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CAUSES OF CHANGE ORDERS AND THEIR IMPACT ON CONSTRUCTION COST: THE CASE OF ADDIS ABABA DESIGN AND CONSTRUCTION WORKS BUREAU.

By

Girum Haile

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Causes of change orders and their impact on construction cost: The Case of Addis Ababa Design and Construction Works Bureau.

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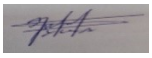
Yilikal Wassie_(Asst. Prof.)		_27/06/2022_____
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DECLARATION

The undersigned, Girum Haile, declares that this thesis is my own work, written under the supervision of Dr. Maru Shete. All sources of information used in the thesis have been properly credited. I further confirm that the thesis has not been submitted to any other higher learning institution, in part or in whole, for the intention of obtaining a degree.

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Endorsement

With my consent as a university advisor, this thesis has been submitted to St. Mary's University's School of Graduate Studies for assessment.

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Abstract

This research has been conducted to make assessments on causes of change orders and their effect on project cost, the case of Addis Ababa Design and Construction works Bureau. The research adopted a casual/ explanatory model on top of a descriptive research provided. Emphasis was given on the identification of the causes of change orders and 21 causes were analyzed. A closed ended questionnaire was designed and distributed to the employees and contractual stakeholders of AADCWB. Respondents were selected using a statistical formula. From the 60 questionnaires were distributed and 55 were returned with a response rate of 91.6%. The result was analyzed in SPSS version 26 using descriptive statistics and regression analysis. As a result, the most common causes of change orders were identified as; Errors and Omissions in design, Change of design, and conflict between contract documents. The study concludes that change order is a significant predictor for the performance of cost. Therefore, if there are a high number of change orders in a project, the cost overrun will be significantly higher. Finally, the theses recommend for adaptations of critical planning and prevent change order from happening by further scrutinizing design documents together with all contractual stakeholders and to involve further market studies to minimize indirect cost effects.

Key Words: Construction Projects, change orders, cost of a project.

List of Acronyms

AADCWB	Addis Ababa Design and Construction Works Bureau
ANOVA	Analysis of Variance
BOQ	Bills of Quantity
CCD	Construction Change Directive
CII	Construction Industry Institute
COMS	Change Order Management System
DB	Design Build
DBB	Design Bid Build
FIDIC	Federation Internationale Des Ingenieurs-Conseils
PCO	Potential Change Order
PMBOK	Project Management Book of Knowledge
RFI	Request for Information
RFP	Request for Proposal
RII	Relative Importance Index
SPSS	Statistical Package for Social Science

Chapter One

Introduction

1.1. Background

Addis Ababa's residents enjoy greater living conditions than those in other cities in the country, which has resulted in a slew of industrial and construction jobs. As a result of the rapid rise of the population, the growth of sub-cities has accelerated. Contractors and construction businesses have been attracted to large and costly projects. Following these situations, the city administration has organized a Bureau that oversees its construction projects under proclamation 74/2014e.c. called the Addis Ababa Design and construction works Bureau. The Bureau is a large construction office that controls 11 sub-cities and builds governmental projects including Hospitals, business complexes, schools, police stations, renovation projects, green area projects, youth centers, manufacturing sheds, and so on. It is responsible for designing and supervising government buildings based on the request from the various city authorities depending on their budget. And although these projects vary in scope and purpose, they all have similar limitations being over budget as a result of change orders initiated by contractual bodies mainly the consultant according to the Quarterly report of Addis Ababa design and construction works bureau (2021).

In the construction process, the final project deliverable is at a fixed location and all the necessary resources need to be moved to the designated construction site to be assembled by construction workers. Several resources, equipment, and labor will be used to deliver these projects. The overall process consists of numerous variables to control which can cause variations. This in return requires strong management throughout the construction process (Soares, 2012).

Change orders have long been a common occurrence in the construction industry. It is unusual to complete a construction project without making any changes. Change typically occurs as a result of various causes attributed to the various parties involved in project execution. According to Khalifa and Mahamid (2019), A change order is a set of written instructions to the contractor, approved by the owner, which is issued after the contract has started to be executed, approving a change in the job or an adjustment in the contract price or contract time.

According to Al-Dubaisi, (2000) Change orders have been identified as one of the primary causes of cost overruns in building projects. In any building project, these changes are unavoidable. Khalifa and Mahamid, (2019) research in also agree with Al-Dubaisi's (2000) theory by adding that Changes to one project will also have an impact on other unrelated projects by tying up more resources that are already dedicated to other projects. Not only is workflow impacted, but attempting to get a fast response to says, design documents, and the many other things that are needed to get up and running quickly puts a strain on working relationships. It is critical to comprehend the impact of change orders on project delivery, but it is also critical to understand the reasons for change orders.

According to the study by Du, (2012), Change orders have a negative and severe impact on the completion of construction projects. Using Discrete event simulation and sensitivity analysis, it has been discovered that optimizing the administrative procedure of change orders benefits all project participants by lowering costs and risks while also encouraging a more trusting relationship.

Ibbs (1997) stated that construction cost is greatly affected by the changes that are made in the project. Desai, Pitroda, and Bhavsar (2015), Jadhav and Bhirud (2015), Love et al. (2002), Staiti, Othman, and Jaaron (2016) agreed that these changes occur due to the complex nature of the construction process and are very common in all types of construction projects.

This Thesis assesses the most common change orders in construction projects undertaken by the Addis Ababa design and Construction works bureau, as well as their causes and the impact they have on the project cost.

1.2. Statement of the Problem

It is almost certain that no matter how carefully a project is planned; there will be major or minor change orders before the project is completed. Endris Yadeta (2016) has stated that Change Orders affect project execution and one of the effects is cost overrun.

Most construction projects will see contract modifications that increase the contract value by 5 to 10%. Serag and Oloufa (n.d). The Addis Ababa design and construction works Bureau has issued change orders for a number of its projects because of changes in scope or plan, changes in schedule, financial difficulties of the client, changes in designs design complexity, Inadequate

design, unavailability of equipment, differing site conditions and defective workmanship after the commencement of the contract. According to the internal report of the organization, the cost overrun due to a change order has an average of 10% increase from the initial contract amount.

According to Bassa, (2019), that studied the cause and effect of change orders caused by design changes stated that next to time, cost of a project is the most affected variable when executing a Design change. Errors and omissions in designs are also causes for change orders. According to Simph (2012) errors and omissions in design cause for 79% of change orders that resulted in additional cost to manage the rework. According to Fetene (2008) one of the important factors of cost overruns in Ethiopia, aside from economic inflation and changes in foreign exchange rates, is change orders and an inability to control change orders, which happens regularly and is becoming a routine trend.

Previously, a thesis conducted by Basha (2015) studied change orders' cause and effect by assessing the case in the Ethiopian road authority showing the cost impact on the organization. But the researcher did not define the target population and sampling methodology in his study. Another paper by Bassa (2019) reviewed only the causes and effects of design changes in construction change orders. In another study, Eden (2000) looked at how changes affect only construction safety, adding to the cost-effectiveness of change orders only indirectly.

Hence, this thesis is an approach to assessing the reasons and cost impacts of change orders on randomly chosen construction projects being undertaken by the Addis Ababa Design and construction works bureau.

1.3. Research Objectives

1.3.1 General Objectives

In general, the objective is to assess the causes of change orders and the cost impacts incurred by the Addis Ababa Design and Construction Works Bureau.

1.3.2. Specific objectives

The specific objectives of this thesis are as follows

- To assess the prevalence of change orders in Addis Ababa design and construction works bureau.
- To explore client, consultant, and contractor-related causes of change orders.
- To examine the cost implications of change orders with the initial budget.
- To identify possible ways of minimizing the cost impacts of change orders in the Addis Ababa design and construction works bureau.

1.3.3. Research Questions

These are the questions that this research will find answers to.

- What are change orders in construction?
- What are the different types of change orders in construction?
- What are the inherent causes of change orders and who causes them?
- How do change orders impact a construction project concerning the cost of the contract?
- What interventions can be made to minimize the impact of change orders?

1.4. Research hypothesis

Several construction projects in Addis Ababa have undergone change orders as a result of a variety of circumstances, including changes in the scope of work due to the owner's insatiable demands, market conditions that drive changes in project specifications, and technological breakthroughs that alter the design and engineer choices. The engineer's review of the design will lead to changes that improve or optimize the design and, as a result, the project's cost performance. Furthermore, flaws and omissions in building contracts, as well as insufficient contract management skills and an inability to anticipate changes, may compel a change.

The Addis Ababa design and construction works bureau is the consulting body for the projects it undertakes, many of its projects has had cost adjustments because of Change orders. These change orders have resulted in budget overruns because they altered the initial assumptions and designs during the implementation of the project, ultimately adding cost. The research hypothesis is if a change order is initiated in a construction project, it increases the project’s cost more than the initial plan.

The hypotheses to be tested in this research are: -

H_1 = Change order affects cost of a construction project.

H_0 = Change order does not affect cost of a construction project.

1.5. Scope and limitations

There are many government construction projects undertaken by the Addis Ababa Design and Construction Works Bureau ranging from new projects, upgrading of projects, and renovation of old constructions to increasing functionality, accessibility and service quality of governmental organizations. This in turn will cause the scope of this to be broad. As a result, the scope is bound to focus on projects that have issued change orders and their effect on project cost.

The purpose of this study is to evaluate the causes and the costs of change orders based on the different types of change orders. To do this, the study is limited to change orders that arise in selected projects of the Addis Ababa Design and construction works bureau from 2017 to 2021. The selection of projects is based on the data provided by the bureau. As a result, the research's focus will be on the reasons and the cost impacts of change orders on project. In order to identify the causes of change orders, the descriptive statistical tool of Relative Importance Index was used.

1.6. Significance of the study

Ethiopia's building industry is a major engine of economic growth. Massive government investment in infrastructure and residential construction projects has propelled the country to the top of the continent's economic rankings. The country has often invested more than 30% of its GDP in Gross Fixed Capital. Because change orders have such a severe influence on project cost, schedule, and performance, it's critical to understand the key causes of change orders, as well as the impact and potential strategies for minimizing and better managing them during construction. As a result, this study will determine the reasons for change orders and their financial impact on Addis Ababa government-funded construction projects, as well as lay the groundwork for future research to adequately handle problems connected to alterations and change orders.

This research will assist the Addis Ababa design and construction works bureau in reviewing and implementing corrective action to reduce the impact of change orders. It will also serve as a springboard for future research.

1.7. Organization of the Thesis

There are five primary chapters in this thesis. The first chapter is an introduction that explains the significance of this research study, identifies the statement's problem, and discusses the investigation's aims, scope, and constraints. The second chapter is a survey of the literature on change in general and changes orders in specific. Construction change and change order, causes of a change order, impacts of the change order, legal elements of a change order, and change order management are the five sections of the chapter. The study approach and research kind, data source and collection, research population, and lastly technique of analysis are all covered in chapter three, which is the research design and methodology.

In chapter four, the questionnaire response rate, the existence and scope of change orders, the assessment of primary reasons for change order categories, the assessment of cost impact of change orders, and the test for agreement are all covered data analysis and discussion. Conclusion and recommendation, the fifth and last chapter, expresses the research's findings and makes a recommendation on how to reduce adjustments and change orders in Addis Ababa design and construction works bureau projects.

Chapter Two

Review of Related Literature

2.1. Introduction

Change orders have always been an element of the construction project. It's a rare occurrence when a building project is completed without any changes (Beshah, 2015). Change occurs as a result of a variety of factors ascribed to the many parties involved in the project's implementation. Change is legally regularized when it is acknowledged by the issue of a change order, which is a document that describes the extent of the change and its impact both on cost (Khalifa and Mahamid, 2019). To gain a full understanding of change and change orders, their major causes, and their effects on project performance in terms of cost, this section will review relevant literature in-depth, focusing on determining the main causes of change, their effects on cost of a project, and possible solutions to minimize cost overruns, and manage change orders to meet the research objectives.

2.2. Definitions

2.2.1. Changes and Change orders in Construction

The construction sector is huge, fickle, and requires a lot of money. A change in a project can occur for a variety of reasons, including design faults, design revisions, scope expansions, or unexpected conditions (Karthick, 2015). In an ideal world, changes would only be made during the planning stages. Late adjustments, on the other hand, are common throughout construction and often cause major project disruption (Malik, 2019).

The contract terms for payment, methods of compensation, percentages of man-hours executed at various percentages of project completion, processing time, any work stoppage due to, the number of owner- and contractor-initiated change items, the number of change items/hours submitted, and approved, and a list of possible reasons for change with the percent of man-hours resulting from each reason were all included in the change order of project data (Hanna, 2000). Most construction contracts include a procedure for making changes. But even if a framework is in place to cope with these last-minute changes, additional cost always takes precedence in the

decision-making process. If the change has an impact on the design, it will likely have an impact on the construction process as well as operation and maintenance (Malik, 2019)

A thorough grasp of the underlying causes of changes and their possible collateral impacts is required for effective change and change order analysis. To manage a change, one must be able to predict its impacts and control, or at the very least analyze the cost implications (Hester, 1991).

2.2.2. Construction Changes

In literature, a change is described as any departure from an agreed-upon, well-defined scope, and timeline. To put it another way, a change is a difference between the contract requirements as stated in the initial agreement between the parties and the requirements imposed after that agreement (Fisk and Reynolds 2009). But in all cases, owners or clients must approve of all changes before execution.

To aid in the decision-making process, the impact of changes to a building project must be assessed on a case-by-case basis. Though certain changes may provide "benefits" to stakeholders, particularly the owner, most changes, if not properly managed, will have "negative" consequences, most often resulting in expense overruns. In general, changes in the upper stream have a greater influence (Hester, 1991).

The contract package is initially delivered to the contractor in the form of blueprints, drawings, equipment lists, and other papers. This is the foundation of his plan. Based on this original package, the contractor is forced to compute labor cost, material cost, and schedule. Any changes to this group of documents have undoubtedly affected his plans and estimates (Al Dubaisi, 2000).

Furthermore, change orders in the construction process can occur at any of the three stages. This means that such changes may occur during specification preparation, either as a result of the owner's overzealousness or the consultants' unfeasible material and design specifications; during the design stage, as a result of the designer's or consultant's impractical design, which may or may not take into account the actual site condition; and finally, during the construction stage, as a result of the contractors' lack of special skills and the owners' frequent change demands (Beshah, 2015).

Even though the contract defines what constitutes a change, according to (Laufer and Cohenca, 1990) change is classified as follows: Cardinal Changes, Constructive Changes, and Directed changes.

Cardinal Changes.

A change that is outside the contract's scope is known as a Cardinal Change. This type of change has the effect of substantially changing the work to be accomplished from what the parties agreed upon when the contract was bid and awarded. And it is only carried out when the scope has been completely redefined and the contract has been renegotiated. This type of change may not be a single change, but rather a collection of changes that have the cumulative effect of changing the original scope. Cardinal modifications are often seen by the owner as a breach of contract, and a contractor is not bound to carry out a cardinal change if the owner directs it. The following are examples of such changes: Third-party obligations, such as those imposed by permitting agencies, utility companies, and so on, and unforeseen Environmental Issues (Laufer and Cohenca, 1990).

Constructive Changes

Constructive changes are usually the outcome of the owner's or owner's representative's failure to do or not do something. Because this type isn't initially documented as a change, it can become a topic of contention. The owner's or owner's representative's failure can take the shape of a design or drafting error, a misinterpretation of contract agreements by an Engineer, a change in the construction process enforced by a project necessity, and so on. Constructive changes are more difficult to detect than directed changes, and as a result, they frequently become the source of a disagreement or, in the worst-case scenario, a legal claim. Constructive changes can include the following, depending on the contract's unique needs (Laufer and Cohenca, 1990).

- Failure to disclose material information
- Impossibility or impracticality of performing the work as designed
- Imposition of joint occupancy or use of the project before completion
- Slow turnaround of submittals and requests for information
- Untimely Inspections

Directed changes

Changes to the contract that are ordered by the owner and authorized by the owner are referred to as directed changes. Changes are always subject to the contract's specific criteria, and examples of such changes include Addition or deletion of work, Revision to material specifications, Revision to project phasing, change to site access or hours of operation, and change to contract duration.

Additionally, changes can be categorized as follows based on their net effect on scope (CII report, 1990),(Fisk and D. Reynolds 2009):

- **Additive change**. This involves the addition of work to the original scope (adding a new module for example).
- **Deductive change:** Unlike the previous type this change involves deletion of work or shrinking the scope of work - Contractors call this a negative change since it usually involves deduction in contract value.
- **Rework** - due to quality deficiency. Although this type involves no scope change it could have a huge cost impact.
- **Force majeure change**: Although this has the effect of a change, a force majeure caused change may entitle the contractor to schedule adjustment and (I) or cost adjustment depending on the conditions of the contract.

2.2.3. Construction changes orders

Because of the uniqueness of each project and the limited resources of money available for planning, change, defined as any occurrence that results in a revision of the initial scope, execution time, or cost of work, is unavoidable on most construction projects. Change can happen on a project for a variety of reasons, including design faults, design revisions, scope expansions, and unexpected conditions. Contractors are entitled to a fair adjustment to the base contract price and schedule for all productivity consequences resulting from the change for each change. Whenever a change is made during the construction phase, it must be communicated to the consultant, either orally or in writing. when the change is a true difference from what was agreed upon, the consultant issues a written change order to the contractor. These adjustments, on the other hand, occur after the first contract has been awarded or work has begun on the

construction sites. According to Hossain, (2012) and Arefazar, (2019), changes can be of two types, external and internal. Unexpected events, such as incorrect market assumptions, the emergence of new products, and the utilization of new materials, unpredictable weather conditions, might trigger external changes. Internal changes can happen as a consequence of the ambiguity in design and construction processes such as future customer needs, changes in construction methods influencing factors, and interdependencies between tasks. And according to Al-Dubaisi, (2000) changes are classified into informal and formal changes.

Informal Change Orders

Informal change orders are the outcome of constructive changes that arise from the owner's or his representatives' informal acts and activities, and they may increase the contractor's cost of performance. The effects of an informal change order are similar to those of a formal change order (Al-Dubaisi, 2000).

Formal change orders

An authorized representative of the owner or the contractor issues a formal change order to a subcontractor in writing. Because formal change orders are usually recognized before they are implemented, they rarely cause difficulties. They are founded on the contractual parties' intentional and planned choices. Unilateral and bilateral change orders are the most common types of formal change orders, as mentioned briefly below (Al-Dubaisi, 2000):

Unilateral change orders: - When a deal is achieved in discussions or a contractor fails to present his proposals on time, a unilateral change order is issued. It is based on the owner's estimation of labor costs and time. Most of the time, such a change order is not desired because it requires the owner's approval, which could result in an appeal. As a result, a unilateral change order must only be made after all practicable efforts to achieve an agreement have been attempted.

Bilateral Change orders: - This is a supplementary agreement in which the owner offers instructions to the contractor in consideration for a bilateral price or time contract. Supplementary agreements are defined as mutual agreements between the parties to increase or decrease the agreed-upon work.

2.2.4. Causes behind Change orders

Because the construction industry is a multi-party industry, the client acts as the project's promoter, the consultant acts as an expert to aid the client in technical concerns and is expected to be reasonable, and the contractor builds according to the drawings and specifications. Change can be initiated by all parties involved in the construction process in this type of working environment. The potential causes of change orders in construction projects, in general, are examined in this section (Al-Dubaisi, 2000).

2.2.4.1 Changes caused by the Owner

According to the literature, the most significant reason for construction alterations is a change in plans or the scope of a project. Normally, this source of change arises from a lack of preparation during the project definition stage or simply from the owner's lack of involvement throughout the design stage. Changes like these are usually expensive, especially if they are made later in the construction process (Al-Dubaisi, 2000) An increase in building area, as well as an increase or decrease in the number of stories, are examples of changes in scope or plans. Such adjustments are usually kept to a minimum when the owner is involved early in the project objective development and later in the facility design. Owner-initiated changes and designer errors and omissions are the two most common causes of change orders (Navon, 2007)

Changes in scope or plan are one of the most prevalent causes of change in construction projects CII (1990). And this is frequently the result of insufficient planning during the project definition stage, or the owner's lack of participation in the design process (Kim, 2020). This source of change has a significant impact on the project's later stages. Furthermore, property owners may change the project's timeline during the construction phase, resulting in significant resource reallocation (Oladiran 2018). Because time has the same worth as money, a change in schedule means the contractor will either add more resources or keep some resources idle. In both circumstances, there is an additional expense. When project owners are faced with financial constraints that force them to make adjustments to save money, the project's development and quality can suffer (Alnuaimi 2010). This problem could be solved with proper planning and review of the project's financial flow.

Other key causes of change orders in building projects include poor project objectives (Arain and Pheng, 2006). As a result, during the project's building phase, multiple modification orders may

be required. Change in the specification is one of the primary effects of weak project objectives (Chen & Hsu, 2007; Fisk & Reynolds, 2009). During the building phase, modifications in the owner's specifications may need considerable alterations and adjustments in project planning and procurement processes.

During the construction phase, large change orders are caused by material changes. It is the effort of procuring a material because it was done with inadequate material the first time which affects the project cost (Arefazar, 2019).

According to a study by Ali (2021), The top three sorts of change orders that have a substantial impact on project cost and duration are "Owner's Financial Problems," "Change of Scope," and "Impediment to Prompt Decision Making Process." "Inadequate Project Objectives," "Change in the Specification by the Owner," and "Obstinate Nature of the Owner" are the fifth and sixth-ranked change orders affecting project cost and time, respectively in their study.

2.2.4.2. Change Orders Caused by Consultants.

The causes of the consultant-initiated changes are discussed in this section. In other circumstances, the consultant makes changes directly, or the adjustments are required because the consultant fails to meet specific project requirements. The following are some of the causes for consultant-initiated adjustments. According to (Al-Dubaisi, 2000), the following are examples of changes caused by consultants.

Change in design: - Changes in design are more common in projects where construction begins before the design is completed or in projects where design and construction are done simultaneously. If the project is schedule-driven and time is the controlling factor, the owner may choose this mindset. At this point, most owners will protest against any design alterations. However, a new design element that hasn't been explored before, or a clear design advantage that the change assumes, may encourage moving through with the modification. When the design is assessed by the consultant, who may have a different perspective than the designer and wish to make adjustments, the design may change (Al-Dubaisi, 2000).

Errors and Omissions in Design: - It is difficult to construct a completely error-free design. Among the project's many documents, one will frequently find a note that has been erased, a detail that has been mis-referenced, or an incomplete specification sheet. The contractor's goal is

to avoid incurring more costs and looks for ways to do so. This is perfectly legal and justified. In this instance, the owner must choose between paying the additional cost (change order) or accepting a subpar product or design. This source of change should be minimized via a quality assurance program in the designer's office (Al-Dubaisi, 2000).

Conflict Between Contract Documents: - During the design phase of a construction project, various types of designs are drawn by different types of engineers or design employees. Despite strong cooperation across design personnel or disciplines, errors are occasionally discovered. In most cases, contracts specify which document takes precedence in the event of a disagreement. The owner, on the other hand, may suggest that the governing document's representation or standards are inadequate and opt to alter them (Al-Dubaisi, 2000).

Technological Change: - The term "technology change" refers to developments in technology that can shorten the time it takes to complete a project. This could be one of the reasons for project adjustments. As a result, project planning should be adaptable to new beneficial adjustments (CII, 1994b). This is because new technology can be useful throughout the project life cycle, such as lowering project maintenance costs. Unless defined clearly in the planning stage, technological change can be a cause for disputes and change orders (Al-Dubaisi, 2000).

Lack of clarity in the scope of work: - The modification is necessitated here not because of the owner's change of heart, as we mentioned earlier, but rather because of a lack of clarity in the documents regarding the scope of work. This may occur, for example, when work is divided among several contractors but the borders are not well defined. Drawing the boundary lines between different packages or phases of the same project takes a lot of time and work, especially in large complicated projects where all systems are virtually integrated. To avoid such scenarios, clear demarcation on designs as well as clarifying annotations is required. In many cases, the owner hires a third party to do work that he assumed was included but cannot substantiate (Al-Dubaisi, 2000).

Differing Site Conditions: - The majority of the time, this source of change is due to soil conditions in the construction of a building. The contractor may be confronted with rock rather than soft soil, as the tender document may have said. This will necessitate additional excavation effort as well as further compensation for the contractor. This form of shift is most common on

renovation or revamp projects, as new constructions interact with existing structures and need a re-evaluation of the situation (Al-Dubaisi, 2000).

Value Engineering: - Cost-minimizing suggestions are always appreciated. This is an important source of change that should not be overlooked. Value engineering can be done professionally as a formal value engineering study with all of the needed aspects, or it can be done in a simple and disorganized manner. In either situation, the cost savings must be significant enough to justify the change, as it is not worthwhile to go through the difficulties of change if the benefit-to-cost ratio is not favorable (Al-Dubaisi, 2000).

The first three causes of change orders that have a substantial impact on project cost are "Inadequate Working Drawings & Details," "Change of Specification," and "Conflicts among Contract Documents" (Ali, 2021).

2.2.4.3 Change orders caused by contractors

Contractors, as active participants in the construction process, may be able to suggest beneficial adjustments to the project. Changes may also be required if the contractor fails to meet certain project standards. As a result, according to (Al-Dubaisi, 2000), the following are the most typical reasons for contractor-caused changes:

Contactor Financial Difficulties: - Because there are so many new contractors in huge building construction projects in Ethiopia, especially Addis Ababa, many of them will have financial issues completing large projects. These issues harm their capacity to execute and deliver. As a result of the financial difficulties, delays in the completion timeline (schedule change) may occur.

Unavailability of Equipment (Lack of Equipment): - The lack of a piece of equipment, like the preceding source of change, may force a change in the strategy. Lifting a big structure, for example, may necessitate crane capacity that is not accessible in the country, prompting the contractor to consider alternative lifting methods. The hazard stems from the fact that some designs are created outside of the country by corporations unfamiliar with the local resources. This source of change will be minimized if the owner participates actively in the design process.

Unavailability of Skills (Shortage of Skilled Labor): - Certain works may necessitate specialized knowledge that is not readily available in the local market, and as a result, the owner or consultant may agree to modify the construction method or procedure. This type of shift is more likely to occur in construction that involves some level of technological complexity, rather than in standard building construction.

Defective Workmanship: - In some cases, defective workmanship of completed projects may necessitate demolition and rework, or it may necessitate revisions. Accepting substandard workmanship owing to a tight deadline may necessitate a facility upgrade to compensate.

Lack of involvement in Design: - According to (Arain et al., 2004) The contractor's participation in the design process may aid in the development of better designs by accommodating his creative and practical suggestions. Changes may occur as a result of the contractor's lack of involvement in the design process. Practical ideas that are not considered during the design phase will eventually have a negative impact on the project.

Ali, (2021) have stated in their paper that the first three causes of change orders from the contractors' point of view that have a substantial impact on project cost are "Contractor Financial Issues," "Lack of Strategic Planning," and "Unavailability of Equipment." Correlating with (Al-Dubaisi, 2000) and (Beshah, 2015) researchs.

2.2.4.4 External Causes of Change

Beshah, (2015) has stated that changes can be caused by factors that are outside the control of contractual bodies. These factors obstruct the progress of a building project by producing significant adjustments. The following can be considered as other causes of change.

Weather conditions: - can affect outside activities in a construction project (Fisk and Reynolds, 1998). When weather conditions change, the contractor must make adjustments to the work timetable. This can sometimes harm the project's progress, causing construction delays. If the contractor is compelled to change his work schedule owing to weather circumstances such as an extended rainy season or heavy winds, he may be entitled to compensation under the terms of the contract. In addition, if a portion of the work is damaged by the elements, such as flooding, the contractor will be compensated according to the contract provisions.

New Government Regulations: - Local governments may have their own set of rules and laws that must be followed (Arain, 2004). Normally, the designer ensures that his design adheres to these guidelines. However, between design and construction, new restrictions may be published, requiring certain adjustments to the original plan. Environmental and labor standards are updated regularly, and contractors and facility owners are expected to comply.

Health and Safety Considerations: - If any safety features were ignored during the design phase, the owner or consultant may decide to make changes to the facility to include more safety features. Except for the fact that safety is usually not compromised, this can't be distinguished from any other design flaw. Typical changes include the addition of particular safety measures such as a relief valve in an industrial facility or an escape door in a building.

2.2.5. Cost Impacts of Change orders

Two types of literature have been published: qualitative and quantitative. Qualitative research looks at the different aspects of cost and consequences without quantifying them. Quantitative studies, on the other hand, try to quantify the different aspects of cost consequences. The productivity component in change was the focus of the majority of quantitative investigations. According to a study by Du, (2012), Change orders have a negative and significant impact on the cost of construction projects.

According to Anees, (2013) the average cost overrun due to change orders was between 11 and 15 percent of the original contract value, in their study "Evaluation of change management efficiency of construction contractors.". (Hsieh, 2004) discovered that in metropolitan public works, the ratio of change order cost to total project cost is normally 10–17 percent.

According to (Rashid Ibrahim et al., 2014) contract cost overruns range from 6 to 10% of the contract value on average owing to changes. Change orders in civil work, according to (Senouci, 2017), accounted for 42 percent of the project cost overrun.

According to the CII, publication (1990), the impacts of cost that relate to change orders are

1. Direct Cost Impact
2. Indirect or Consequential Impact.

2.2.5.1. Direct Cost Impact.

The direct effects are those that are specific to the work package in which the modification is implemented. The cost impact on the owner could be favorable (savings) or negative (loss) (more expenditure). The contractor's perspective on whether a modification is favorable or harmful will be opposed to the owners. And According to the American Society for Engineering Education (2007), most construction projects will see contract revisions that increase the contract value by 5 to 10%.

The cost of a change is divided into two parts: labor and materials. Material costs are simple to estimate and predict with a high degree of precision. However, estimating labor costs is challenging due to: the influence of changes on productivity rates themselves; and the ambiguity regarding the breadth of a change (exact engineering, procurement, and construction activities that form a changing work). The context for this examination of labor cost impact will be a case in which a change is issued after work has begun. According to CII report (1990) Changes in labor costs can be divided into three categories;

a. Productivity Degradation
b. Delays.
c. Demolition and rework.

Productivity degradation

Change orders, particularly repetitive changes, have a negative influence on worker productivity, as we saw in our analysis of change literature. As a result, labor costs rise, as does the entire project cost. This effect is not felt in places where labor is cheap. However, this loss of productivity may result in additional days or weeks of costly labor (CII, 1990).

Delays

Change orders might cause issues with the supplies and tools needed to complete a task. Consider an order to modify the type of doors on a building after the vendor has already received the order for doors. The new type of door may not be available from the seller, and ordering or fabricating them may take longer. This causes a delay in the delivery of materials, which delays the completion of future tasks. A tool delay can occur when, for example, a certain erection

process has changed, necessitating the use of a larger crane that is not easily available. A delay of this magnitude can be extremely coasty (CII, 1990).

Demolition and rework

Changes that occur after the project's development often necessitate the demolition and redoing of the portion of the work. On the project time curve, this is the worst moment to consider adjustments, and the cost of changes is the highest. According to (CII, 1990): Changes incorporated while construction is underway or even completed involve various direct cost elements that can be stated as follows; - Cost of labor to deconstruct an existing system; Cost of equipment to demolish an existing facility; By removing old work, materials are destroyed; Associated engineering/shipping and waste material handling costs.

2.2.5.2. Indirect Cost Impacts

Changes that are overlooked or underestimated always have indirect consequences (CII, 1990). Consequences can occur later in other work packages, affecting the overall project. As a result, it is critical to recognize this possibility and develop a mechanism to assess its significance. The contract change clause should take into account both direct and indirect (consequential) effects.

Among the possible indirect impacts, these are the following according to (Al-Dubaisi, 2000)

- Increase in overhead costs – Obviously, if the change affects the schedule, materials, or administration level, the project overhead rises proportionally.
- Changes in a previous task or package have an impact on the methods or procedures used in successive work packages.
- Impact on subcontractors: Normally, subcontractors have their own plan and schedule, assuming that the main contractor maintains the original conditions that allow work to begin and end on time. When a change occurs, the subcontractor may need to revise his plans and schedule. In turn, the subcontractor may request a price and/or schedule adjustments.
- Productivity decline in subsequent packages or activities: Productivity studies cited earlier confirmed that a decline in productivity in the change package is followed by a decline in productivity in subsequent packages. A decrease in productivity was also observed in concurrent activities as a result of a change.

- There are also potential cost elements that can be overlooked like; Because of a change, the time value of capital becoming tied, Effects of procurement activities, Additional bonding and insurance may be required, engineering work that involves the correction of drawings and documents, Work may be shifted to a less favorable time.

In summary, changes in construction have far-reaching consequences that extend beyond the working package or activity in which the changes occur. This is referred to as a "Ripple Effect." While the ripple effect has received a lot of attention, there have been no quantitative studies that illustrate the extent of these effects.

2.3. Contract Forms and Change orders

According to Komurlu and Arditi, (2017) construction contracts fail to mention the additional expenses that may be incurred as a result of change orders. Change order disagreements usually include related expenditures and, as a result, usually result in claims. The paper stated that the contract administration procedure begins with the contract signing and continues until the project is completed. The contract terms and project conditions are the focus of this process. It should be noted, however, that contract conditions are frequently not strictly enforced. The contract's primary purpose is to see the project through to completion.

According to Komurlu & Arditi, (2017) Six risks must be evaluated to assess potential contract administration issues:

- **Proposal risks**, which include risks in the definition, clarity, and scope of the project
- **Surety and liability risks**, cover the financial and legal issues
- **Scheduling risks** are related to timely delivery
- **Contractual risk** consists of change orders, dispute resolution, and contract termination.
- **Performance risk** relates to the conditions at handing over the constructed facility,
- **Price risk** involves the timeliness of payments

To reduce contractual risks, the contract should spell out who has the power to make modifications, how those changes will be carried out, and how disagreements will be resolved if an agreement cannot be reached.

Not all contract types are equally susceptible to change orders. The latter will be the most sensitive to changes if contracts are categorized as cost reimbursable or fixed cost. Fixed-price contracts are preferred for projects with a well-defined scope and low risk. Cost-reimbursable contracts, on the other hand, are chosen for projects with a broad scope and a tight deadline. Cost is directly transferred to the owner in cost-reimbursable projects. When deciding on the type of contract for their project, owners should think about the contract's ability to restrict and reduce changes (Al Dubaisi 2000).

2.3.1. Change Clauses

Construction Industry Institute publication (1986) states that the change clause is the most essential, in this regard: "Change clauses are a key feature of the contract because they provide a mechanism for contract modification (either in response to unanticipated occurrences or because the owner requests change) and appropriate remuneration".

Further in Komurlu and Arditi, (2017) research, the owner awards time and money for modifications in the work induced by the owner or external causes. The owner and the contractor must negotiate force majeure, varying site circumstances, and external influences.

In the Ethiopian Civil Construction Law, Change is permitted whether or not a clause to that effect is included in the contract. While creating the right, it puts some limitations on the right to exercise and implement changes or variations to the work.

The Following are Articles in the Ethiopian Civil Construction law with Change orders.

Art.3031. – Changes required by client- 1. Right of client

> *The client may demand that alterations be made in the work as originally planned where such alterations can technically be made and are not such as to impair the solidity of the work.*

Art.3032.- 2. Effect

The client may require a reduction in the price as originally agreed where the alterations required by him reduce the expenses of the contractor. The contractor may require an increase in the price and his remuneration as originally agreed, where the alterations required by the client increase his expenses, work or liability. Where the parties do not agree, such reduction or increase shall be settled by arbitrators appointed by the parties or, failing such, by the court.

Art.3033.-3. Contractor refusing alterations

(1) The contractor may refuse the alterations required by the client where such alterations affect plans, schemes or other documents on which the parties had agreed.

(2) The contractor may also refuse the alterations where they are of such a nature or importance that they constitute a work absolutely different to the agreed work.

The work shall be deemed to be absolutely different to the agreed work where it implies an alteration exceeding by twenty per cent the value at which the original work was or could have been estimated.

Art.3034. – Changes required by contractor

Where it appears necessary for technical reasons to make alterations in the work as originally agreed, the contractor shall, except in urgent cases, give notice thereof to the client.

The contractor shall give such notice notwithstanding that the proposed alterations do not result in the client having to pay an increased price.

Art.3284. 2. New works.

The administrative authorities may, against payment of an additional remuneration, require the contractor to perform works which were not mentioned in the contract.

They may not, however, require him to perform a work which by its object would be totally different to the work mentioned in the contract or which would have no relation to such work.

Nor may they require him to perform a work under conditions entirely different to those which have been mentioned in the contract.

According to the Fédération Internationale des Ingénieurs-Conseils (FIDIC), Change orders clauses are states that throughout the contract, the owner, through its agent, has the right to make written adjustments in quantities or other alterations as necessary to finish the work. Such changes in quantities or alterations neither invalidate the contract nor release the surety. FIDIC 1991, Clause51 (a to f).

The notification clause is significant because it prohibits the contractor from jeopardizing the owner's right to examine, mitigate, and document the change while it is still possible. Notice clauses are frequently enforced, and failure to notify the owner within the given time frame may result in the contractor losing all rights to additional cash or time. Notice clauses not only encourage or compel parties to communicate efficiently, but they also kick start the collaborative process required for project participants to resolve the change.

FIDIC law states Under Clause 20.1; the Contractor must give notice of any claim, whether for time or money, not later than 28 days after the Contractor became aware, or should have become aware, of the circumstances giving rise to the claim. If he does not comply with this rule, he will not receive an extension of time, he will not be entitled to additional payment, and the Employer s discharged from all liability in connection with the claim.

2.3.2 Potential Change Identification

Whenever a compared alternative change order is discovered, it also is vital to appropriately categorize it and follow the correct protocols. In this step of the method, a potential change is classified as one of the numerous types of change clauses specified in the contract. Infrastructure contracts are usually thorough in their descriptions of the many types of alterations that may arise during construction and the procedures that must be followed once they are detected.

According to Beshah (2015), the following are the common types of change provisions:

- ✓ Change in the character of work,
- ✓ Unforeseeable Site Conditions,
- ✓ Suspension of work,
- ✓ Extra work, or
- ✓ Elimination of work.

Change in the character of work

According to Al-Dubaisi (2000), Majority of the time, this occurs as a result of the owner's contractual authority to make changes in quantities and alterations in the works that are required for the project's appropriate completion.

Condition contract, FIDIC 1991 Clause 51.1 empowers the Engineer (Owner's representative) to make any changes to the form, quality, or quantity of the works that he deems necessary. This section allows for variations such as "raise or decrease the quantity of any work covered in the contract" and "alter the character, quality, or kind of any such job."

The following is the FIDIC clause 52.1 of the 1991 Red Book: -

> *All variations referred to in Clause 51 and any additions to the Contract Price which are required to be determined under Clause 52 (for this Clause referred to as "varied work"), shall be valued at the rates and prices set out in the Contract if, in the opinion of the Engineer, the same shall be applicable. If the Contract does not contain any rates or prices applicable to the varied work, the rates and prices in the Contract shall be used as the basis for valuation so far as may be reasonable, failing which, after due consultation by the Engineer with the Employer and the Contractor, suitable rates or prices shall be agreed upon between the Engineer and the Contractor. In the event of disagreement, the Engineer shall fix such rates or prices as are, in his opinion, appropriate and shall notify the Contractor accordingly, with a copy to the Employer.*

Unforeseeable Site Conditions

Unforeseeable means that it is not reasonably foreseeable by a skilled contractor [FIDIC, MDB Harmonized 2010 version]. Natural and manufactured physical circumstances, as well as other physical impediments and pollutants, that the contractor confronts at the site while carrying out the works, including subsurface and hydrological conditions but excluding climatic variables, are examples of such site conditions. When such site conditions occur during execution, the following is how FIDIC, MDB Harmonized 2010 edition sub-clause 4.12 addresses the case as follows:

> *If and to the extent that the Contractor encounters Unforeseeable physical conditions, gives such a notice, and suffers delay and/or incurs Cost due to these conditions, the Contractor shall be entitled subject to notice under Sub-Clause 20.1 [Contractor's Claims] to:*

(a) An extension of time for any such delay, if completion is or will be delayed, under Sub-Clause 8.4 [Extension of Time for Completion], and

(b) Payment of any such Cost, which shall be included in the Contract Price.

Upon receiving such notice and inspecting and/or investigating these physical conditions, the Engineer shall proceed per Sub-Clause 3.5 [Determinations] to agree or determine whether and (if so) to what extent these physical conditions were Unforeseeable, and the matters described in subparagraphs (a) and (b) above are related to this extent. However, before additional Cost is finally agreed upon or determined under the sub-paragraph

(ii), the Engineer may also review whether other physical conditions in similar parts of the Works (if any) were more favorable than could reasonably have been foreseen when the Contractor submitted the Tender.

The Engineer shall take account of any evidence of the physical conditions foreseen by the Contractor when submitting the Tender, which shall be made available by the Contractor, but shall not be bound by the Contractor's interpretation of any such evidence.

Suspension of work

A work suspension is described as an order issued by the owner/or the owner's agent to halt the work, or portions of the job, for a set length of time. Work suspensions are significant alterations because they prevent the contractor from completing the work in the sequence or manner that the contractor expected. A suspension could be imposed by either contractual party, based on their contractual rights.

Suspension by the Employer/Engineer Sub-clause 40.1 of FIDIC Conditions of Contract recommends suspension of work where such suspension is necessary because of: breach of contract by the contractor or climatic conditions on the site, for the proper execution of the works, or the safety of the Works or any part thereof.

Sub-Clause 40.1:

The Contractor shall, on the instructions of the Engineer, suspend the progress of the Works or any part thereof for such time and in such manner as the Engineer may consider necessary and shall, during such suspension, properly protect and secure the Works or such part thereof so far as is necessary for the opinion of the Engineer. Unless such suspension is:

(a) Otherwise provided for in the Contract,

(b) Necessary because of some default of or breach of contract by the Contractor or for which he is responsible,

(c) Necessary because of climatic conditions on the Site, or

(d) Necessary for the proper execution of the Works or the safety of the Works or any

If the owner or the owner's representative suspends or delays the performance of all or any portion of the work in writing for an unreasonable period (i.e., more than 84 days) and the engineer does not grant permission to resume work, the contractor may submit in writing to the engineer requesting permission to proceed with the suspended works within 28 days under Clause 40.3.

Suspension by the Contractor In contrast to sub-clause 40.1, sub-clause 69.4 states that the contractor has the contractual right to suspend or reduce the rate of work if the employer fails to pay the contractor the amount certified under any payment certificate approved by the engineer within the time specified on the contract. However, before suspending or reducing the rate of labor, this contractual prerogative should be supported by written notice to the employer and the engineer.

Sub-clause 69.4:

Without prejudice to the Contractor's entitlement to interest under Sub-Clause 60.10 and to terminate under Sub-Clause 69.1, the Contractor may, if the Employer fails to pay the Contractor the amount due under any certificate of the Engineer within 28 days after the expiry of the time stated in Sub-Clause 60.10 within which payment is to be made, subject to any deduction that the Employer is entitled to make under the Contract, after giving 28 days' prior notice to the Employer, with a copy to the Engineer, suspend work or reduce the rate of work….

If the Contractor suspends work or reduces the rate of work under the provisions of this Sub-Clause and thereby suffers a delay or incurs costs the Engineer shall, after due consultation with the Employer and the Contractor, determine:

(a) any extension of time to which the Contractor is entitled under Clause 44, and

(b) the number of such costs, which shall be added to the Contract Price, and shall notify the Contractor accordingly, with a copy to the Employer.

Extra Work

Extra work is defined as additional work that was not included in the original contract but was discovered to be necessary for the project to be completed satisfactorily within its intended scope. Extra work may be added to the project scope as a result of a design consultant's error or omission, or as a result of revisions requested by the owner or demanded by a third party. The extra work clause is particularly essential since it allows the owner to introduce new parts of the work. Sub-clause 51.1(e) of the FIDIC condition of the contract gives the Engineer the authority to order the contractor to "perform additional work of any sort essential for the completion of the Works," and the contractor shall do the work per the instruction.

Eliminated work

Original contract items that are no longer desired or essential to finish the job and are thus removed from the project's scope by the owner via a deductive change order are referred to as eliminated work. However, if the contractor has already paid costs for those items, such as purchased materials, eliminated work items can form the foundation for a dispute. It is typical for the contractor to pursue repayment for actual costs expended in such circumstances. Whenever the owner has a requirement to omit work, sub-clause 51.1(b) of the FIDIC condition of the contract gives the Engineer the authority to advise the contractor to "omit any such work (but not if the omitted work is to be carried out by the Employer or another contractor)".

2.3.3. Measuring the Effect of Change Order

The first step in assessing the contractor's claim to additional costs connected to an alleged change is establishing that a change has happened, as per the contract, and then determining if the contract provides the contractor with remedies for the change (Al Dubaisi 2000).

To prove that a change occurred, the contractor must identify the exact change-related contract language that is associated with the purported change. The contractor should then, referencing the specific change provision, explain that the purported change is, in fact, a change by comparing it to the contract's baseline criteria. After demonstrating that a change happened following the contract, the contractor must demonstrate that the relevant contract provision allows for the reimbursement of additional costs incurred as a result of the permissible change. Only when a contractor has proved entitlement to a change can the change's impact be measured. Typically, a change will involve the addition or removal of tasks. If a modification necessitates

the addition of work, the contractor should consult the contract's cost addition clause to understand how the price caused by the change should be measured and the appropriate cost addition is decided (Beshah 2015).

2.3.4. Negotiation and Execution of Change Order

Several agreements include the process, including the cost frame that each party must adhere to handle any possible changes to the construction contract. The contractor must distribute the material provided with an owner's Request for Proposal (RFP) to all affected parties, including subcontractors, and then compile the full replies to support the projected cost caused by the modification within the stated time frame (Charoenngam & Mahavarakorn, 2011).

When the owner receives a contractor's answer to an RFP, he or she will analyze the material as indicated in the third activity of the change management process and reply within the time frame set in the contract. At this point, the owner will either accept the contractor's proposal as provided and generate a modification order for signature, or reject the proposal and explain why. Both of these actions should be completed in writing as a normal practice for record-keeping considerations, (Al-Dubaisi, 2000)

If it appears that the change order process is taking too long and interfering with the pace of the job, the owner may choose to handle the issue by a method other than a bilaterally executed change order. A construction change directive (CCD) could be issued to the contractor, instructing that the work be done on a time-and-materials basis, invoking the contract's force account clause, with or without a not-to-exceed sum. A unilateral change order issued by the owner to the contractor permits the work to be completed in line with the contract's modifications clause without the cost and time extension being agreed upon in advance by the two parties (Charoenngam & Mahavarakorn, 2011)

2.3.5. Recording the executed changes

Change order documentation is a critical responsibility of all parties involved in the construction project, particularly the contractor's and employer representative's staff. Staff should construct standardized forms, processes, a contract document log, an issues log, a request for information (RFI) log, and a possible change orders (PCO) log at the start of a project to ensure that detail project information is maintained (Charoenngam & Mahavarakorn, 2011).

Most of the time, the contract documents log begins with the bid documents and includes the most recent drawings or sketches that the owner or consultants may have produced as part of an RFI or additional requirements. The development of the contract documents log aids in determining the contract's baseline requirements. As documents are revised and incorporated into the contract, they should be made available to all project personnel so that the most up-to-date information can be used in evaluating changes or assisting in the generation of the as-built set of documents as the project progresses and work is completed (Charoenngam & Mahavarakorn, 2011).

2.4 Empirical Framework

Several researchers around the world have conducted a study on the various cause ofvariation order and their effects on construction project performance. Some of their findings is discussed in this section.

Ndihokubwayo (2008), a study on "An analysis of the impact of variation orders on project performance" has confirmed the prevalence of change orders on construction projects by doing a comparative analysis of two apartment complex projects in Western Cape Province of South Africa and found a combined total number of 193 variation orders occurred in 24 months. In this study, the researcher obtained that more than 85% of site instructions were change orders.
Smith (2016) in his study on "The Effect of Variation Orders on Project Cost and Schedule Overruns" also revealed that 75% of the projects had about 3 or more change orders and 25% of the projects had about 9 or more change orders, he mentioned that not only did all projects have change orders, but multiple variation orders were common in most construction projects.

Oloo (2015) in his study "Modified Variation Order Management Model for Civil Engineering Construction Projects" found that the top five most important causes of a variation order in Kenya to be delay in land acquisition/ compensation, differing site conditions, change of plans or scope by the client, change of schedule by the client and lack of coordination between overseas and local designers. Similarly, the researcher ranked the five most important effects of variation order as cost overruns, contractual disputes and claims, time overruns, increased overhead, costs and progress degradation.

Tewodros (2015) in his research "Causes and effects of Variation orders in road construction projects" also ranked the top five most frequently occurring causes of change orders as right of way (access to the site) problem, change in design, errors and omissions in design, lack of coordination, change of plans or scope.

Tadesse (2009) also identified the five most significant causes of change order in his study " causes and effects of change orders in Ethiopian federal road projects conducted as the right of way or access to site problem, change in defined scope, lack of proper planning, lack of proper evaluation of tender documents at tendering phase by contractors, contractors' financial problems. Furthermore, the researcher found that the five most significant effects of variation order are increase in project cost being the primary effect.

Ismail et al. (2012) in their research "Factors Causing change Orders and their Effects in Roadway Construction Projects" ranked the five most important causes as a change of plans or scope by the employer, errors, and omissions in design, differing site conditions, contractor's financial difficulties, and weather condition. The researcher also identified the top five effects of variation order as increase in project cost, delay in completion schedule, disputes between owner and contractor, additional revenue for the contractor, and decrease in quality of work.

An exploratory study done on residential and shopping apartment complexes by Ndihokubwayo and Haupt (2008) found that both projects increased to 33% and 9% of the initial completion time, and many modifications during the construction phase affected time overruns. On the two projects, the change orders occurred is 8% and 4% of the contract sum on average.

Ibn-Homaid et al. (2011) study on "Change orders in Saudi linear construction projects" revealed that overall construction project costs increase around 11.3% on average due to changes orders.

The results of the study conducted by Alaryan, Emadelbeltagi, Elshahat, and Dawood (2014) on "Causes and Effects of Change Orders on Construction Projects in Kuwait "showed 6 to 10% of the contract value cost overrun on average due to changes and the cost overrun was shown to be in the range of 10 to 20%.

Aneesa, Mohamed and Razek (2013) in the study "Evaluation of change management efficiency of construction contractors" concluded that the average cost overrun due to change orders was between 11 and 15% of the original contract value. Hsieh, Lu, and Wu (2004) in their study also found that the ratio of change order cost to total project cost is typically 10‑17% in metropolitan public works.

The effect of variations on the project time is also observed to be considerable in Yogeswaran et al. (1998) study in which 50% of the projects surveyed had been granted an extension of time due to variations.

The study result of Tadesse (2009) based on his study on 12 projects in the Ethiopian Federal Road Projects shows that the magnitude of variations in these projects ranges from 0.72 % to 109 % with 38 variation orders.

In another study made by Tewodros, (2015) the findings from 16 randomly selected city road projects showed all projects faced variation orders ranging from 1 to 7 and an increase of 24.11 % of the original project contract amount and time overrun of 126.50% of the original contract period.

2.5 Synthesis

The literature review shows that researchers have identified change orders in more than one way. However, it would be reasonable to generalize and summarize variations as any addition, deletion, modification, or a substitution on the original design drawings, plans, and documentation requested by the project's owner or owner's representative.

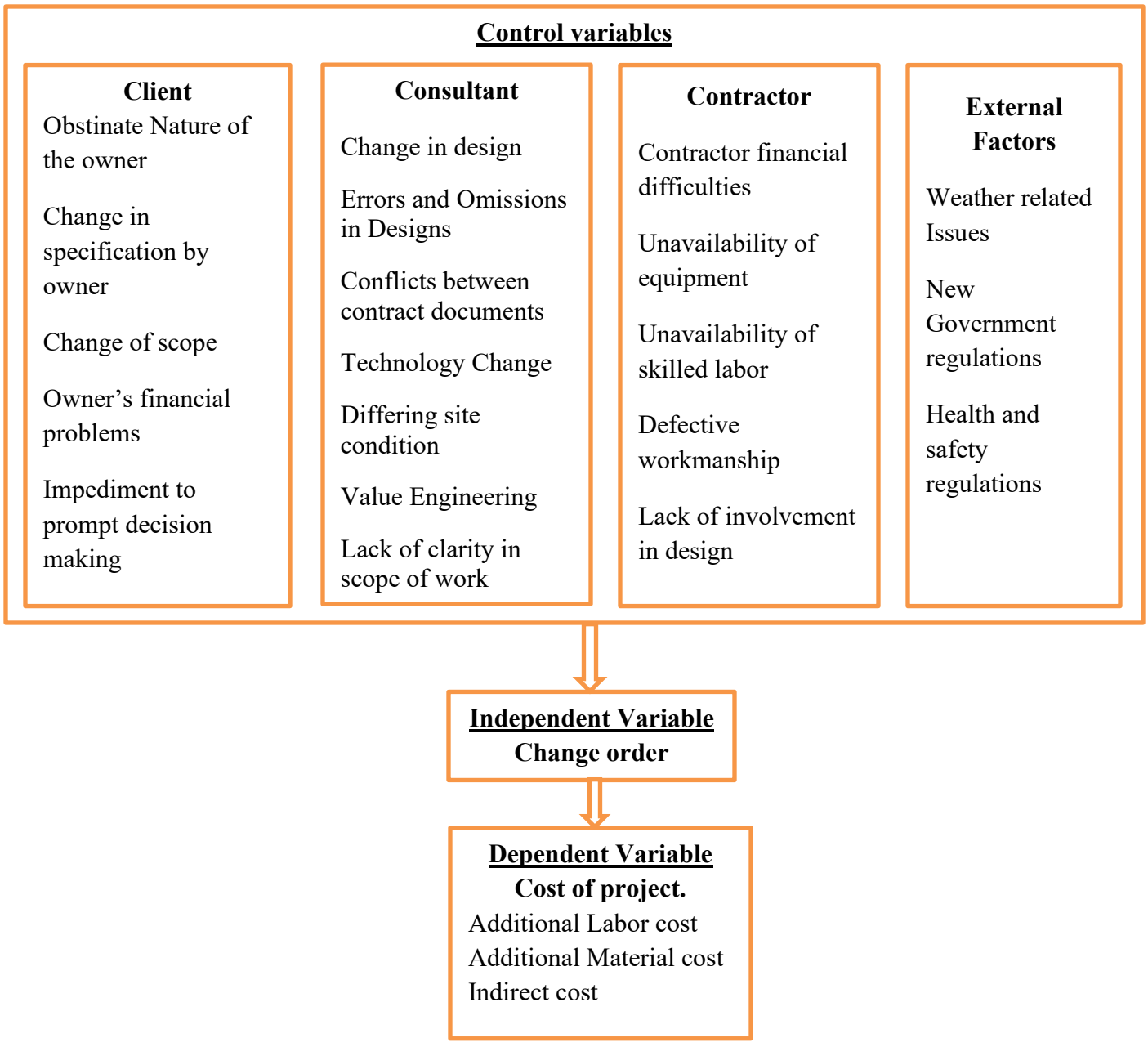
According to the literature change orders in the construction sector are common but unwanted. Change orders, their causes, and effects have been studied by a wide range of researchers in different geographical locations and with different analytical methodologies, tools, and techniques but not many in Ethiopia.

In one study conducted by Ndihokubwayo (2008) the researcher obtained that more than 60% of site instructions were change orders orders. Smith (2016) also revealed that 75% of the projects had about 3 or more change orders and 25% of the projects had about 9 or more change orders, he mentioned that not only did all projects have a variation order, but multiple change orders

were common in most construction projects. Aneesa (2013) concluded that on average 11-15% of the original contract of cost overrun was due to change order

The effect of variations on the project cost is also observed to be considerable in Yogeswaran (1998) study in which 50% of the projects surveyed had been granted additional cost due to change orders.

2.6. Conceptual Framework.



Chapter Three

Research Methodology

3.1. Research Approach and Design

This study used a quantitative technique to address the research questions and test the hypothesis. According to Creswell and Garrett, (2008) quantitative approach is a means of putting objective hypotheses to the test by evaluating the relationship between factors; these variables can then be measured. Usually on instruments, so that numbered data can be examined statistically.

In the case of this research, the researcher has preferred an explanatory approach to address the objectives stated in Section 1.3 by assessing the relationships between change orders and the causes behind them. The objectives require statistical evaluations of payment and budget document analysis to quantify the cost impact of change orders. This strategy is chosen to assist the researcher in developing a causal explanation for the relationship between Change order and project performance from the point of view of cost and time.

According to Kothari (2004) research design is the conceptual framework within which research is carried out; it guides data collection, measurement, and analysis. A survey research design is excellent for studies that try to uncover correlations between variables and will provide a quantitative description of trends and opinions of a population by evaluating a sample of that group (Creswell & Garrett, 2008).

This research is designed in casual research on top of the description provided about the subject to identify and record all elements of a change order and its impact on project cost in a systematic way. Such identification and recording will be done from a cost point of view.

3.2. Data Sources, and Data Collection Methods

The variables to be explored in this research are the change orders in construction projects in the Addis Ababa design and construction works bureau and the effects they have on construction cost.

The study drew on data sources to develop documents for responders as well as archival papers. Closed ended questionnaire was used to collect opinions and insights from professionals in the building business such as clients, consultants, and contractors. The majority of the archive materials were from reports of completed and ongoing projects, which will be crucial in recognizing reoccurring problems associated with change orders in the construction projects undertaken by Addis Ababa Design and Construction Works Bureau.

3.3. Population and Sampling

Clients, contractors, and consultants are among the stakeholders in the infrastructure building business who provided research samples. The Addis Ababa Design and Construction Works Bureau is the primary solicitor for government construction projects in Ethiopia's capital. Whereas there are many consultants and contractors in the construction industry, just a handful are utilized as a sample for the study, chosen at random bases on their experience with construction projects.

When assessing the responses, to remove prejudice and missed findings caused by unbalanced population size, the number of questionnaires will be equally divided between the client, consultant, and contractor.

To determine the sample Yamane (1967) provides a simplified formula to calculate sample sizes, which was used in this research to calculate the sample sizes. A 90% confidence level and e = .1 are assumed.

Equation 3. 1 Determining sample size

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

The population size was assumed from the total number of projects being undertaken in the Addis Ababa Design and construction works Bureau to be approximately 130. The number of consultants added from the employee list is taken to be 25. So, the population for this study is 155. Taken to be 10% which makes e= 0.1

From the formula, the sample size is derived to be 60.78 ~ 61.

Data Source

The study used both primary and secondary data to achieve the study's goal. The questionnaire is a structured questionnaire that was created using the variables identified in the literature research

as the causes of the Change order and their effect on the cost of building construction projects. To achieve the research aims, the questionnaire was divided into four sections: Part I, Part II, Part III, and Part IV. Part I contains general information (company and respondent profiles), Part II discusses the incidence of change orders in Addis Ababa Design and Construction Works Bureau construction projects, Part III discusses the influencing reasons or independent variables for the change orders and Part IV discusses the effect of change orders.

3.4. Methods of Data Analysis

The mean score approach is used in the analysis to determine the relative relevance of the factors of a change order on Addis Ababa design and construction projects. Furthermore, a Likert scale of five scale measuring the influence of the variable with each statement (1, 2, 3, 4, and 5) is used to generate the level of influence for each factor, which is then utilized in the SPSS linear regression analysis to determine the cause-and-effect relation of the independent and dependent variable. To evaluate the data received from the questionnaire, descriptive analyses such as frequencies, percentages, mean, standard deviation, and inferential/ statistical analysis/ regression analysis are utilized.

As a result, tables are used to compute and provide descriptive statistics for components that cause change orders and their impacts. The most essential reasons for change orders, in relation to cost impacts are ranked and discussed using the relative importance index formula found in the discussion part. The research variables are as follows: -

Dependent Variable (Y): - cost effect of a change order in a project
Independent Variables (X): - Change Order

Linear Regression Model $Y= \alpha+ \beta X +e$

Where Y = Effect on cost of a project
e= sampling error
α = constant
β = Coefficient of X
X= Change order

Equation 3. 2 Linear Regression Formula

3.4.1 Reliability & Validity

According to Kothari (2004) and Haimanot (2021), For a test to have reliability, the measurements used need to be tested. A research tool is said to be trustworthy if it is consistent and stable, therefore predictable and accurate, according to Kumar (2011). For example, a test is dependable if it can be repeated under the same conditions and produce the same result. As a result, a pilot test was done to determine the validity of the instrument, as well as if it covers the topic adequately, whether the content of the items will be useful in answering the research questions, and the clarity of the questions.

According to Bland and Altman (1997), internal consistency is required when components are utilized to build a scale. Because the items should all measure the same thing, they should be correlated. In the case of this research, the statistical instrument Cronbach's Coefficient alpha (α) is used. The formula is: -

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\Sigma s_i^2}{s_T^2}\right)$$

Equation 3. 3 Cronbach's Alpha reliability formula

Where, α = is the Coefficient S_i^2 = is the variance of the item

K = is the number of scale items S_t^2 = is the variance of the total score

Alpha values of 0.9 to 0.8 are regarded as good for comparing groups using the rule of thumb. 0.8 to 0.7 will be considered acceptable, and 0.6 to 0.5 will be considered inadequate.

Table 3. 1 Cronbach's Alpha coefficient Values own survey

Reliability Statistics			
Type of Variables	Cronbach's Alpha	Cronbach's Alpha Values	N of Items
Prevalence of CO	0.731	0.738	2
Client	0.872	0.878	6
Consultant	0.929	0.929	7
Contractor	0.942	0.942	5
External Factors	0.823	0.821	3
Cost effect of CO	0.903	0.904	3
Total reliability	0.867	0.868	27

Source: Own survey (2022)

Using the SPSS scale and reliability tools, the Cronbach's alpha reliability result for each question is calculated to be over 0.7 in the table above, indicating that the study's Cronbach's alpha value is within the acceptable range. This shows that the variables are trustworthy. The variables are made up of sub-variables or questionnaire responses that have been folded into a single variable.

The questionnaires were produced in advance and pre-tested (pilot test) using a limited number of respondents who were randomly picked from the target respondents to ensure the research instrument's validity. This would help to eliminate any ambiguities; therefore, the questionnaire was focused on expert opinion to verify the data collection instrument's validity. This entailed reading over the questionnaire concerning the objectives and ensuring that it contained all of the information needed to answer these questions.

Chapter Four

Results and Discussion

This study looked into the causes and cost impacts of change orders on the operations of Addis Ababa Design and Construction Bureau's construction projects. This chapter summarizes the results of the analysis and examines the most important findings. The data was analyzed using the Statistical Package for Social Science (SPSS) version 26. The data analysis and discussion were finished and organized in accordance with the research objectives. The analysis results are presented in the form of graphs and tables. The findings are compared to the literature review, and the most important findings are discussed.

4.1. Response Rate and Respondents' profile

In this section of the research, the respondent profiles and the response rates for the questionnaire are discussed. Based on the population and sample size determined in section 3.3, a total of 61 questionnaires were distributed equally to the Client, Consultant and Contractors with 20 questionnaires each. From the distributed questionnaires, 55 were filled and returned having 91.67% of response rate, which is suitable for data analysis and study discussion.

When the respondent's responsibility in the company was considered, 9 project managers and 9 Resident engineers responded, each accounting for 16.4 percent of the total response. Contract Administrators and office engineers each had 12 respondents, both accounting for 21.8 percent of the total 55 questionnaires response. Site engineers had the most questionnaires response, with 13 respondents accounting for 23.6 percent of total respondents.

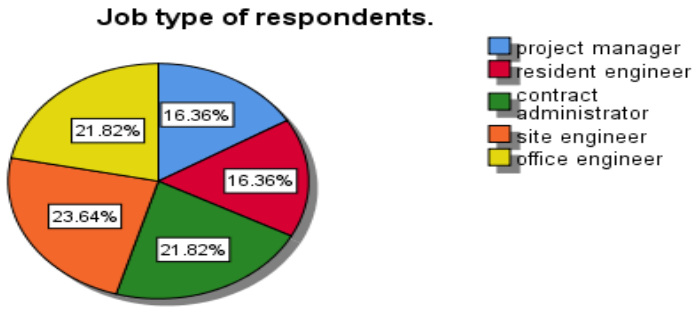


Figure 4. 1 Responsibility of respondents in their company

The research targeted professional employees working in various ranks and companies in the projects of Addis Ababa Design and Construction Works Bureau. 19 Clients from the 20 responded with a percentage of 34.5 of the total respondents. All consultants 20 questioned returned their questionnaire compromising of 36.4% of the total questionnaire. The third and last category of respondents, Contractors, had the least number of questionnaires returned. 16 of the 20 respondents complied with 29.1% of response rate from the total respondents.

Table 4. 1 Respondent's types of organization.

Type of organization respondent is in	Total number of questionnaires distributed	Returned number of questionnaires	Percentage of returned questionnaires	Valid Percent
Client	20	19	95	34.5
Consultant	20	20	100	36.4
Contractor	20	16	80	29.1
Total	60	55	91.67	100.0

Source: Own survey (2022)

The questionnaire also took into account the respondents' experience level, as shown in fig 4.2, with 38.2 percent having 0-5 years of experience. With 9.1 percent, respondents with more than 15 years of experience have the lowest response rate. Respondents with 5-10 years of experience make up 29.1% of the total, while those with 10-15 years make up 23.6 percent.

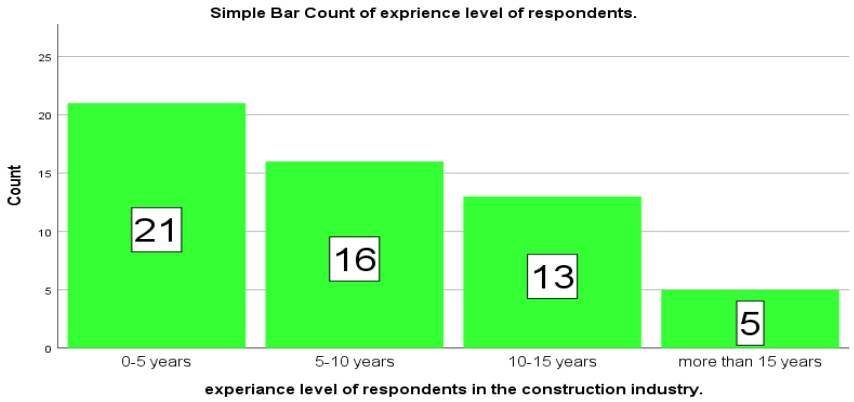


Figure 4. 2 Experience level of respondent

Source: Own survey (2022)

4.2. Results

This part presents descriptive analysis of the questionnaire response about change orders and their effect on cost of construction projects in Addis Ababa Design and construction works Bureau. In order to evaluate the responses, Descriptive statistics was used and Relative Importance Index method determined the most occurring change order causes were ranked based on the questionnaire response for the variables. Because respondents can easily answer questions in this format, a five-point Likert scale that ranged from 1-5 was used to analyze Relative Importance Index.

$$\textbf{Relative Importance Index} = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Equation 3. 4 Relative Importance Index

Where: w = the weighting given to each factor by respondent ranging from 1 to 5

A = the highest weight meaning 5 in this case

N = total of respondents

The mean score level for variable responses is valued with a range where 4.5 and above is strongly agreed, values ranging from 3.5 – 4.5 are agreed, variables with 2.5 –3.5 mean score values are neutral and 1.5 – 2.5 are disagreement whereas mean scores of 0 – 1.5 are strong disagreements to the questions. RII score ranges from 0 – 1 and the closest values to 1 are ranked the highest variables.

4.2.1. Existence and prevalence of change orders in AADCWB

To examine the existence and prevalence of change orders in the projects of AADCWB, the first two questions in the survey where the first question asked opinions if change order is a problem in Addis Ababa Design and Construction Works Bureau and the responses were 30.9 percent strong agreement and 69.1 percent agreement which resulted the mean value for the question at 4.31. The second question which asked if change order frequently occurs in the organization had results of 34.5% strong agreements, 61.8% agreements and 3.6 percent of neutral responses which resulted a mean score of 4.31.

This means that, from the primary stakeholders working in AADWCB points of views, change order is a problem frequently occurring in the organization, fulfilling the first objective of this study which was assessing the prevalence of change orders in AADCWB.

Table 4. 2 Mean score and std. Deviation of prevalence of change orders.

Variable	Mean	Standard Deviation
Change order is a problem in AADCWB	4.31	0.466
Change order frequently happens in AADCWB	4.31	0.540

Source: own survey (2022)

4.2.2 Examination of Causes of change orders

In this section independent variables that cause change orders are examined. A total of 21 causes were identified from literature divided in to the three contractual parties i.e., change orders caused by clients, change order caused by consultants and change orders caused by contractors. The most occurring change orders are then ranked using questionnaire response and relative important index.

Change orders caused by owners

From the change order variables caused by clients, Impediment to prompt decision making is the most prevailing cause with an RII of 0.79. The proceeding client causes of change orders are change of scope by owner and change or specification by owners, with RII values of and 0.77 and 0.76 respectively. Owners' financial problems had the least amount of relative importance index with 0.68 RII meaning the financial problems of owners causes the least amount of change orders in Addis Ababa Design and Construction Works Bureau.

Table 4. 3 RII client causes of change orders.

Client causes of change orders	Mean	Standard Deviation	RII
Impediment to prompt decision making process.	3.95	0.870	0.79
Change of scope by the owner.	3.84	1.198	0.77
Change in specification by owners.	3.80	1.043	0.76
Inadequate project objectives by clients.	3.75	1.190	0.75

Obstinate nature of owners.	3.58	0.712	0.72
Owners' financial problems cause.	3.40	1.029	0.68

Source: Own survey (2022)

Change orders caused by consultants

Change orders caused by consultant resulted in the highest values of RII with errors and omissions by designers having an RII result of 0.92. Respondents strongly agreed that this variable causes the greatest number of change orders in construction. Change in design by consultants is the second favorite causes of change orders from the questionnaire responses with an RII of 0.87. The third most selected cause of change order from the consultant side is conflict between contract documents respondents have selected this cause resulting in RII of 0.86. Other causes, Lack of clarity in scope and differing site conditions have close ranges of RII values of 0.85 and 0.86 meaning they have significant numbers of change orders issues in AADCWB. Respondents have agreed that Value Engineering and Technological changes are the least change order causing variable with relative index of 0.82 and 0.72. The table below describes all variable's mean scores and relative importance indexes.

Table 4. 4 RII consultant causes of change orders

Consultant Causes of Change orders	Mean	Standard Deviation	RII
Errors & omissions by consultants	4.58	0.498	0.92
Change in design by consultant	4.36	0.825	0.87
Conflict between contractual documents	4.31	0.717	0.86
Lack of clarity in scope of work	4.24	0.719	0.85
Differing site conditions	4.18	0.475	0.84
Value engineering	4.11	0.809	0.82
Technological changes	3.60	0.760	0.72

Source: Own survey (2022)

Change orders caused by contractors.

Contractor related change orders are the third categories of change order causes and respondents agreed that unavailability of equipment and lack of contractor's involvement in design are the most prominent causes of change orders both with RIIs of 0.80. the third important type of change order in this section is defective workmanship which had an RII result of 0.79. Respondents agreed that this type of change order causes the third most change orders in the projects of AADCWB. Contractor's financial difficulties are ranked fourth with a slight margin of RII score 0.78, meaning that this change type of change order is also significant in creating cost overrun of projects. The least amount of RII was recorded by unavailability of skilled worker of RII score of 0.75 which respondents agreed that it doesn't cause as much change order as the predecessors.

Table 4. 5 RII of change orders caused by consultants.

Contractor Causes of Change orders	mean	Standard deviation	RII
Unavailability of equipment	4.00	1.018	0.80
Lack of involvement of contractor during design stage	4.00	0.839	0.80
Defective workman ship causes	3.95	0.970	0.79
Contractors' financial difficulties	3.58	1.272	0.78
Unavailability of skilled labor	3.73	1.254	0.75

Source: Own survey (2022)

External Causes of change orders

Change order causing variables which are external and are not under the control of the primary contractual bodies are examined here. According to the questionnaire response, the most occurring external cause of change order is Weather conditions. It recorded an RII value of 0.81. the second prominent cause is new government regulation that had a calculated RII value of 0.80. the least change order causing variable from external factors is Health and safety considerations with 0.75 RII value.

Table 4. 6 RII of External causes of change orders

External Causes of Change orders	Mean	Std. Deviation	RII
Weather conditions	4.04	0.744	0.81
New government regulations	4.02	0.828	0.80
Health safety considerations	3.73	0.849	0.75

Source: Own survey (2022)

Prominent Causes of Change orders

Putting together the three primary stakeholders in projects and analyzing the most important causes of change orders are presented in this section and the table below. It describes the 10 most important causes of change orders and which contractual body initiated them. From the Table Below it is deduced that the top six reasons for change orders in Addis Ababa Design and Construction works Bureau are consultant-related change orders. External factors, Weather conditions, and new government regulations, next to consultant-related change orders are the 7th and 8th causes of change orders. The least causes of change orders are contractor-related factors which are unavailability of equipment and lack of involvement during design.

Table 4. 7 RII of total causes of change orders.

Causes of Change orders	Mean	Std. Deviation	RII
Errors & omissions by consultants	4.58	0.498	0.92
Change in design by consultant	4.36	0.825	0.87
Conflict between contractual documents	4.31	0.717	0.86
Lack of clarity in the scope of work	4.24	0.719	0.85
Differing site conditions	4.18	0.475	0.84
Value engineering	4.11	0.809	0.82
Weather conditions	4.04	0.744	0.81
New government regulations	4.02	0.828	0.80
Unavailability of equipment	4.00	1.018	0.80
Lack of involvement of contractor during the design stage.	4.00	0.839	0.80

Source: Own survey (2022)

4.2.3. Desk Study on selected projects.

In this section, the study will assess 15 randomly selected projects from the Addis Ababa Design and construction works bureau which have overrun their budget. Because the first goal of this study was to determine the prevalence of change orders in construction projects and whether they are a problem in Addis Ababa Design and Construction Works Bureau projects, data was gathered through a desk study of some of the bureau's completed construction projects, as shown below. Change orders were identified as one of the biggest concerns of budget in Addis Ababa's design and construction works bureau, indicating that it is a problem in the construction industry as a whole.

As described in Table 4.1 Change orders In Addis Ababa Design and Construction works Bureau have increased the Final/estimated total cost of a project by 12%. Similarly, to the studies, but with an increase in cost (Beshah, 2015), on which change orders caused an increase by 10% of total cost in his study.

Table 4. 8 Initial cost of project and additional cost of change orders

No.	Project	Initial Amount in Birr	Additional Cost in Birr	Final Cost /Estimated cost of completion in Birr	Increase in %
1	Menelik hospital Eye Center	119,767,033.095	35,920,992.41	155,688,025.51	30
2	Bole General Hospital	1,899,351,264.49	95,589,564.59	1,994,940,829.08	5
3	Nifas Silk Laphto General Hospital	637,665,820.90	65,689,369.79	703,355,190.69	10
4	Arada sub-city Administration building	290,081,891.54	33,956,656.88	324,038,548.42	12

5	Kolfe Hospital	733,315,710.40	70,934,753.65	804,250,464.05	10
6	Children and youth theater building.	225,881,559.40	25,829,517.23	251,711,076.63	11
7	Abebe Bikila Stadium Roof Cover, Track, and fieldwork	105,568,845.41	10,631,597.56	116,200,442.97	10
8	Jan-Meda Gymnasium	50,643,968.12	5,914,832.46	56,558,800.58	12
9	Akaki kality Zonal stadium.	514,392,809.16	50,789,296.66	565,182,105.82	10
10	Lion Zoo Park (peacock)	91,202,354.24	11,596,745.25	102,799,099.49	13
11	Ambessa Gibi renovation project	28,381,080.79	4,247,173.81	32,628,254.60	15
12	Zoo office and administration block	52,900,000.00	5,859,543.88	58,759,543.88	11
13	Gelan Primary School	49,484,888.36	5,247,361.12	54,732,249.48	11
14	Tegbare-id poly technique college	81,111,329.89	11,852,456.54	92,963,786.43	15
15	Yeka Primary School	51,282,168.28	5,659,719.55	56,941,887.83	11
Total		4,931,030,724.08	439,719,581.38	5,370,750,305.46	12.4

Source: AADCWB (2022)

The average cost increase of the projects in Addis Ababa Design and Construction works Bureau is 12% where the maximum cost increase is 30% and the minimum is 5%. This has shown both direct and indirect cost impacts negatively affecting projects' planned budget. Concurring with the paper by (Serag & Oloufa, n.d. 2007), which showed change orders causing a 10% increase in total cost.

Table 4. 9 Initial cost of project and additional cost of change order.

No.	Project	Change order	Cause of change order	Initiator	Effect of cost
1	Menelik hospital Eye Center	Additional facilities for doctors change of hollow blocks in radiation room to R.C.	Change of scope, changes in design, technological change.	Consultant, client	30% Additional cost.
2	Bole General Hospital	Change of slab type. change of floor work type. change of external cladding	Change in Design, material change.	Consultant	5% Additional cost.
3	Nifas Silk Laphto General Hospital	Addition of facilities. Change of foundation and earthwork amount	Errors and omission in design, differing site condition	Consultant	10% Additional cost.
4	Arada sub-city Administration building	Changing the entire front side 60mm thick ceramic cladding and cover to granite paint.	Material change Change in design	Consultant	12% Additional cost,
5	Kolfe Hospital	Design discrepancies,	Errors and	Consultant	10%

		Changing foundation design type.	omissions in design, Differing site conditions.		Additional Cost
6	Children and youth theater building.	Change of Schedule change of external glass window, change the size of aluminum in partition work.	Contractor's financial difficulties, errors, and omissions in design	Contractor	11% Additional cost.
7	Abebe Bikila Stadium Roof Cover, Track, and fieldwork	Errors and omissions in design. change of running track pitch specification, and equipment.	Design change, change of material, Value engineering	Consultant	10% Additional cost.
8	Jan-Meda Gymnasium	Change in the specification for wooden floor work and R.H.S. roof work	Errors and omissions in design, differing site conditions.	Client	12% Additional cost
9	Akaki kality Zonal stadium.	Change of Running track Change of Number of spectator seats. parking area facilities design.	Errors and omission in design, Design change	Client,	10% Additional cost.
10	Lion Zoo Park (peacock)	Design modification of animal living area and visitor fence. water drainage pipe change	Errors and omission in design, technological change.	consultant	13% Additional cost.

11	Ambessa Gibi renovation project	Change of walkway material. change of fence design	Design change,	client	15% Additional cost.
12	Zoo office and administration block	Additional facilities change of material for external work change of finishing material.	Design change.	Consultant.	11% Additional cost.
13	Gelan Primary School	Change of room size, additional lavatories, addition of dining area size.	Design change, change of scope, change of material.	Client	11% Additional cost.
14	Tegbare-id poly technique college	Change of external cladding, And sunshade addition of laboratory sink. Change of galvanized pipe to brass pipe.	Errors and omission in design, differing site conditions.	Client.	15% Additional cost.
15	Yeka Primary School	Change of floor work from tiles to epoxy,	Change of material	Client	11% Additional cost.

Source: AADCWB (2022)

The previous table shows the specific change orders that happened in the selected projects. One project can have one change order or a set of various change orders. The change order costs are summed up in Table 4.1. From the observed change order types, the most recurring and prominent types of change orders are described as follows.

Errors and Omissions in design are the most occurring reasons for change orders occurring in 8 out of the 15 sample projects. According to Peter, Zahir, and Edwards (2005), errors and

omissions are caused by reasons which affect the designing engineers as error-provoking conditions within the consulting firm and project. From the desk study, 7 out of 15 projects have seen design changes making the variable the second most important cause of change order. Larsen, Shen and Brunoe (2016), the study that conducted project performance with 26 factors, found that design changes are the second highest causes of change orders in a project resulting in cost overruns, Yanna stated in his study that change in designs results in 12.4% of cost deviations from the total cost of project. and are primarily initiated by Owners in their study while in this research it is consultants.

According to (I. D. Cox , J. P. Morris , J. H. Rogerson & G. E. Jared, 2010) change orders resulting from contractual documents are the primary causes of disputes and arbitration in construction projects because one clause or specification mat be supported in one document and opposed in another. Errors in contract documents become payables when someone who has a right to rely on the professional is seriously injured or damaged.

Out of the 15 observed projects, differing site conditions happened in 6 projects making them the third most cause of a change order. A model study by (Ali V. , F.Nasirzadeh & A. Mills, 2020) showed that raising the level of project scope clarity can minimize design cost by reducing design changes in project delivery, which can ultimately reduce project cost. This means that reducing the clarity level of the project scope has a negative impact on project cost throughout the delivery of the project. (B. Xia, B. Xiong, e.t., 2016) studied the casual relationship between scope clarity/definition with project performance. Scope definition was found to be significantly correlated with project success in a survey of Chinese construction.

In this study, out of the 15 projects, four projects were approved for material changes ranking this cause as the fourth most change order causing variable. Material changes can be caused by the desire to reduce weight, the desire to increase strength, the durability of the material, installation factors, labor productivity can result in material change ultimately causing cost adjustment in the projects. Technological changes and changes of scope have been recorded in two projects ranking them as fifth and sixth change order causes in the sample projects. value engineering, poor project objectives, and contractor financial difficulty have also been observed in three projects once and are ranked as 7^{th} 8^{th} and 9^{th} important causes for change orders.

4.2.4. Cost Effect of Change orders

In its third objective this research aimed at identifying the cost effect of change orders. The questionnaire survey asked which types of costs are the most prominent outcomes from a change order. There are three types of costs identified from the literature and using the Relative Importance Index of the questionnaire response they are ranked in the table below. The respondents have strongly agreed that all three results are effects of change orders but the most observed effect is change orders result is additional material cost with an RII of 0.956. Additional Labor cost is the second most prominent result of change order with an RII of 0.949. the third-ranked cost effect of a change order is Additional Indirect cost resulting in an RII of 0.935.

Table 4. 10 Rank of cost effects of change order.

Cost Effect of Change Orders	Mean	Std. Deviation	RII
Additional Labor Cost	4.75	0.440	0.949
Additional Material Cost	4.78	0.417	0.956
Additional indirect cost	4.67	0.474	0.935

Source: Own survey (2022)

Additional material costs: - According to Fetene (2008) there are times when the local market cannot produce certain materials and more times when there is a shortage of that construction material. Change orders more often result in the addition or rework of certain construction materials that will inevitably result in adding a budget that wasn't planned in the beginning resulting in cost overrun. Taking market inflation and market productivity into consideration, material costs are the most prominent types of cost that increase the change order cost.

Additional Labor Costs: - According to (Hanna, Asce, et al., 2001) Labor costs comprise 30 – 50% of total project costs. Primarily, When the required level of labor quality is not met, a project will be completed with less-skilled workers. A project cannot meet its basic labor demand when a craft labor quantity issue arises. A project carried out under either of these two conditions is highly likely to incur cost increases (Hossein, Timothy, Gabriel B. Dadi and Paul M. Goodrum, 2018). As a result, change orders will impact labor costs by creating additional payments for Additional designs, Design reworks, demolition, and rework for a variety of works

in the project. this study found that those additional labor costs are the second most important type of cost that overrun project budget.

Indirect Costs: - According to (Hsieh et al., 2004) indirect costs are difficult to measure exact values because of their variety but the research (Al-Dubaisi, 2000) identified the following Indirect costs of change orders; increase in overhead cost, cost of the methodology of rework, impact on subcontractors, time value of money and market inflation. When a change order is undergone in construction all the above indirect costs play part in the cost overrun of the project. in this study, indirect costs are the third important types of cost that raise the price of a change order.

4.3 Discussion of Results.

The study ranked causes of change orders according to the formatted questionnaire response and occurrence of change order variables in the desk study. This resulted in determining which particular causes are contributing the most to the additional costs that were observed in the sampled projects. the following is a discussion on the most important causes of change orders in the Addis Ababa Design and Construction Works Bureau.

Errors and Omissions in Design: - In both the questionnaire and desk study, Errors and omissions in design are the most important causes of change orders. According to Peter, Zahir, and Edwards (2005), errors and omissions are caused by reasons which affect the designing engineers as error-provoking conditions within the consulting firm and project. Time constraints, understaffing, fatigue and inexperience are all reasons causing Errors and omissions in design. He went on to say that these influences contribute to unworkable relationships and procedures, as well as design and construction flaws, which result in a change order. Resulting in additional costs from the initial budget plan. According to James, Jodi and Ledbetter (1992), Errors and omissions are the second highest causes of cost deviations in a study that was conducted across 9 projects accounting for 24.5 percent of the additional cost incurred. A study by Larsen, Shen and Brunoe (2016) stated that Errors and omissions in consulting material was the highest cause of cost overrun in their paper. Errors and omissions include a variety of defects that include error in design items like roof of a gymnasium that needed to include fire protection system but is only built with structural fitness. Omitted material in the bill of quantity but is included in drawings,

like missing pavement. These are examples of the many errors and omissions in design that result in a change order and cost overruns that are observed in the organization.

Change in design: According to Bassa (2019), the Design change is a common process that influences the entire project's construction. And one of the effects of design changes in construction is cost overrun. Larsen, Shen and Brunoe (2016), the study that conducted project performance with 26 factors, found that design changes are the second highest causes of change orders in a project resulting in cost overruns, Yanna stated in his study that change in designs results in 12.4% of cost deviations from the total cost of project. and are primarily initiated by Owners in their study while in this research it is consultants The factors causing design changes from literature are found to be 1. Lack of design review during the design process. 2. Errors and omissions of consultants, 3. Incomplete contract documents. Both the questionnaire response and desk study showed that Design changes are the second most important cause of change orders that resulted in cost overrun. In practical examples change in designs can be numerous but to mention a few from observation: change of structural elements, change of direction and design of access road, change of finishing materials.

The conflict between contractual documents: - in the questionnaire results these are the third most important causes of change orders. According to (N. Jaffar*, A. H. Abdul Tharim, M. N. Shuib, (2011)) contractual Document errors become the designer's fault when the errors cause financial liabilities based on the judgment of its peers and industry custom. According to (I. D. Cox , J. P. Morris , J. H. Rogerson & G. E. Jared, 2010) change orders resulting from contractual documents are the primary causes of disputes and arbitration in construction projects because one clause or specification mat be supported in one document and opposed in another. Errors in contract documents become payables when someone who has a right to rely on the professional is seriously injured or damaged. The consulting body is the responsible organizer of contract documents and in situations like this it will be the most affected party. In this study defects in contractual documents are ranked the 3rd cause of cost overruns.

Lack of Clarity in scope: - the questionnaire responders agreed that if the scope of the construction project isn't specified in the contract documents of the project. A model study by (Ali V. , F.Nasirzadeh & A. Mills, 2020) showed that raising the level of project scope clarity can minimize design cost by reducing design changes in project delivery, which can ultimately

reduce project cost. This means that reducing the clarity level of the project scope has a negative impact on project cost throughout the delivery of the project. (B. Xia, B. Xiong, e.t., 2016) studied the casual relationship between scope clarity/definition with project performance. Scope definition was found to be significantly correlated with project success in a survey of Chinese construction. And not only does it scope clarity positively correlates with project success it also is a major contributor to the cost performance of a project.

Differing site condition: - these causes of change orders are the third most important causes in the desk study and 5th in the questionnaire response resulting in change orders. According to (Siddiqi & Akinhanmi, 2006) it is caused by site conditions that differ significantly from those specified in contract documents and is a common source of Cost overrun in construction. According to (I. D. Cox , J. P. Morris , J. H. Rogerson & G. E. Jared, 2010), its important to acknowledge the necessity as well as the difficulty involved in data collection of design elements. The study described that differing site conditions have the adverse effect that result in 7.6% of cost overrun from total change orders conforming the necessity of higher emphasis during the planning stage of projects and involvement of technology. (W. Amarasekara, B. Perera and M. Rodrigo, 2018) stated in their study that lumpsum contracts are the highest affected contract types and it is the contractor that is expected to account for risk of unforeseen site conditions by including a contingency factor in his bid. These differing site conditions include Inadequate bearing capacity soil, Soils that cannot be reused as structural fill, unexpected groundwater, and rock in the formation are common conditions that are categorized as differing site conditions. And from the researcher's personal experience this factor is the most occurring and a significant (B. Xia, B. Xiong, e.t., 2016)cause for cost overrun and disputes in government financed construction projects. unexpected ground water in the most recurring cause.

Material Change: - According to (Goodrum et al., n.d. 2009) constructions that have seen significant changes in material technology have also seen significantly greater long-term improvements in labor and partial factor productivity but also result in significant additional cost. Material changes can be caused by the desire to reduce weight, the desire to increase strength, the durability of the material, installation factors, labor productivity can result in material change ultimately causing cost adjustment in the projects. the research found that in the desk study material changes are the fourth important causes for change orders by being approved in 4 of the

15 sampled projects. (Mahamid, 2020) stated that not only material change has a direct impact on construction it also has indirect and consequential effect by creating material waste as a result of demolition. And can also be caused by non-conformance with specification by which the liable contractual party is the contractor. (Mahamid, 2020) adds that rework due to worker errors, selecting the lowest bidder contractor/subcontractor, frequent design changes, and design and construction detail errors are the top five affecting causes for material change, according to the contractors. In this study the researcher also adds that poor site management, lack of proper skilled labor and inadequate planning from contractor are observed in the area of study. And the contractor is the most affected contractual party that is financially affected by this variable.

4.4 Regression Analysis and Review

According to (chatterjee, Samprit, and Ali s., 2006) Regression analysis is a concise method for investigating functional relationships between variables. Using the mentioned formula in the methodology part of this study, regression analysis will be done in this section. But before continuing to the analysis certain assumptions need to be tested. The following are assumptions made before regression analysis.

Linearity test.

This test determines the relationship between the variables. The value of sig. for deviation from linearity has to be more than 0.05 for the variables to be linearly dependent. And if the value of sig. is less than 0.05, the variables will not be considered as linearly dependent.

Table 4. 11 Linearity test

ANOVA Cost effect of CO on projects							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		120.974	48	2.520	1.413	0.355
	Linear Term	Weighted	81.421	1	81.421	45.647	0.001
		Deviation	39.553	47	0.842	.472	0.931
Within Groups			10.702	6	1.784		
Total			131.676	54			

Source: Own survey (2022)

As presented in the table sig value for the linearity test of the variables is greater than 0.05, this means that the relationship between the variables i.e., change orders and cost of a project is linear.

Normality Test.

Normality test computes the sample results to a normally distributed set of results with the same mean and standard deviation to determine whether the error is normally distributed. Even though some residuals fell outside the curve, majority of the residuals are inside the curve and are very close. As is can be seen from the figure, the histogram is ball shaped making the disturbance of error distribution normal.

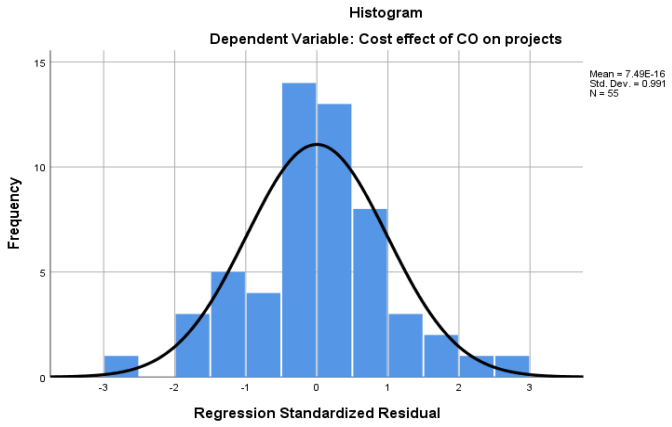


Figure 4. 3 Frequency distribution Standardized Residual

Figure 4.4 also testes Regression assumption by using Normal Probability Plot (P-P) using standardized residual scatter plot. The points on the scatter plot are reasonably consistent on the straight line conforming the assumption that the variables are linear.

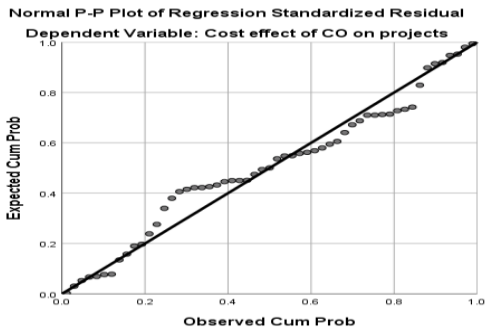


Figure 4. 4 Probability Plot of standardized residuals

Heteroscedasticity test (scatter plot)

Using the scatter plot of SPSS output, this test can be performed simply by looking at the diagram below. It determines whether the variance of a regression's errors is affected by the values of the independent variables. The extinction of a particular pattern in the plot will justify the Heteroscedasticity of the analysis. And if there exists a pattern of points in the diagram, the Heteroscedasticity test fails.

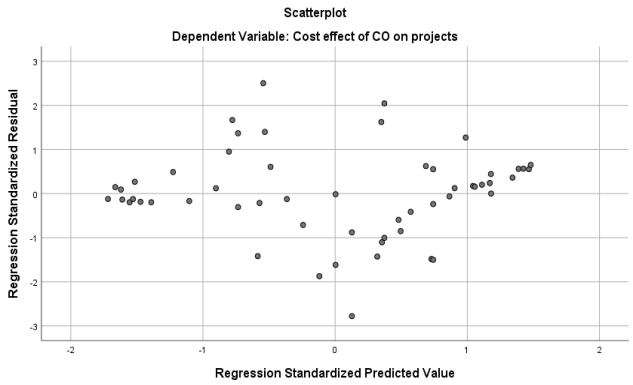


Figure 4. 5 Scatter plot Diagram

As it can be observed in the above figure, the points on the diagram are distributed with no aligning pattern, which can be agreed that the regression model conforms with heteroscedasticity assumption.

Regression Analysis

In order to analyze the cause of change orders and their effect of project cost, a linear regression was conducted after the above tests were completed. The following section examines the result gathered from SPSS regression analysis software.

The following table's model summery shows that R, which tells us what percentage of the variation in our dependent variable is explained by the independent variable, is 0.786. R^2 which statistic indicates how much of the variance in the dependent variable is explained by the independent variables collectively, is 0.618. This means that 61.8% of the variables have explained causes of change orders and the rest 32% is explained by factors outside the studied factors like competence of employees or other external factors like material inflation.

Table 4. 12 Model Summary of Regression

Model Summary[b]							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	0.786[a]	0.618	0.611	0.974	0.618	85.869	1

Source: Own survey (2022)

The next table shows the ANOVA output of the analysis. If the Significance (Sig.), which shows the slope of null hypothesis was greater than 0.05, it will mean the Null Hypothesis will have to be accepted. But the Sig. value is less than 0.01, which is statistically significant and the Null Hypothesis is Rejected. As a result, the regression model predicts the effect change orders have on project cost.

Table 4. 13 Analysis of Variance

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	81.421	1	81.421	85.869	0.000[b]
	Residual	50.255	53	0.948		
	Total	131.676	54			
a. Dependent Variable: Cost effect of CO on projects						
b. Predictors: (Constant), Change order on projects						

Source: Own survey (2022)

The next description shows summary of coefficient the graph of the slope or regression. It displays significance value of the independent variable less than 0.01 which can be concluded that change orders have a significant effect on project cost. The constant results are $\beta = 0.151$ meaning that one percent of increase in change orders, the cost of project will increase by 15.1 percent. There for the result implies that change order is a significant predictor for the overrun of costs in a project. the regression equation also predicts the cost effect the effect of change orders on project cost as presented below. The graph of the slope with negative Y intercept means that effect of change orders on projects with lower initial costs can further be examined with larger sample size in future researches.

Table 4. 14 Regression Model Summary

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-1.192	1.489		-0.801	0.427		
	Change order on projects	0.151	0.016	0.786	9.267	0.000	1.000	1.000

Source: Own survey

$Y = \alpha + \beta X + e,$ $Y = -1.192 + 0.151 X$

Where, Y = Project Cost, α = -1.192 (constant), β= 0.151 (Coefficient of X)

X= Change order e = Sampling Error.

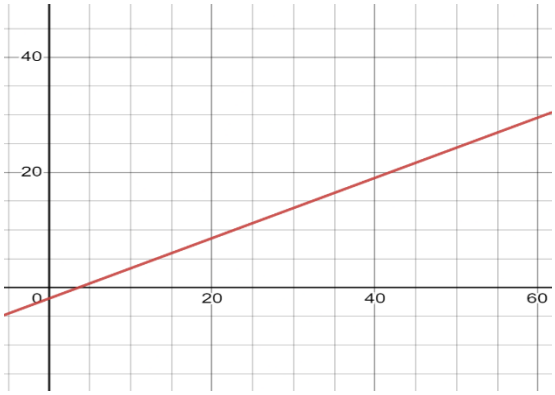


Figure 4. 6 Regression Diagram

4.5. Hypothesis Testing

As discussed in previous sections, the relationship between change orders and their effect on project cost is significant. The coefficient of X (change order multiplier), is significant because $\beta = 0.151$ and significant of the null variable (p) from ANOVA result is less than 0.01.

As a result, H_1: Change Order affects Cost of Construction project is Accepted.

The hypothesis and result of this research in which change orders affect cost of a project has been further incorporated by previous researches. According to (Senouci, 2017) Because of change orders, most construction projects will see contract adjustments that increase the

construction cost by 5 to 10%. These in turn will have various ripple effects in the economy and plan of all contractual paties. (Cox, 1997) also stated the impacts of change orders can have on indirect costs like insurance, time value of money and inflation. (Alnuaimi, n.d.) also confirmed that change orders, if not managed, can cause disputes and arbitration because the material and labor costs will be affected primarily. The study by (Oladiran, 2018) in Lagos also confirms that change orders will affect the overall cost of a construction project and bring about further performance issues in the overall project.

Chapter Five

Summary, Conclusion & Recommendations

5.1. Summary

The research set out with four specific objectives to understand causes of change orders and their effect on cost of a project. using questionnaire survey and desk study a relative importance index for the most prominent causes of change orders were identified.

As a result, change orders caused 12% of cost increase in the final/estimated cost of projects in the desk study. The most prominent causes of change orders that the research identified were 1. Error and Omission in design. 2. Design change. and 3. Differing site conditions. These causes for change orders happened in more than half of the observed projects the minimum cost increase in a project was 5% and the maximum was 30% of the initial budget plan.

The result of the questionnaire analysis correlates with the desk study that the most prominent causes for change orders is Error and omissions in design and change in design is the second. But different from the desk study, conflict between contractual documents is the third most occurring cause for change orders.

Further regression analysis was performed on the questionnaire data to predict the effect change orders have on project cost. Testes for normality, the tests for linearity, normality and Heteroscedasticity were performed using AVOVA test, Histogram and scatterplot respectively which allowed the regression to continue. The coefficient of determination (R^2) result is 0.611 and this resulted in the regression constant alpha to be - 1.192 means that the effect of change orders in this study has been studied on projects of larger initial costs. The constant of X = 0.151 and the significance of the null hypothesis (sig.) is less than 0.01, on which the null hypothesis was deemed unacceptable.

All the three specific objectives of the paper were met and the first hypothesis, change order affects cost of a project, was accepted and the null hypothesis, change order does not affect cost of a project was rejected.

5.2. Conclusion

The paper started out by trying to identify the prevalence of change orders and weather they affect cost of projects in Addis Ababa Design and Construction Works Bureau. The result determined from the questionnaire concluded that 100% of respondents agreed change order is a problem in the organization and 96.4% agreed change orders happen frequently in Addis Ababa Design and Construction Works Bureau. The sample projects in the desk study also strengthen this result by indicating the cost impact of change orders resulting to an average of 12% increase in cost from initial budget. Therefore, Change Orders are one of the major problems regarding cost overruns in Addis Ababa Design and Construction Works Bureau.

Regarding causes of change orders, 21 possible causes were examined using RII and the findings from this analysis has deduced that the 5 most important causes that are resulting cost overruns are Errors and Omissions in Designs, Design Changes, Conflicts in contractual Documents, Lack of clarity in scope and Differing site Conditions. All of these variables, as presented in the literature section, fall under the control of the consultant which in turn will imply the necessity of higher emphasis during design phase of projects.

The research's third objective was to examine the cost implications of change orders and Additional Material cost has been found to be the most affected type of cost resulting in cost overrun. Additional Labor cost and Indirect costs are the second and third implications that change orders are affecting project cost.

To further implicate the results, the regression analysis resulted in 61% of change orders can be accounted for change orders in a project. Additionally, change orders are significant predictors of the cost performance of a project. The regression result has indicated that one percent of a change order will increase the cost of a project cost by 15.1%.

5.3. Recommendation

As concluded by the research, change orders play a significant role in determining the cost performance of a project. Managing them properly will determine if the project is going to overrun the budget of the project. Also, the fourth and final objective of this paper is to propose ways of mitigating the effect of change orders on project cost. Establishing effective construction change management is the first thing that needs to be given attention in order to minimize change

orders and their cost effects, which requires both engineering and project management knowledge. Proactive change manager it is important for identifying and forecasting potential changes as well as developing solutions before it happens.

As the study indicated, the predominant causes of change orders lie in the consultants' territories. From the beginning of the project to its completion on the ground, consultants should play their part according to the expected disciplinary requirements. This is because it is the consultant's job to coordinate all types of information in order to meet the needs of employers and other stakeholders.

High emphasis needs to be put on gathering the necessary field data during site investigation, holistic feasibility studies should be conducted that would accommodate the various stake holders, and make a proper market study and analyze costs of materials, labor and also investigate the indirect costs that can be incurred before issuing a change order. providing clear and errorless designs are also required from the consultant, making it necessary for preliminary design revisions by the contractual bodies before ground break.

Involving contractors in the design phase is also recommended. After the commencement, the project's major activities fall on the contractor's lap. The contractor's insight in design phase might help prevent change orders that will happen during construction.

The employers (the various city authorities) should conduct a thorough and comprehensive project feasibility study before implementing the projects to their material equivalent as project promoters. This would save money and prevent the client from changing their mind about the project. It is preferable if the ideas of other stakeholders are properly understood to help minimize such shifts in thinking. And, once the project is underway, the employer should stick as closely as possible to the very first of its project ideas in order to avoid scope changes that may occur during implementation. Further research can also be performed on the independent variables and how Technology can help minimize these factors

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Appendix A

St. Mary's University

School of Graduate Studies

MA in Project Management

Questionnaire survey

Causes of change orders and their impact on construction cost: The Case of Addis Ababa Design and Construction Works Bureau.

By Girum Haile

Greetings, this is research being conducted for the partial fulfillment of a Master of Arts degree in project management at Saint Mary's university. This questionnaire is designed under the advisory of Dr. Maru Shete (ass. Prof.) to assess the causes of change orders and their impact on construction cost, particularly in Addis Ababa design and construction works bureau.

I sincerely request your support and involvement by answering all the questions to the best of your knowledge. The questions are simple and the answering mechanism is only putting (√) in the space provided. Any information you may provide is appreciated. It's a strictly confidential questionnaire and your answers will only be used for academic purposes.

The questionnaire has 4 parts and I kindly request you to fill all the questions as this academic paper will be helpful in understanding the subject matter from different perspectives of professional knowledge and experience.

Sincerely,

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Part I

Dear respondent, in this part of your questionnaire, you are only required to give information about your personal background. You can proceed answering by putting only the "√ "sign in the box provided.

1. What type of organization are you in?

   1. Contractor ☐ 2. Consultant ☐ 3. Client/Owner ☐

2. What is your responsibility in the organization?

   1. Project Manager ☐ 4. Site Engineer ☐

   2. Resident Engineer ☐ 5. Office Engineer ☐

   3. Contract Administrator ☐ 6. Material Engineer ☐

   If there are others please specify _____

3. How long have you been working in the construction industry? _____ Years

Part II

In this part of the survey, the researcher wants to know the existence and prevalence of Change orders and also the level of influence it has from your perspective in the Addis Ababa Design and construction works bureau.

No	Variable	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1	Change order is a problem in AADCWB.					
2	Change order frequently occurs in AADCWB.					

Part III

In this part the researcher wants to ask your opinion on the factors that cause Change orders. The variables are listed on the bases of contractual stake holders in the Addis Ababa Design and construction works bureau and your responses should be putting any symbol or letter on your preference in only one space in line with that particular variable or reason.

No	Independent Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Owner Related Causes	1	2	3	4	5
1	Owners' financial problems					
2	Change of scope					
3	Impediment to prompt decision making process					
4	Inadequate Project Objectives					
5	Change in the specification by owner					
6	Obstinate nature of the owner					

The next table is for factors that cause a change order from the Consultant point of interest.

No	Independent Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Consultant related causes	1	2	3	4	5
1	Change in Design					
2	Errors & omissions in design					
3	Conflict between contractual documents					
4	Technological change					
5	Lack of Clarity in Scope of work					
6	Differing site conditions					
7	Value Engineering					

In this part, the factors causing change orders are from the contractor's side.

No	Independent Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	Contractor related causes	1	2	3	4	5
1	Contractor's financial Difficulties					
2	Unavailability of Equipment					
3	Unavailability of skilled Labor					
4	Defective workmanship					
5	Lack of Involvement in design					

This table is for the additional reasons that are out of the control of the contractual bodies but can still cause a change order in construction projects.

No	Independent Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	External Factors	1	2	3	4	5
1	Weather Conditions					
2	New Government Regulations					
3	Health & Safety Considerations					

Part IV

This is the final section of this questionnaire, and in this part, the question is about the cost effect of change orders. From your perspective, please reply on the level of disagreement or agreement you have on the impact and put any symbol or letter in line with the variable.

Dependent Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Indicators of Change orders	1	2	3	4	5
Additional Material cost					
Additional Labor Cost					
Additional Indirect Costs.					

Thank You!

Appendix B

Reliability Analysis (Cronbach's Alpha)

Prevalence of CO

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	0
	Total	55	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.0.731	0.738	2

Owner related Variables

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	.0
	Total	55	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.872	0.878	6

Consultant related factors

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	.0
	Total	55	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.929	0.929	7

Contractor Related Factors

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	.0
	Total	55	100.0

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.942	0.942	5

a. Listwise deletion based on all variables in the procedure.

External Factors

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	.0
	Total	55	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.823	0.821	3

Cost Effects of CO

Case Processing Summary			
		N	%
Cases	Valid	55	100.0
	Excluded[a]	0	.0
	Total	55	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics		
Cronbach's Alpha[a]	Cronbach's Alpha Based on Standardized Items[a]	N of Items
0.903	0.904	3

Appendix C

Descriptive statistics of respondent's factors causing change orders.

variables related to owners		SD	D	N	A	SA	SUM	MEAN	Std. DEV
Owners' financial problems	N	3	4	9	10	29	55	3.40	1.029
	%	1.65	7.27	16.36	18.18	52.73	100		
Change of scope by the owner	N	2	2	10	19	22	55	3.84	1.198
	%	1.10	3.64	18.18	34.55	40.00	100		
Impediment to prompt decision making process	N	2	0	10	13	30	55	3.95	0.870
	%	1.10	0.00	18.18	23.64	54.55	100		
inadequate project objectives by clients	N	1	6	8	14	26	55	3.75	1.190
	%	0.55	10.91	14.55	25.45	47.27	100		
Change in specification by owners	N	0	9	9	16	21	55	3.80	1.043
	%	0.00	16.36	16.36	29.09	38.18	100		
obstinate nature of owners	N	0	2	20	24	9	55	3.58	0.712
	%	0.00	3.64	36.36	43.64	16.36	100		
Variables Related to Consultants		SD	D	N	A	SA	SUM	MEAN	Std. DEV
Change in design by consultant	N	0	4	0	23	28	55	4.36	0.825
	%	0.00	7.27	0.00	41.82	50.91	100		
errors &	N	0	0	0	23	32	55	4.58	0.498

omissions by consultants	%	0.00	0.00	0.00	41.82	58.18	100		
Conflict between contractual documents	N	0	0	8	22	25	55	4.31	0.717
	%	0.00	0.00	14.55	40.00	45.45	100		
Technological changes	N	0	4	19	27	5	55	3.60	0.760
	%	0.00	7.27	34.55	49.09	9.09	100		
Lack of clarity in scope of work	N	0	0	9	22	24	55	4.24	0.719
	%	0.00	0.00	16.36	40.00	43.64	100		
Differing site conditions	N	0	0	2	12	41	55	4.18	0.475
	%	0.00	0.00	3.64	21.82	74.55	100		
Value engineering	N	0	1	12	22	20	55	4.11	0.809
	%	0.00	1.82	21.82	40.00	36.36	100		
Variables related to Contractors		SD	D	N	A	SA	SUM	MEAN	Std. DEV
Contractor's financial difficulties	N	0	18	6	12	19	55	3.58	1.272
	%	0.00	32.73	10.91	21.82	34.55	100		
unavailability of equipment	N	0	9	1	26	19	55	4.00	1.018
	%	0.00	16.36	1.82	47.27	34.55	100		
unavailability of skilled labor	N	0	2	10	20	17	55	3.73	1.254
	%	0.00	3.64	18.18	36.36	30.91	100		
Defective workman ship	N	0	8	3	28	16	55	3.95	0.970
	%	0.00	14.55	5.45	50.91	29.09	100		

lack of involvement of contractor during design stage	N	0	6	1	35	13	55	4.00	0.839
	%	0.00	10.91	1.82	63.64	23.64	100		
External Factors		SD	D	N	A	SA	SUM	MEAN	Std. DEV
weather conditions	N	0	0	14	25	16	55	4.04	0.744
	%	0.00	0.00	25.45	45.45	29.09	100		
new government regulations	N	0	0	18	18	19	55	4.02	0.828
	%	0.00	0.00	32.73	32.73	34.55	100		
Health safety considerations	N	0	4	17	24	10	55	3.73	0.849
	%	0.00	7.27	30.91	43.64	18.18	100		
Cost effects of change orders		SD	D	N	A	SA	SUM	MEAN	Std. DEV
Additional Labor Cost	N	0	0	0	14	41	55	4.75	0.440
	%	0.00	0.00	0.00	25.45	74.55	100		
Additional Material Cost	N	0	0	0	12	43	55	4.78	0.417
	%	0.00	0.00	0.00	21.82	78.18	100		
Additional indirect cost	N	0	0	0	18	37	55	4.67	0.474
	%	0.00	0.00	0.00	32.73	67.27	100		