a lack of geotechnical investigation.

This conclusion is consistent with Mendelsohn's (1997) estimate that over 75% of construction project difficulties or reworks were caused during the design phase. A lack of interaction among design consultants might result in errors and omissions in project documentation. The project's planning and execution teams frequently misread the client's requirements (Koskela et al., 2002).

Furthermore, Mohamad et al, (2012) stated the following variables caused design changes in residential reinforced concrete buildings: incompatible information in drawings, lack of geotechnical investigation/wrong assessment of results and inadequate explanation regarding current site condition, incorrect design/part of design improvement, contract variation.

4.4.3. Managing Consultant-Related

The next section presents the design changes made by Managing Consultant-Related components of Addis Ababa construction projects. The data are given in descriptive statistics using the mean and standard deviations.

Table 6 Summary of Managing Consultant-Related

Factors	N	Minimum	Maximum	Mean	Std. Deviation
Communication of responsible parties	93	1.00	5.00	3.9892	1.28955
The changes requested by the consultant	93	1.00	5.00	3.1290	1.53386
Lack of precise and rapid decisions	93	1.00	5.00	3.1613	1.65694

As can be seen in the above table, the first item related with managing consultant has a mean value between 3.40 and 4.09, which is regarded to be a high occurrence and the remaining two items fall in the range of mean 2.6 – 3.40 which denotes medium occurrence of factors. This finding reveals that communication between responsible parties, revisions requested by the consultant, and a lack of specific and timely choices were the primary causes for design changes in Addis Abeba building projects, notably the Bole Ayat one project.

4.4.4. Contractor and Site Related

According to the research discussed in earlier chapters, the contractor may request design changes in order to use the material already on hand, correct construction errors, use alternative construction methods to save time and money, and raise the caliber of the work being done on the project site. Additionally, the contractor may request that the original construction methods be altered to a new approach and that improper construction or human mistake result in the need for on-site repair work..

The design modifications made by contractor and site related elements of Addis Ababa construction projects are shown in the next section. Utilizing the mean and standard deviations, the data are presented in descriptive statistics.

Table 7 Summary of Contractor and Site Related

Factors	N	Minimum	Maximum	Mean	Std. Deviation
The unrealistic construction's schedule	93	1.00	5.00	3.8280	1.33208
The changes initiated by contractors to improve quality & constructability	93	1.00	5.00	3.7312	1.52615
Rectify construction mistakes	93	1.00	5.00	3.8172	1.35892
Poor site/project management skill	93	1.00	5.00	3.5484	1.43342
Unforeseen underground condition	93	1.00	5.00	3.5376	1.44131

All of the contractor and site related characteristics, as shown in the above table, fall within the mean range of 3.40 to 4.09, which is regarded as a high occurrence for each item. These elements include; unrealistic construction's schedule, the changes initiated by contractors to improve quality & constructability, rectify construction mistakes, poor site/project management skill and unforeseen underground condition.

Proof of these discoveries Sun & Meng (2009) cited weak site/project management abilities, delays in selecting subcontractors, delays in subcontractors' work, poor craftsmanship, low efficiency, and inadequate logistic control as major issues. According to a study conducted by Iliyas et al., (2016), contractors face challenges such as an unattainable construction timeline and an inadequate building budget. Contractor's lack of design involvement; Contractor's targeted income, cost escalation, and financial concerns Change requests from contractors for simpler management and greater profitability within the project's authorized parameters; Collaboration issues among design team members.

4.4.5. Political and Economic Factors

It was stated in the preceding section that government regulation has the biggest influence on project outcomes. External effects highlighted included changes in work regulations/rules issued by government bodies, neighborhood groups, and collaboration with utility systems.

The following section depicts the design adjustments made to the Addis Ababa building projects due to political and economic considerations. The mean and standard deviations are used in descriptive statistics to present data.

Table 8 Summary of Political and Economic Factors

Factors	N	Minimum	Maximum	Mean	Std. Deviation
The changes in policies and regulations	93	1.00	5.00	3.7634	1.30549
Inflation and price fluctuation	93	1.00	5.00	3.6022	1.54737
Unavailability/shortage of materials	93	1.00	5.00	3.7634	1.38625
Change of market demand	93	1.00	5.00	3.4839	1.44923
Political instability	93	1.00	5.00	3.4516	1.48555

All of political and economic concerns, as shown in the above table, fall within the mean range of 3.40 to 4.09, which is regarded as a high occurrence for each item. These elements include; the changes in policies and regulations, inflation and price fluctuation, unavailability/shortage of materials, change of market demand and political instability.

Similarly, the outcome of the project is mainly influenced by government regulations. Changes in work rules/regulation by government organizations, neighborhood groups, and coordination with public utilities have been defined as external variables by Hsieh et al. (2004).

In contrast, (Sun and Meng 2009), (Chang et al. 2011), (Wu et al. 2005), and (Chang 2002) identified change orders as a major external element in their studies. (Alaghbari et al. 2007) expanded the criteria to include marketplace materials, market tools and supplies, market economic circumstances, law and regulation, and external works owing to government departments (roads, infrastructure, and municipal services).

Smallwood and Shakantu (2011) define natural environmental variables, economic policies, and sociopolitical settings as elements in their analysis. According to Iliyas et al., (2016), political and economic issues include factors such as shifts in policies and regulations;

managerial changes and the effect of price increases and price; unavailability/shortage of materials; and fluctuation in consumer demand for the intended application of buildings.

4.4.6. Environmental factors

Weather patterns, natural calamities, geological circumstances, and unforeseen ground conditions are some of the environmental influences.

The design modifications made to the Addis Ababa construction projects as a result of Environmental factors are shown in the following section. The mean and standard deviations are used in descriptive statistics to present the data.

Table 9 Summary of Environmental factors

Factors	N	Minimum	Maximum	Mean	Std. Deviation
Changes of weather conditions	93	1.00	5.00	3.4409	1.54260
Natural disasters such as flooding and earthquakes occurring, etc.	93	1.00	5.00	3.6452	1.39600
Insufficient information on geological conditions	93	1.00	5.00	3.5161	1.44923

According to the aforementioned table, every environmental factors falls between the mean range of 3.40 and 4.09, which is regarded as a high occurrence for each item. These items consist of; Weather changes, natural disasters such as quakes and floods, and a lack of data on geological history are all factors to consider.

4.4.7. Third Parties' Factors

In the previous sections, it has been stated that poor communication with local authorities will compromise the success of the project. Factors affecting third parties include neighborhood objections, modifications made in response to requests from end-users or regulatory bodies, and requests from investors who arrived before construction began..

The design modifications made to the Addis Ababa construction projects as a result of

Third Parties' Factors considerations are shown in the following section. The mean and standard deviations are used in descriptive statistics to present the data.

Table 10 Summary of third parties factors

Factors	N	Minimum	Maximum	Mean	Std. Deviation
The request made by end user	93	1.00	5.00	3.8172	1.24190
The request from regulatory bodies	93	1.00	5.00	3.9892	1.20230
The request from investor who came while construction has started	93	1.00	5.00	3.6667	1.36997

Every third party‟s factors, as shown in the aforementioned table, have a mean value between 3.40 and 4.09, which is considered to be a high occurrence for each item. These products include; the request made by end user, the request from regulatory bodies as well as the request from investor who came while construction has started cause design changes Addis Ababa construction projects.

4.5. Correlation Results

A correlation analysis, according to Saunders et al. (2009), is used to determine the pattern and link between variables. The correlation coefficient measures the degree of strength of a linear link between the two variables.

In light of this, the following correlation analysis was performed for the independent and the dependent variable:

Table 11 Correlation Matrix of variables

		Design Changes
Design Changes	Pearson Correlation	1
	Sig. (2-tailed)	
	N	93
Client related factors	Pearson Correlation	.355**
	Sig. (2-tailed)	.000
	N	93
Design related factors	Pearson Correlation	.596**
	Sig. (2-tailed)	.000

	N	93
Managing consultant-related	Pearson Correlation	.737**
	Sig. (2-tailed)	.000
	N	93
Contractor – related	Pearson Correlation	.360**
	Sig. (2-tailed)	.000
	N	93
Site – related	Pearson Correlation	.606**
	Sig. (2-tailed)	.000
	N	93
Political and economic factors	Pearson Correlation	.143
	Sig. (2-tailed)	.172
	N	93
Environmental factors	Pearson Correlation	.229*
	Sig. (2-tailed)	.027
	N	93
Third parties' factors	Pearson Correlation	.152
	Sig. (2-tailed)	.146
	N	93

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

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation coefficient might have a value ranging from 1 to +1. The coefficient's overall significance increases with the strength of the relationship between the variables. An absolute value of 1 for the Pearson correlation shows an ideal linear connection. A correlation around zero shows that there is no linear relationship between the variables. The direction of the link is indicated by the sign of the coefficient. If both parameters tend to rise or fall together, the coefficient is positive, and the correlation line slopes upward. If one variable increases while the other falls, the coefficient is negative, and the correlation line dips downward.

According to the correlational results of this study, which are provided in the table above, there is a positive and substantial correlation between the independent factors and the dependent variable (Design Change). More specifically, Client related factors (r =.355), design related factors (r =.596), managing consultant-related (r =.737) contractor related(r =.360), site – related (r = .606), political and economic factors (r = .143), environmental factors(r = .229), and third parties' factors (r = .152).

Therefore, design changes in construction projects in Addis Ababa is related with client

related factors , design related factors , managing consultant-related contractor related, site – related , political and economic factors, environmental factors, and third parties' factors.

4.6. Multiple Regression Result

The regression analysis below is used to estimate the associations between variables. It allows for the determination of the strength of the link between variables as well as the predictive capacity of the independent factors on the dependent variable. In summary, regression enables a researcher to determine how much an alteration in the value of the dependent variable causes a change in the value of the independent variables while other independent variables remain constant. Regression analysis is a statistical method for determining whether factors have an effect. While there are many different forms of regression analysis, they always focus on the impact of one or more independent variables on a dependent variable.

Before proceeding with the regression analysis, the fundamental assumption checks for the mode must be completed. This is a necessary prerequisite for describing the links between dependent and explanatory variables. Four fundamental assumptions were evaluated and found to be satisfactorily met: Linearity Test, Homoscedasticity Test, Auto Correlation (Durbin Watson Test), and Normality Test. Each test is described below:

The regression analysis below is used to estimate the associations between variables. It allows for the determination of the strength of the link between variables as well as the predictive capacity of the independent factors on the dependent variable. In summary, regression enables a researcher to determine how much an alteration in the value of the dependent variable affects a change in the value of the independent variables while other independent variables remain constant.

1. Linearity Test

The P-P plot for the model may be used to examine the linearity of connections between dependent and independent variables. The nearer the dots are to the diagonal line, the closer the remaining values are to normal. Visual examinations of the p-p plot indicated a linear connection between the dependent and independent variables, as seen in the graph below.

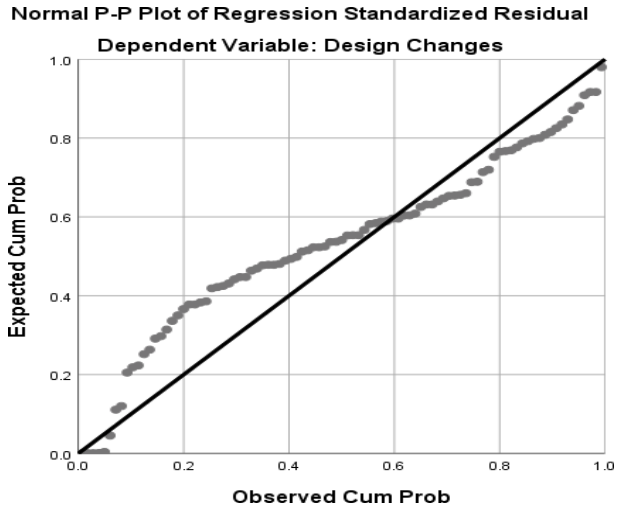

Figure 2 P-P Plot of Regression Standardized Residual

2. Homoscedasticity Test

The premise of homoscedasticity refers to the idea that mistakes have the same variance across all levels of the independent variables (Osborne & Waters, 2002). This implies that the residual terms must be distributed evenly or the error terms must be homogeneous throughout the data. Visual evaluation of a plot of the standardized residuals by the regression standardized predicted value can be used to assess for homoscedasticity (Osborne & Waters, 2002). The issue is not damaging to analysis if the erroneous words are scattered randomly with no discernible pattern. Figure 4.2 indicates that the standardized residuals in this study are distributed uniformly, indicating that there is no violation of homoscedasticity.

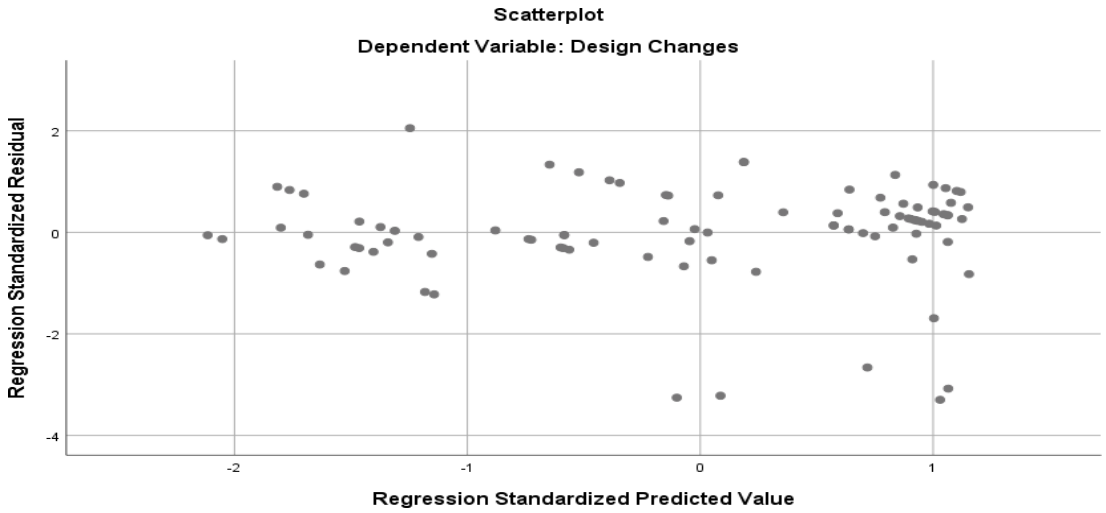

Figure 3 Scatterplot of standardized residuals

3. Auto Correlation (Durbin Watson Test)

The notion that mistakes are independent of one another, meaning that subjects are responding separately, is referred to as autocorrelation. Stevens, B. (2009). To test the assumption that our residuals are independent (or uncorrelated), we may utilise the Durbin-Watson statistic. This statistic can range between 0 and 4. The Durbin-Watson value must be close to 2 in order for this assumption to be satisfied (Field, 2006). Values less than one and greater than three are troublesome and provide cause for worry. To validate this assumption, examine the Model Summary box shown below.

Table 12 Durbin Watson statistics

Model	Std. Error of the Estimate	Durbin-Watson
1	.63521	1.916
a. Predictors: (Constant), Third parties' factors, Site - related, Political and economic factors, Client related factors , Managing consultant-related, Contractor - related, Design related factors , Environmental factors		
b. Dependent Variable: Design Changes		

With a Durbin-Watson score of 1.916, the above shows that mistakes respond independently and that autocorrelation is not a worry. As a result, the auto-correlation test can be said to have been passed.

4. Normality Test

Multiple regressions need regularly dispersed independent variables. This indicates that mistakes are regularly distributed, and a plot of the residual values resembles a normal curve (Keith, 2006).

Frequency distribution may take numerous forms and sizes. As a result, it is critical to provide a general definition for frequent sorts of distributions. In a perfect world, our data would be symmetrically distributed about the centre of all scores. As a result, if we draw a vertical line across the distribution's centre, it should look the same on both sides. This is referred to as a normal distribution, and it is distinguished by a bell-shaped curve. This shape shows that the bulk of scores are clustered towards the centre of the distribution (Field, 2006). The normal distribution graph in fig 4.3 below demonstrated that the assumption of normality was met.

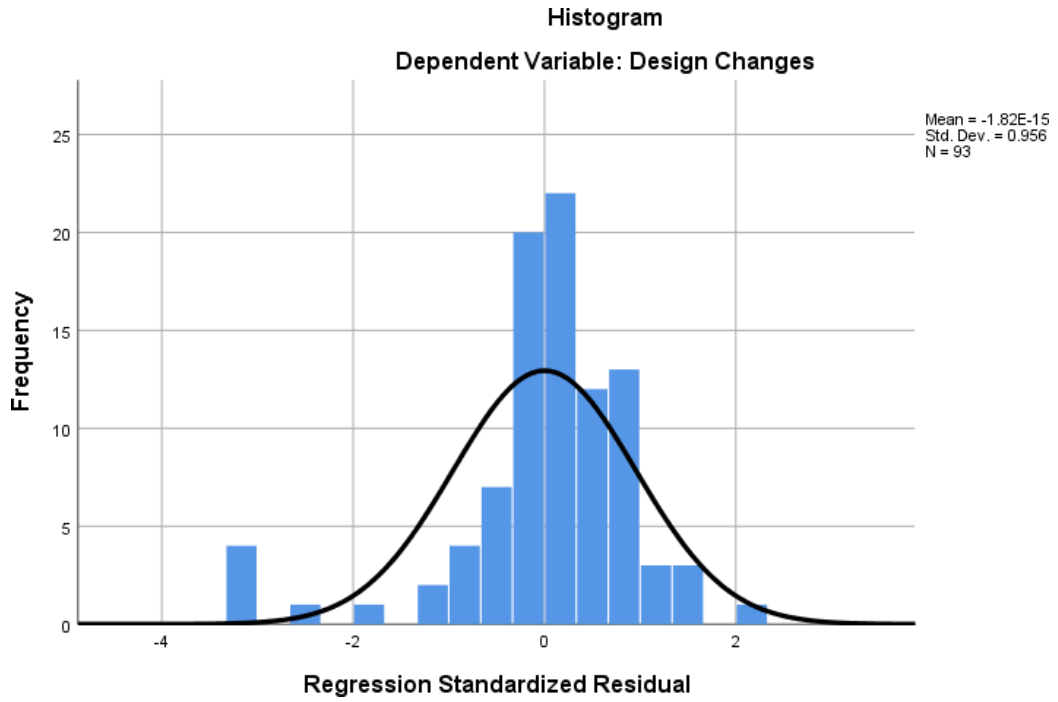

Figure 4 Normality Histogram

5. Multi-collinearly Test

Multi-collinearity arises when an independent variable in a multiple regression equation is substantially correlated with any one of the other independent variables. It's an issue since it diminishes an independent variable's statistical significance. The results of the multi-collinearity test of the dependent variables for this study are shown in the table below.

Table 13 Multi-collinearly test of the Independent Variable

Model		Collinearity Statistics	
		Tolerance	VIF
1	Client related factors	.190	5.266
	Design related factors	.369	5.910
	Managing consultant-related	.252	3.966
	Contractor - related	.386	5.382
	Site - related	.399	8.091
	Political and economic factors	.675	1.482
	Environmental factors	.306	9.414
	Third parties' factors	.201	9.876
a. Dependent Variable: Design Changes			

The variation inflation factor (VIF) is a measure of the opposite of the complementary nature of the inter-correlation between the independent variables. The decision rule is a variable whose VIF value more than 10 signals the possibility of a multi collinearity problem. Tolerance (TOL) is a measure that shows the variability of the stated independent variable that isn't clarified by another independent variable in the model. Many scholars use it to test the degree of collinearity. A variable with a TOL value less than 0.1 indicates the possibility of a multi-collinearity problem (Gujarati, 2004).

Based on the information in the preceding table, all VIF variables are fewer than 10 and all tolerance (T) is larger than 0.1, indicating that this study does not have a multi-collinearity problem

Table 14 The regression model statistics

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	782[a]	.611	.574	.63521

a. Predictors: (Constant), Third parties' factors, Site - related, Political and economic factors, Client related factors, Managing consultant-related, Contractor - related, Design related factors , Environmental factors

b. Dependent Variable: Design Changes

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.230	8	6.654	16.491	000[b]
	Residual	33.893	84	.403		
	Total	87.124	92			

a. Dependent Variable: Design Changes

b. Predictors: (Constant), Third parties' factors, Site - related, Political and economic factors, Client related factors, Managing consultant-related, Contractor - related, Design related factors , Environmental factors

The above model also demonstrated that the model proved useful in predicting design changes, which is interpreted as 61.1% of variance in design changes being due to independent variables (third-party factors, site-related, political and economic factors, client-related factors, managing consultant-related, contractor-related, design-related factors, environmental factors) (p value 0.05). Whereas the rest of the variability was unaccounted for in the present model, it may be explained by including other factors not included in this model. As a result, the p-value test table indicates that the model is functioning properly.

Table 15 Coefficients

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.167	.888		.188	.851
	Client related factors	.365	.180	.317	2.029	.046
	Design related factors	.326	.121	.446	2.697	.008
	Managing consultant-related	.813	.124	.890	6.564	.000
	Contractor - related	.227	.165	.217	1.375	.173
	Site - related	.354	.161	.475	2.195	.031
	Political and economic factors	.221	.189	.097	1.170	.245
	Environmental factors	154	.248	.129	.618	.538
	Third parties' factors	.222	.265	.179	.836	.405
a. Dependent Variable: Design Changes						

As depicted on the results on the above coefficient table, Contractor – related, Environmental factors, Third parties' factors, and Political and economic factors did not have a significant effect on design changes in construction projects in Addis Ababa (Sig > 0.05).

However, Client related factors, Design related factors, Managing consultant-related and Site – related were found significant in causing design changes than the other factors in construction projects in Addis Ababa (Sig < 0.05).

The results supports the hypothesis for Client related factors, Design related factors, Managing consultant-related and Site – related were found significant in causing design change whereas Environmental factors, Third parties' factors, and Political and economic factors did not have a significant effect on design changes the construction project.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The objective of this study is assessment of factors affecting design changes in construction projects in Addis Ababa. On the bases of the analysis given in the previous chapter, the following conclusion is drawn.

Based on the results the main client related factors are the owner's requests for changes, the owner's change in schedule due to financial difficulties, the owner's failure to review documents at the appropriate time, the owner's provision of incorrect or unclear information at the initial stage of design, and the client's obstinate nature (not taking into account other constructive ideas) are the main client-related factors that lead to design changes in construction projects in Addis Ababa, particularly in the case of the Bole Ayat project.

The absurd time frame for design, insufficient details in the tender documents; errors and omissions, conflicts between contract documents (drawing vs. specification), poor craftsmanship quality, design mistakes, poor interaction among design team members and with the client, lack of expertise, insufficient available resources, and a lack of geotechnical inquiry.

The main causes of design revisions in Addis Ababa building projects, particularly in the case of the Bole Ayat one project, were lack of specific and prompt decisions, poor cooperation between responsible parties, and changes sought by the consultant. Unrealistic construction schedules, adjustments made by contractors to increase quality and constructability, correct construction errors, inadequate site/project management abilities, and unexpected subsurface conditions are all factors that contribute to poor construction.

Changes in laws and regulations, price increases and price fluctuations, unavailability/shortage of supplies, changes in consumer demand and political instability, changes in the environment, the presence of natural disasters such as flood, earthquake, etc., and lack of data on geological conditions all lead to design changes in Addis Abeba construction projects, particularly the Bole Ayat project.

The request made by end user, the request from regulatory bodies as well as the request from investor who came while construction has started cause design changes Addis Ababa

construction projects. According to the impact assessment presented in the above table, the major impact of construction design changes are escalation of construction costs, demotion and reworks, and breakout of conflict between various stakeholders of the construction industry in Addis Ababa.

Based on the correlational results, design changes in construction projects in Addis Ababa is related with client related factors , design related factors , managing consultant-related contractor related, site related , political and economic factors, environmental factors, and third parties' factors

The regression analysis revealed that the model proved effective for forecasting design changes, which means that the independent variables account for 61.1% of the variation in design changes. The remaining variability, on the other hand, remains unexplained in the current framework and can be addressed by including other factors that aren't included in this model. As a result, the p-value test table indicates that the model is functioning properly.

Environmental factors, Third parties' factors, and Political and economic factors did not have a significant effect on design changes in construction projects in Addis Ababa (Sig > 0.05). However, Client related factors, Design related factors, Managing consultant- related and Site – related were found significant in causing design changes than the other factors in construction projects in Addis Ababa (Sig < 0.05)

5.2. Recommendations

Based on the findings, the following recommendations are made

- Clients are highly recommended to request a clear and thorough design brief at an early stage. This would assist the customer in understanding the design idea and solving the problem of demanding changes during the building stage, which would result in project delays, cost overruns, and rework.
- Consultants should conduct and schedule reasonable project durations utilizing thorough work breakdown structures and current tools such as MS Project and Primavera, which will assist in creating a detailed and structured timetable for the project to minimize excessive time and cost deviations.
- Since project characteristic factors affect project design changes, It is advised that the consultant and the client adequately oversee and follow-up on the actions of the contractors. Although clients desire lower cost and higher quality project inputs, contractors must fulfill at least the specified quality.
- Since the external environment factors affect project design changes, because they cannot change the external environment, project management must adapt the internal environment. Because inflation is causing material prices to rise, contractors and clients are advised to stockpile critical resources. Project managers are supposed to be alert and adaptable. They should scan and monitor the external environment on a regular basis and respond quickly and thoroughly.
- The contractor must increase stakeholder's interaction and cooperation. By establishing regular and established meeting times for the parties to discuss the current design and real work on site. This will prevent repeated design changes, which result in time, cost, and rework overruns.
- It is advised that design consultants participating in building construction projects do thorough research during the design and tender document preparation process to avoid frequent design changes, design faults, and unrealistic contract requirements. This would aid in decreasing time and expense overruns, both of which have an impact on project performance.
- Owners, consultants, and contractors should meet often for discussion and develop electronic medium to bridge the communication gap. Frequent meetings enable them

to monitor, update, and oversee project implementation progress. They may also solve problems, assess present performance, and enhance future work. Both contractors and consultants do not provide training for project staff. Training is necessary in accordance with the project's nature and length.

5.3. Limitation

Limitation encountered during the research while undertaking this study is like, unwillingness of respondent to fill the questionnaire, delay in returning back the questionnaire and not all individuals involved in Ayat One building construction projects could participate in the study through questionnaires and site observations. The study only included respondents who played an active role in the project, such as project engineers, site and office engineers, and construction foreman.

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Questionnaire sample

Dear participant,

I am doing a research entitled “Assessment of factors affecting design changes in construction projects in Addis Ababa: A case of Bole Ayat one project” as part of my master of project management at Addis Ababa University.

Please answer all questions as much as possible. All the information gathered will be kept strictly confidential and will be used only for academic research and analysis without mentioning the names of individuals companies involved, Hence, I honestly request you to complete and return the questionnaire in short period of time.

Thank you for giving your precious time and cooperation in advance.

Natnael Agonafer May, 2023

Part One: General Information Demographic information of the respondents

There are four items in this section. Please put a tick mark (✓) in the box corresponding to the demographic characteristic which best describes you in each case.

1. **Sex**
   - Male ☐
   - Female ☐
2. **Age**
   - 20-30 years ☐
   - 31 – 40 years ☐
   - 41 – 50 years ☐
   - Above 50 years ☐
3. **Educational background**
   - Certificate and below ☐
   - Diploma ☐
   - First Degree ☐
   - Master's Degree and above ☐
4. **Your position**
   - Project manager ☐
   - Site Engineer ☐
   - Resident Engineer ☐
   - Other ☐
5. **Experience**
   - < 5 years ☐
   - 5 – 10 years ☐
   - 11- 15 years ☐
   - Above 15 years ☐

Part Two: General Information about determinants of design change

Instruction:- Please express your opinion on the rank of the factors in affecting performance of your project work. Please put a tick (√) parallel to a number from 1 to 5 using the scale below

(1: No occurrence, 2: Low occurrence, 3: Medium occurrence, 4: High occurrence, 5: Certain occurrence)

Causes of Design Change	Frequency of occurrence				
(Internal Factors)	**1**	2	3	4	5
1. Client – related					
1.1 Changes requested by the owner					
1.2 Owner's change of schedule due to financial Problem					
1.3 Owner fails to review document at the right Time					
1.4 Incorrect/unclear information given at initial stage of Design					
1.5 Obstinate nature of client (not considering others constructive idea)					
2. Design – related					
2.1 The unrealistic period to design					
2.2 Inadequate information in the tender documents; errors and omission.					
2.3 Conflicts between contract document (drawing Vs. specification)					
2.4 Poor design quality, design error					
2.5 Poor communication among design Team & with client					
2.6 Lack of knowledge					
2.7 Lack available resources					
2.8 Lack of geotechnical investigation					
3. Managing consultant-related					
3.1 Communication of responsible parties					
3.2 The changes requested by the consultant					
3.3 Lack of precise and rapid decisions					
4. Contractor – related					
4.1 The unrealistic construction's schedule					
4.2 The changes initiated by contractors to improve quality & constructability					
4.3 Rectify construction mistakes					
4.4 Poor site/project management skill					

5. Site – related					
5.1 Unforeseen underground condition					
(External Factors)					
6. Political and economic factors					
6.1 The changes in policies and regulations					
6.2 Inflation and price fluctuation					
6.3 Unavailability/shortage of materials					
6.4 Change of market demand					
6.5 Political instability					
7. Environmental factors					
7.1 Changes of weather conditions					
7.2 Occurrence of natural disaster such as, flood, earthquake, etc.					
7.3 Insufficient information on geological conditions					
8. Third parties' factors					
8.1 The request made by end user					
8.2 The request from regulatory bodies					
8.3 The request from investor who came while construction has started					

Part Three: Impacts of design change

Instruction:- Below are possible impacts that can be occur due to factors affecting design changes in building projects. Rank on a scale of 1-5 the degree of impact due to design change in building projects.

No.	Degree of Impact
1	No impact
2	Low impact
3	Medium impact
4	High impact
5	Very high impact

Impacts of Design Change	**Degree of impact**				
	1	2	3	4	5
1. Delay of projects					
2. Change of cost of the Project					
3. Wastage of materials					
4. Conflicts between the Parties					
5. Demolition and rework					

Part Four: General Questions

1. What are the factors that causes design change in the building project?

2. What are the impacts of design change in the building project?

3. How frequent is the change of design in building projects in the project?

4. Which contracting party/parties are more responsible in initiating majority of these causes and which are most affected?