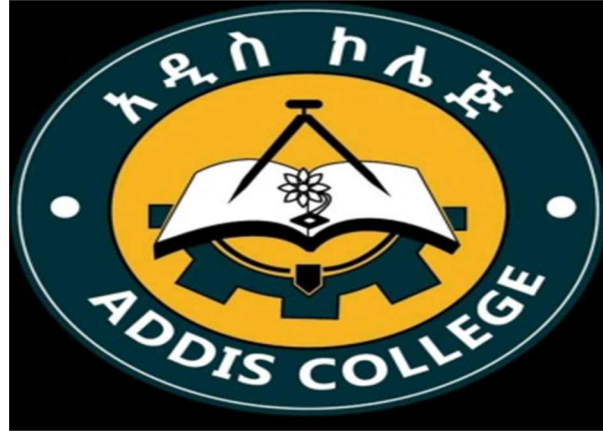


**ADDIS COLLEGE
SCHOOL OF GRADUATE STUDIES**



**DEPARTMENT OF CONSTRUCTION TECHNOLOGY
AND MANAGEMENT**

**RESPONSIBILITIES AND STRATEGIC TOOLS TO
MINIMIZE VARIATION WORKS**

By

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**A Thesis Submitted to School of Graduate Studies of
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Fulfillment of the Requirements for the Degree of Master of Science in Construction
Technology & Management.**

**August 2023
Addis Ababa, Ethiopia**

**ADDIS COLLEGE
SCHOOL OF GRADUATES STUDIES**

CERTIFICATE OF APPROVAL

This is to certify that the thesis entitled “Responsibilities and Strategic Tools to Minimize Variation Works on Building Projects in Addis Ababa: the case of projects supervised by BUDSWS” submitted in partial fulfillment of the requirements for the Degree of Masters of Science in Construction Technology and Management complies with the regulations of the college and meets the accepted standards with the respect to originality and quality.

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DECLARATION

I, Asrat Solomon, hereby declare that this thesis entitled “Responsibilities and Strategic Tools to Minimize Variation Works on Building Projects in Addis Ababa: the case of projects supervised by BUDSWS” is my own work and has not been submitted to any University for similar purposes. The references used in this thesis are duly recognized by proper citations.

Asrat Solomon
Name of student

Signature

August 8, 2023
Date

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ABSTRACT

Construction projects involve the integration of different parties and are executed in a changing environment which makes them complex and dynamic. Decisions on project objectives are decided with certain degree of uncertainties. Due to these features, almost all projects are subjected to variations. Because these variations impact the performance of projects mainly in terms of time, cost and quality, they have to be managed. Building projects are under construction in Addis Ababa and these projects suffer from the effects of variations. The objective of this study is to identify the causes and determine the effects of variations thereby developing strategic tools that minimize them. A questionnaire that addresses the objectives of the study was developed together with semi structured interview questions. Desk study was also conducted. Questionnaire, interview and desk study were the methods used. Data from questionnaire were analyzed using relative important index method whereas commonly given points from interviews were analyzed thematically. Cost implications of variation orders were used to prioritize the causes and impact of variation orders from desk study. Results obtained were triangulated. Change of plans or scope, change in specifications, errors and omissions in design and conflict between contract documents were identified as causes of variation orders whereas increase in project cost, project completion delay, increase in overhead expenses, additional payment for Contractor and effect on work progress were determined as effects of variations. A well prepared project brief, conducting soil tests, producing complete design, identifying variations at early stage and regulatory body's responsibility to bring accountability on variation issuance are recommended to minimize variations.

Key words: VARIATION ORDER, CAUSE, EFFECT, STRATEGIC TOOLS, BUILDING PROJECTS, ADDIS ABABA

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LIST OF ABBREVIATIONS

BOQ	Bill of Quantity
BOT	Build Operate and Transfer
BUSDSWS	Building and Urban Design and Supervision Works Sector
CII	Construction Industry Institute
DB	Design and Build
DBB	Design Bid and Build
ECPMI	Ethiopian Construction Project Management Institute
ECPMMS	Ethiopian Construction Project Management Manual Series
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
FPPA	Federal Public Procurement Agency
FIDIC	International Federation of Consulting Engineers
GCC	General Condition of Contract
MDB	Multilateral Development Bank
SBD	Standard Bid Document
SPSS	Statistical Package for Social Science
OSH	Occupational Safety and Health
RII	Relative Importance Index
UNICEF	United Nations International Children's Emergency Fund

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The construction industry makes significant contribution to socio-economic development process of countries. Its importance is manifested directly or indirectly by impacting other sectors' economic contribution. It uses a huge material resource. It also plays a vital role in reducing unemployment. However, though its versatile contribution is immense, the industry faces different challenges during implementation. The implementation of construction projects worldwide passes through different phases from inception to closeout. During all the phases there are factors that influence the ultimate goal of the project in either way: positively and/or negatively. One such factor is the issuance of variation orders during the construction phase which has the potential to affect project performance (Mohammed, 2001).

What is to be performed in a construction project is described in the project's scope of work in the contract documents. When the scope of work in the original contract is altered, then the change is entertained as variation work. Ibbs et al., (2007) define change as any event that results in modification of the original scope, execution time, cost and/or quality of work. Variation orders involve alteration, addition, omission, and substitution in terms of quality, quantity and schedule, at work and even in our daily lives are very common (Arain and Low 2006). Contractual clauses related to variation orders are included in contract agreements enabling the contracting parties to issue and entertain variations.

Due to the dynamic and complex nature of construction projects, variation orders are unavoidable. Project Clients' new or/and additional requirements, errors in design, ambiguities or conflicts in contract documents, Client's financial problems & challenging issues, material, equipment & plant unavailability, change in the specification, omissions in the contract documents are encountered during the implementation of projects. Such issues force the occurrence of variation orders. Sun and Meng (2008) mentioned that a change in construction projects refers to an alteration to design, building works, project programs or

project aspects caused by modifications of pre-existing conditions, assumptions, or requirements.

The Ethiopian government through its Ten Years Plan (2020/21 - 2029/30) sets targets of which one of them is what the construction industry development has to accomplish in order to play its role in the rapid development of the country. Two of the targets expected from the industry are to reduce the time wasted in implementing construction projects by 50% and to raise customer satisfaction by 75% (FDRE Planning and Development Commission, Ten Years Development Plan 2021 - 2030).

The construction industry in Ethiopia is booming all across the country. In Addis Ababa, high rising buildings both public and private are under construction at every corner. The budget allocated by the Ethiopian government to the construction sector is on the top list of other sectors (UNICEF Ethiopia, Analysis of 2020/21 and 2021/22 Federal Budget Proclamation). However, the implementation of projects faces extremely low performance mainly in terms of time and cost. Like any other project, projects in Addis Abba suffer setbacks in their implementation due to various factors both external & internal. One such factor and that is the area of focus of this study is the issuance of variation orders.

Some building projects that are under construction in Addis Ababa were selected for the study to assess relevant issues in connection with variation orders. The projects have had different commencement dates ranging from June 2015 to November 2022 and their financial work progress varies from 1% to 137% (as per March 2023 monthly work progress reports). The study focused on identifying the causes of variation orders and their subsequent effects on the performance and delivery of the projects during implementation and recommends strategic tools that minimize their effect.

1.2 Statement of the problem

The ultimate goal of the construction industry is to provide infrastructures and buildings for socio - economic development of mankind. However, the practice of effective project delivery in time, cost and quality and other related project objectives is a challenge due to the very complex and dynamic nature of the industry. One such attribute to this challenge of

effective project delivery in time, cost, and quality is the case of changes made in drawings and contract documents that result variation orders. Variation orders affect construction projects mainly in a way of cost overrun and time overrun. According to Arian and Pheng (2005a) the most frequent effect of variation is project cost and time over run due to additional work or change in design which is not incorporated prior to signing of contract.

Studies show that variation orders make a contribution of 6% to 17% cost overruns in construction projects (Hsieh et al., 2004, Mohamed, 2001); whereas, time overrun due to variation orders are in the magnitude of 10% up to 50% (Kumaraswamy et al., 1998). Variation orders are also the major causes of contractual claims, with a staggering 60% of all claims being attributed to variation order (Munala, et al., 2014).

Currently in Ethiopia, it is common to see project completion reports that projects are completed taking twice or thrice of their original contract time and as double as their original project budget. Most of the problems are related with the way the projects are managed from inception to closeout. One of the problems is issuance of variation orders which are unavoidable (Ibbs et al., 2001).

As per the data collected from one of the projects on which the study was conducted, by the time the financial work progress of the project was 67.47%, the sum of money already approved for variation orders was 63.69% of the originally accepted contract price during bidding whereas the time extended for the same variation orders was 63.89% of the original contract time. These figures show the severity of the problem on how variation orders are adversely affecting project implementation.

Services that could have been obtained and yet lost from projects due to late delivery, incomes that could have been generated from projects had they been completed in time are huge. When we look the problem on the aggregate over the whole of projects nationwide or globally for that matter, the adverse effect be it due to variation orders or other lack of project management skills is significant. Construction project in Addis Ababa are not different and are affected hugely. Preliminary assessment on the adverse effect of variation orders on building projects in Addis Ababa completed or under construction were/are significant.

The objective of this study is to investigate the causes and effects of variation orders in building construction projects in Addis Ababa supervised by BUDSWS. Knowing the causes and effects highly enable to articulate proactive or active measures that keep variation orders as minimum as possible. The benefits that could have been obtained and yet lost because of variation orders mentioned above are also widely seen on these projects. The study also developed strategies how variations can be minimized in future projects or reduce their effects on ongoing ones so that projects may benefit from the contribution of the research mainly in reducing the delays and unplanned budget expenditure.

1.3 Objective of the study

1.3.1 General objective

The general objective of this research is to investigate the causes and effects of variation orders in building projects in Addis Ababa supervised by BUDSWS thereby identifying responsibilities and strategic tools to minimize variation works.

1.3.2 Specific Objectives

The specific objectives of the study are:

- 1) To identify the causes & assess the impacts of variation orders in building construction projects
- 2) To examine the responsibility of the regulatory body of the Ethiopian construction industry to bring accountability to Consulting firms for variation orders above the acceptable norm
- 3) To develop strategic tools that can be taken to keep variation orders as minimum as possible and reduce their adverse effects when they occur.

1.4 Research Questions

The study attempts to answer the following research questions:

- 1) What are the causes of variation orders in building projects?
- 2) What are the effects of variation works with regards to project performance and delivery of building projects?

- 3) What does the government regulatory body need to do to bring accountability as regards to controlling variation orders by bringing accountability on consulting firms?
- 4) What strategic tools can be taken to minimize variation orders starting from procurement planning phase up to project completion?

1.5 Scope of the study

1.5.1 Thematic scope

Construction projects are ongoing across Ethiopia owned by both the government and private entities. Many of the projects do involve Engineering Consultancy firms taking on both design and supervision & contract administration works or either of them on the projects. Most of the Consulting firms are private companies and there are also a few owned by the government. One such government consulting firm established and rendering engineering consultancy services since 1977 is BUDSWS, of which variation orders on building projects under supervision & contract administration were the focus area of the study. The study focused on the causes and effects of variation orders of the above mentioned projects whose construction commencement dates is from 2015 to 2022. The survey of the study was conducted among those direct contracting stakeholders of the projects.

1.5.2 Spatial Scope

The study was conducted in Addis Ababa, Ethiopia. The building projects selected for the study were those ongoing construction projects supervised and contractually administered by BUDSWS. The research on causes and effects of variation orders was limited to the building projects supervised and contractually administered by BUDSWS in Addis Ababa area. The specific location of the projects with respect to the eleven sub-cities of Addis Ababa has been indicated on Table 4.9 and map of the study area is also shown Fig 3.1.

1.6 Significance of the study

The construction industry has experienced a huge volume of work in Ethiopia especially in the last two decades. Due to several reasons, almost all construction projects in the country have encountered changes that have been costly and most of the time unwelcomed by the

contracting parties. Thus, changes have to be managed well to minimize their adverse effects so that project objectives can be met as planned during project implementation.

The outcome of this study boldly stated the causes and effects of change orders thereby providing measures that can be taken during pre-construction and during construction phases of building projects so that it would be possible to minimize variations both in number as well as their adverse effects. Findings of the study are believed to contribute valuable knowledge to how projects can better be managed in achieving project objectives as regards to variation orders. Project Employers and Consultants will benefit from the findings of the research which they can use during their preparation of contract documents including design drawings. Policy makers make informed decisions based on studies conducted by the respective professionals in a way of researches. Respective government bodies involved in the construction industry like that of Ministry of Infrastructure and Urban Development for the case of Ethiopia may find some useful points from such studies from which they may articulate and present to the policy makers or use for themselves. The recommendations that are to be given based on this research could be an input in formulating procurement methods that shall have to be forwarded as a directive or circular. Last but not least, the research can be used as a reference for other researchers and interested groups in the field of variation orders.

1.7 Organization of the study

The study is divided into five chapters, each chapter having sub chapters based on the titles that address the objectives of the research. Each chapter is organized as shown below, with a short brief as extracted from the right ups.

Chapter 1: This is the Introduction part in which background of the study was discussed. The very reasons that led to conduct the study were explained. The chapter also includes research parts like statement of the problem, objectives, the questions to be answered, scope of the study, significance of the study and organization & framework of the research.

Chapter 2: This is the chapter in which the literature review part of the study is organized. The literature was presented referring books, journals, magazines, internet

searches, unpublished documents that discuss the research topic. Causes, effects and controlling mechanisms of variation orders are mentioned in this part in reference to the respective reviewed documents. Most of the variables used to address the research objectives were selected from the review made.

Chapter 3: The methodology by which the research was conducted is covered in this chapter. The systematic approach followed to solve the research problem is covered in this chapter. Research design, sampling technique, methods used to collect data, data analysis methods and other relevant items are described in this chapter.

Chapter 4: This chapter contains results and discussion part. Data collected from questionnaire, interview and desk study were analyzed from which results were obtained. Discussion on the results in reference to previously conducted studies by others on the research topic was also made.

Chapter 5: This is the last chapter of the study in which conclusions were drawn from the research findings together with the measures recommended to be taken proactively and actively in order to minimize variation orders and reduce their negative effects when they occur. Recommendation for future studies on related subject matters that can be taken to add some value on the research topic were also forwarded for consideration.

Summary of the contents of the study mentioned above, represented by their respective chapters and the framework of the study are presented below.

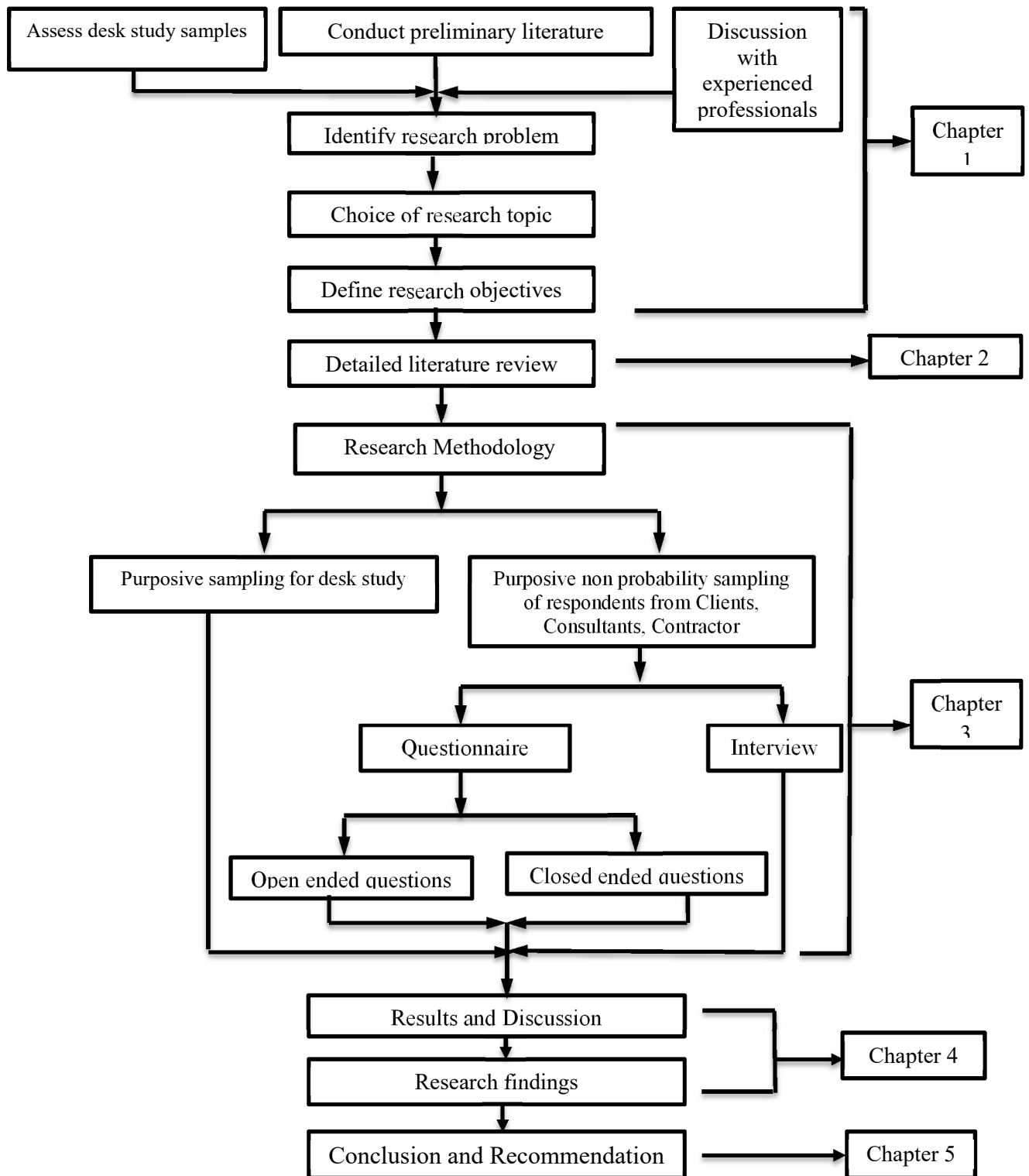


Figure 1.1: Framework of the study and the chapters in which the study is organized

CHAPTER TWO: LITERATURE REVIEW

Variation orders being unavoidable and do have a major impact mainly on cost and time of projects, it is imperative to deal with their effects during the construction phase (Ibbs et al., 2001). To do this, identifying their root causes and mitigate their sources and taking proactive measures in a way that would minimize the adverse effects of variation orders on project performance is necessary (Mohammed, 2001). As to this effect, various related issues of variation orders are reviewed in this chapter.

2.1 Conceptual Literature

Definition of variation orders and how common they are

The definition of variation orders in construction differs from one standard form of contract to the other. There is no a single definition of variation order accepted worldwide though the very basic principle is the same. Most authors define variation order as alteration from what was agreed in the original contract scope of work that includes addition, substitution, omission and modification. The alteration could be due to different reasons. Technological, advancement, statutory changes or enforcements, changes in the site conditions, unavailability of specified materials & equipment, design errors & omissions, further development of the design after the contract has been awarded, scope changes, etc are some of the reasons behind the change. According to Arain & Pheng (2005b), a variation order is any modification to the contractual guidance provided to the Contractor by the Client or the Client's representatives. Al – Dubasi (2000) broadens the definition of variation order and addressed it to have a legal status. For him, a variation order is a written order given to the Contractor, signed by the Client and issued after the execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time. The Research Report 158 -11 published by the CII (2001) also defines change in construction as any event which results in a modification of the original scope, extension time, or cost of work. As their meanings are equivalent, in this research paper change order and variation order are used interchangeable as they mean the same.

In addition to the above definitions, below are other concepts of variation order as it is stated in the respective documents:

1. Standard Bidding Documents (SBD) Prepared by Ethiopian FPPA and Manuals Prepared by ECPMI

The FPPA (2006) General Condition of Contract for Works defines “Variation” as an instruction given by the Engineer, which varies the Works.

Using the term “Change Order”, the FPPA (2011) General Condition of Contract for Works on Clause 15, states that change order is any modification that may include additions, omissions, substitutions, changes in quality, quantity, form, character, kind, position, dimension, level or line and changes in the specified sequence, method or timing of execution of the works.

The Ethiopian Project Management Institute, in its 19 series manuals on the Construction Project Scope Management Manual (ECPMMS: WM – 02, p -3) describes Variation of Works as alterations in the form of additions and omissions for which change orders are instructed due to incomplete designs, requirement changes and/or missed trade of works. The manual went further and mentioned that these alterations were one of the main reasons that initiated the preparation of the Scope Management Manual Series.

2. FIDIC Standard Form of Contract

According to FIDIC MDB Harmonized Version (2010) General Condition of the Contract, “Variation” means any change to the Works, which is instructed or approved as variation under Clause 13 which may include changes to quantities, qualities & levels or positions or dimensions of the Works in addition to omissions, additions of the works or changes to sequence or timing of the execution of the Works.

3. Variation as per Ethiopian CIVIL Code – 1960(Contracts of Work and Labor)

The Ethiopian Civil Code describes variation as alteration in the work and it may be required by both the Client and Contractor different from the one originally planned. That of the Client request is a right whereas that of the Contractor is for technical reasons. Below are the Articles that describe about variation.

Article 3031. – Alternations required by Client. - 1. Rights of Client

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

Article 3034 – Alteration required by Contractor

- Where it appears necessary for technical reasons to make alternations 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 alternations do not result in the having to pay an increased price.

4. FDRE Proclamation No. 649/2009

As per the proclamation made for procurement and property administration, Proclamation No. 649/2009 addresses the necessity of variation works in the form of additional work by direct procurement. Article 51 Sub-article 1(c) of the proclamation reads as follow:

“Within limits defined in the procurement directives, when additional works which have been not included in the initial contract have, through unforeseeable circumstances, become necessary since the separation of the additional works from the initial contract would be difficult for technical or economic reasons.”

5. Federal Public Procurement Directive of June 2010

The directive issued by FDRE Ministry of Finance & Economic Development in June 2010 after Proclamation No. 649/2009 was proclaimed, also gives outlines for variation order in the form of additional works that can be procured from a single source procurement, in our case a Contractor who is carrying out the construction of a project, if there is any advantage

to be gained from procuring such additional requirements of the same kind from the same source. Article 25 Sub - article 25.1(a) of the directive reads as follow:

“The volume of the additional requirements of goods, works, or consultancy assignment may not exceed 25% of the volume of such goods, works or consultancy assignment under the initial contract.”

If there needs to enter into a new contract or vary the initial contract, or the execution of works which have not been foreseen or not included in the initial contract, Article 25 Sub - article 25.3(a) of the directive reads as follow:

“The Public Body has to ascertain that the additional works should have been included in the initial contract, and the separation of the additional works from the initial contract would be difficult for technical or economic reasons.”

As it can be seen from the above definitions of variation order, the basic principle of all the definitions is the same and that is, it is a “change” from what it was agreed upon originally.

Because of the interconnections they involve and the environment under which they operate, construction projects are complex and dynamic in nature. Because of this nature, they encounter variations. According to Arian & Low (2007), construction projects encounter variation which is costly and un-welcomed by all parties in construction. O’Brien (1998) also stressed that even the well-planned projects may require changes due to several factors they might go through. In line with the above authors, Arain & Pheng (2005b) and Edward E. (2003) also indicated variation as an inevitable phenomenon in construction projects. Mohamed (2001) noted that variation orders cannot be avoided completely. So if variations are unavoidable and yet could adversely affect project performance, it is imperative to know their causes, impacts and measures that can be taken to minimize their negative effect in terms of cost, time, quality and other parameters.

According to Ssegawa et al., (2002), Harbans(2003) and Uyun(2007), variation orders occur due to a number of reasons ranging from finance, design, aesthetic, geological, weather conditions to feasibility of construction, statutory changes, product improvement, discrepancies between contract documents. Some of these causes may be foreseen whereas

others are not. When variations occur, they may have adverse effects. Ibbs (1997) after a thorough study concluded that variation orders affect project performance as they adversely affect productivity and project costs. The studies made on variation orders indicated that variations adversely impact project performance in terms of cost overruns, time overruns, quality degradation, health and safety issues and professional relations. Arain and Pheng (2005b) also indicated that variations could be source of problems such as change in contract price or contract schedule, decreasing labor productivity and disputes among project participants. Ibbs et al., (2001) also pointed out that variation in construction projects can cause substantial adjustments to the contract duration, total direct and indirect cost, or both. Most of the studies made undoubtedly address the negative impact of variations. If construction projects are to be successful, one of the events that needs to be managed and administered properly is that of managing variation order. To do this effectively, knowing the causes and impacts of variations would play a vital role. Project participants need to forecast, analyze and timely manage variations so that their effect would be kept as minimum as possible. According to Ibbs et al., (2001), effective analysis of variation order however requires a comprehensive understanding of the root causes and their downstream effects.

To summarize, it can be concluded that Variation is a change, modification, alteration in the form of addition, omission or substitution to the original scope of work and contract terms that is found out to be necessary to complete the works contained in the main contract thereby enabling to have a successful project completion. As regards to incorporating variation order as part of contract documents of a contract agreement, a change order is issued as a formal document in writing which modifies the work that was specified in the original contract agreement (Fisk, 1997). As changes are unavoidable, they are also common features of most construction projects. What is needed is to reduce their occurrence and address their negative effects when they occur so that project performance will be ongoing as planned.

2.2 Theoretical literature review

2.2.1 Types and classification of variation orders

Different authors and researchers classify variation order in many ways. The classification was made primarily based on the purpose it stands to refer.

According to Nurul (2000), variation order can be grouped into three general categories taking the following three criteria: nature of variation order, initiators identity and effects of variation order. Mohammed et al.,(2010) on the other hand takes the cause that results the variation orders and classified variation order as: design, construction/constructability, fabrication and transportation changes. There are also other types of classification on the basis of different factors. Below is a summary of some of the classifications by different authors and researchers with further brief on the types of the change orders after the table.

Table: 2.1 Classification of variation orders

No	Author/Researcher	Basis of classification	Type of change order
1	Arian & Pheng (2005b)	Nature of change order	<ul style="list-style-type: none"> ▪ Beneficial ▪ Detrimental
2	Arian & Pheng (2006)	Initiator of the change order	<ul style="list-style-type: none"> ▪ Client related ▪ Contractor related ▪ Consultant related ▪ Other factors related
3	Mohammed, et al., (2010)	Factors that caused the change order to occur	<ul style="list-style-type: none"> ▪ Design ▪ Construction ▪ Fabrication ▪ Transportation
4	Bruce (2006)	Time of occurrence	<ul style="list-style-type: none"> ▪ Anticipated ▪ Emergent
5	Stokes & Judith (2006) & Fisk (2000)	The way through which the change order is introduced	<ul style="list-style-type: none"> ▪ Formal or direct change ▪ Constructive change ▪ Cardinal change
6	Fisk (2000)	On the net effect of the scope of work	<ul style="list-style-type: none"> ▪ Additive ▪ Deductive ▪ Rework ▪ Force majeure
7	Ming et al.,(2004)	On the necessity of the variation order in the performance of the final product	<ul style="list-style-type: none"> ▪ Elective ▪ Required

2.2.1.1 Type based on the nature of variation order

One of the ways to characterize variation orders is based on the benefits they deliver and why they come to exist. According to Arain & Peng (2005b), the nature of variation orders can be determined by referring to both the reasons for their occurrence and subsequent effects. They distinguished two types of variation orders, namely: beneficial and detrimental variation orders.

Beneficial variation order

A beneficial variation order is an order that is issued to improve the quality of work, the standard set, to reduce cost, to adhere to or shorten the schedule and to deal with the degree of difficulty in that specific project under consideration. This type of variation order is initiated for value analysis purposes to realize the balance between the cost, the functionality and also the durability aspects of the project so that the Client is satisfied. This variation order optimizes the Clients benefits by eliminating unnecessary costs on the resources used as inputs. But it has to be noted that even if a variation order is a beneficial one, there could be a non-value adding cost to incur.

For example, a variation order is issued to solve discrepancies between contract documents will involve the abortion of works that have been completed. The cost for this aborted works should not be included if discrepancies were not found in that contract document.

Detrimental variation order

A detrimental variation order is an order that has a negative impact on the Client value expected from the project and the performance of the project. This type of variation order compromises the Clients value system intended initially from the project. A Client who experiences a financial problem may substitute the standard quality of materials which are relatively expensive that are specified in the contract agreement with sub-standard cheap materials.

2.2.1.2 Classification based on who initiated the variation order

One of the classifications means of variation order is based on the contracting party who initiates it. According to Arain & Pheng (2006), variation orders are classified based on the party who made them to occur. Based on this classification, variations are classified as Client related, Consultant related, Contractor and “others” related variations.

Client related variation orders

These are variation orders initiated by the Client. The Client is the initiator of the project and it is the one who formulates the terms of references of the project that would help in establishing the scope of the work that in turn help to set project objectives. Usually a project with a well-defined scope of work during the design phase will have a relatively less variation orders than the one not properly defined. According to Cooper and Emory (1995) the most important steps in the development of a variation order are the scope definition. A poorly defined scope will not provide a clear base line which will lead to a variation order that will be evaluated within or outside the scope.

The causes of variation orders under this classification include the following:

- Change in specifications
- Change of scope
- Change of project schedule
- Inadequate project objectives
- Financial problems
- Impediment in prompt decision making process
- Substitution of materials

Consultant related variation orders

Consultants are expected to carry out their contractual obligations with the highest form of professionalism assuming that what a project requires is fulfilled in realizing the objectives. However, this is not always the case and it might be necessary to introduce changes depending on the provisions of the contract. Designs and respective details may not be finalized and yet the project could find itself in the construction phase. There could be design errors and omissions. In such cases, it would be required to give variation order so

that the project would be able to serve the purpose what it is intended for. Furthermore, there is a chance that the Consultant may not know all materials that are available on the market during design stage that could be used for construction with technology. Updating itself on the materials may also make the Consultant to initiate a variation order. Zimmerman and Hart (1982) mentioned that it is impossible to have the knowledge of all new materials and products that are entering the construction market.

The causes of variation orders under this classification include the following:

- Errors and omissions in design, mistakes made in the design
- Changes in overall design
- Design complexity
- Insufficient drawing detail
- Conflicts between the contract documents
- Consultant's lack of experience and in - depth knowledge

Contractor related variation orders

The Contractor has a contractual obligation to carry out Works all as per the contract agreement and deliver the final product to the Client. But during construction, there could be situations in which he fails to meet the requirement due to factors which influence the execution of the project. In such cases, the Contractor may suggest a variation to be made.

The causes of variation orders under this classification include the following:

- A situation where the contractor had not been involved in the project's design stage
- Plant and Equipment Unavailability
- Poor workmanship as a result of incorrect construction methods and procedures
- Contractor's financial problem
- Lack of skilled labour

Variation orders caused by factors beyond the control of the direct contracting stakeholders

These are factors that cause variation order not in relation with the project participants: The Client, Consultant and Contractor. They are beyond the control of these contracting stakeholders and yet can cause issuance of variation order.

The causes of variation work orders under this classification include the following:

- Weather condition
- Government regulation
- Change in economic conditions
- Unforeseen problems

2.2.1.3 Classification based on the cause that forced the change order to occur

According to Mohammed et al., (2010) variation order is classified mainly and primarily on the cause that forced that particular variation work to come into picture. These can be due to:

- Design changes – these could be changes due to design errors & omissions, design improvement through latest technology, Client design changes due to scope changes.
- Construction(constructability) changes – these are changes made due to unforeseen site conditions
- Fabrication changes,
- Transportation changes

2.2.1.4 Classification based on anticipation

Due to the uncertainty nature of projects, it is common to expect before going to construction phase that a project may encounter variation works. Ming et al., (2004) noted that project variations can be classified as “anticipated variation” and “emergent variation”. Anticipated variations are planned in advance and occur as intended. On the other hand, emergent variations arise spontaneously and are not originally anticipated or intended.

2.2.1.5 Classification based on the procedure through which the variation orders are introduced

Another way of classifying variation order is on the basis of the procedures used to

introduce them. According to Stock & Judith (1986) and Fisk (2000), variation order can be introduced for further action using procedures that result Formal or Direct change, Constructive change and Cardinal change.

- Formal or Direct change orders are those introduced by the Client of the project or his representatives using change order clauses
- Constructive change orders are those introduced because of the Client or his representative's failure to do what they were supposed to do during the preparation of the project documents. Errors in design are typical examples that result constructive change orders.
- Cardinal change orders are also called "Scope" change because the change order introduced in this procedure is on those work types that were not in the original scope of work and are executed after re-defining the scope and having negotiation of the contracting parties. These changes are usually generated by the Client of the project.

2.2.1.6 Classification based on the net effect on the scope of the Works

Authors also classify variation order on the basis of the net effect resulted due to of the variation order on the overall project scope. According to Fisk (2000), variation orders are classified as Additive, Deductive, Rework and Force Majeure.

As per the explanation of Fisk (2000), Additive variation orders are those additional works to the original scope of work whereas Deductive variation orders are just the opposite ones. Deductive variation orders decrease the net contract sum of a contract. Rework variation orders are due to quality deficiencies. They are given to fix the defective works that appear during the course of the construction and they do not bring that much change to the scope of the work rather they have cost impact.

2.2.1.7 Classification based on necessity

Variation orders at times could be categorized based on their necessities in the performance of the final end product of a project for the purpose it is intended for. This is another way to view project variation orders as being a necessity. In this way, project

variation order can be classified as “elective variation” and “required variation” (Ming et al., 2004). An elective variation is where one may choose whether to implement the variation order or not and a required variation order is where there is no option but to order the variation.

2.2.2 Causes of variation orders

It has been mentioned in previous parts of this research that the dynamic and complex nature of construction projects makes the occurrence of variation orders unavoidable. Direct stakeholders who are involved in the process of project implementations may foresee some of the variations whereas other variations can be unpredictable.

There are different factors for the cause of variation orders. Errors & omission in design, conflicting contract documents, design discrepancies, lack of detailed drawings, need for design change are among those factors which cause variation orders related to design & contract document. Scope and plan changes together with change of specification can also be other source of variation orders. Financial shortage by both Client and Contractor is also another cause of variation order. Economic condition, weather condition, government regulation and unforeseen events can also be causes of variation orders from external pressures.

Many authors identified different potential sources for causes of variation orders on the basis of different perspectives. Some based their identification on the part who initiated the variation orders as Client, Contractor, Consultant & Other related variation orders and categorized the causes accordingly (Arain and Pheng, 2006). Change in specification, change of plan or scope, inadequate project objectives, financial problems were identified as causes of variation orders related to Clients whereas errors & omissions in design, change in design, conflict between contract documents, design complexity, lack of knowledge of available materials were identified as some of the causes of variation orders that are related to Consultant. Unavailability of equipment & skilled labor, lack of experience, long lead procurement, lack of judgment & experience can be some of the causes of variation orders as related to Contractors. Weather condition, government regulation and economic condition can also be causes of variation orders not directly related to the above participant.

According to Ming et al.,(2004), variation orders may be resulted from pressures which are either external or internal that are applied on projects. He went on and described that external causes could be due to technological changes, changes in customer expectations and tests for better, changes in government regulation and policies, changes in economy and the like. Internal causes could be due to changes in organizational objectives.

One of the authors who identified causes of variation orders, Sunday (2010) mentioned that inadequate working details, design discrepancies, conflicts between contract documents, change of plans or scope, impediment in prompt decision making process, inadequate project objectives, different site conditions, skilled manpower unavailability, more profitability interest, shortage of finance by Contractor are causes of variation orders on construction projects.

There are also authors in the construction contract and law discipline who have given similar views with regards to the causes of variation orders. Murdock and Hughes (2000) identified the following three ways in which a variation can occur:

- Clients may change their minds about what they asked for before the work is completed.
- The designers may not have finished all of the design and specification work before the contract was let.
- Changes in legislation and other external factors may force changes upon the project team.

Variation orders can be minimized or prevented if their origin and causes were clearly known (Mohammed, 2001). If direct stakeholders have a better knowledge and awareness of non-value adding work activities that may result in issuance of variation orders, they could have a better chance of avoiding the variation orders or minimize their adverse effects thereby reducing the overall consequential construction delivery cost and project completion time. So, knowing the causes of variation orders is of vital importance in administering variation orders which would ultimately add its good part to that of the overall project management during implementation.

2.2.3 Effects of variation orders

Due to by their very nature in which they involve complex operations that are exposed to uncertainties, it is very difficult to accurately determine all the necessary activities that would be executed in a construction project to bring the required project to the final delivery.

The maximum performance of a project is achieved when the work activities of that particular project are executed strictly within the time frame set, the quality standards agreed and the budget limits indicated in the contract documents. However, due to so many factors affecting project performance like market condition, design change, Client change of mind on previously done design, design issues and so on, this phenomenon is not practical. Variation orders are one of those events that are resulted from the impact of these project affecting factors.

Because of the reasons mentioned above, variation orders are unavoidable and can even be considered as an outlet from the contract when changes are required to the contract. According to the study of Arain and Pheng (2005b) in which they conducted a research on institutional buildings in Singapore, they noted that variation orders are an unwanted but inevitable reality of any construction project. In their findings, increase in project cost is the first most important effect of variation orders. Additional payment to Contractors, disruption of work progress which does not lead to delay in project completion, project completion schedule delay and increased in overhead expenses are important effects of variation orders that are ranked by the above researchers from second to fifth place.

On another study made on change orders on construction projects in Saudi Arabia by Al – Dubasi (2000), increase in project cost, delay in project completion schedule, additional payment to Contractors, demolition & rework and increase in Contractor’s overhead are the top five most important effects seen on the construction projects.

The changes which are executed in the form of variation works may satisfy the needs of the Client in delivering the overall project based on the purpose it is to be used by enabling to fix or correct problems during the construction phase. This may help to proceed with the

project work with the maximum practical efficiency. On the other hand, if variation orders are not managed properly, they may cause significant problems throughout the project's construction phase by affecting portion of the project directly or indirectly, reducing productivity leading mainly to cost and time overruns.

Even though it is not the case for all variation orders, most of them do not only affect project performance in terms of time and cost, they also adversely affect the quality, health and safety and professional relations. Ibbs (1997) also concluded that variation orders affect project performance as they adversely affect productivity and project cost. According to Ruben (2008), variation orders had an impact on overall project performance and the major adverse impact of variation orders are time and cost overruns and disputes between the parties to the contract.

2.3 Empirical literature review

2.3.1 Causes of variation orders

In general, many studies have been conducted to identify the causes of construction variation orders. These causes as identified by researchers (CII, 1990a; Thomas and Napolitan, 1994; Clough and Sears, 1994; Fisk, 1997; Ibbs et al., 1998; O'Brien, 1998; Mokhtar et al., 2000; Gray and Hughes, 2001; Arain et al., 2004) are shown below in Table 2.2

Table 2.2: Causes of variation orders (Source: extracted from the above research papers)

No.	Causes of variation orders
1	Change of plans or scope
2	Change of schedule
3	Financial Problem of Client
4	Inadequate project objectives
5	Replacement of materials or procedures
6	Impediment in prompt decision making process
7	Obstinate nature of Client
8	Change in specifications
9	Change in design
10	Errors and omissions in design
11	Conflicts between contract documents
12	Inadequate scope of work for Contractor
13	Technology change

14	Value Engineering
15	Lack of coordination
16	Design complexity
17	Inadequate working drawing details
18	Inadequate shop drawing details
19	Consultant's lack of judgment and experience
20	Lack of knowledge of available materials and equipment
21	Honest wrong beliefs of one or more parties to the contract
22	Lack of required data
23	Obstinate nature of Consultant
24	Ambiguous design details
25	Design discrepancies
26	Non-compliant design with government regulations
27	Non-compliant design with owner's requirement
28	Change in specification by Consultant
29	Lack of Contractors' involvement in design
30	Unavailability of equipment
31	Unavailability of skills
32	Contractor's financial difficulties
33	Contractor's desired profitability
34	Differing site conditions
35	Defective workmanship
36	Unfamiliarity with local conditions
37	Lack of a specialized construction management
38	Fast track construction
39	Poor procurement process
40	Lack of communication
41	Contractor's lack of judgment and experience
42	Long lead procurement
43	Honest wrong belief of Contractor
44	Complex design and technology
45	Lack of strategic planning
46	Contractor's lack of required data
47	Contractor's obstinate nature
48	Weather conditions
49	Safety considerations
50	Change in government regulation
51	Change in economic conditions
52	Socio – cultural factors
53	Unforeseen problems

Based on the above literature review and most importantly based on sample of the assessed desk studies on the projects on which the research was made, the following variation causing factors are discussed in brief. These factors together with those given by carefully selected

respondents from pilot test survey were also used in the development of the final questionnaire.

- **Change of plans or scope:** This is one of the causes of variation orders resulted due to insufficient planning at the project planning stage or it can be resulted because of lack of involvement of the Employer in the design phase (Arain et al., 2004). According to CII (1990b), change of plan or scope of project is one of the most significant causes of variation orders.
- **Conflict between contract documents:** this is one of the causes of variation orders which is resulted due to misinterpretation of the actual requirement of a project (CII, 1986a). To convey complete project scope for participants, the contract documents must be clear and straight to the point. Insufficient details in contract documents may adversely affect the project, leading to delay in project completion.
- **Change in specifications:** This can be made by both the Client and Consultant. They are frequent in construction projects with inadequate project objectives (O'Brien, 1998). In a multi-player environment like any construction project, change in specifications during the construction phase may require major variation orders and adjustments in project planning and procurement activities.
- **Errors and omissions in design:** Producing a complete design is usually not a case for construction projects. It is common to find errors and omissions in design. These are an important cause of project delays (Arain et al., 2004). Design errors and omissions may lead to loss of productivity and delay in project schedule (Assaf et al., 1995). Hence, errors and omissions in design can affect a project adversely depending on the timing of the occurrence of the errors.
- **Change in economic conditions:** The economic situation of a country in which projects are undergoing can hugely affect the whole construction industry. It may affect projects negatively, depending on the timing of the occurrence of the variations. Change in economic conditions is one of the influential factors that may affect a construction project (Fisk, 1997).
- **Design discrepancies:** These can be a frequent cause of variation order in construction projects (CII, 1990a; Fisk, 1997). Design discrepancies affect the

project's functionality and quality. Eventually, this can affect a project adversely depending on the timing of the occurrence of the variation order.

- **Consultant's lack of required data:** due to insufficient data, Consultants are prone to develop designs based on their own perceptions which may not be what the Client wants. This may cause major variation order and affect the project negatively. Lack of data can result in misinterpretation of the actual requirements of a project (Assaf et al., 1995; Arain, 2002).
- **Inadequate project objectives:** These are one of the causes of variation order in construction projects (Ibbs and Allen, 1995). Due to inadequate project objectives, the designers would not be able to develop a comprehensive design which leads to many variation orders during the project construction phase.
- **Change in design by Consultants:** These are frequent in projects where construction starts before the design is finalized (Fisk, 1997). Change in design for improvement by the Consultant is a norm in contemporary professional practice (Arain et al., 2004). Design changes can affect a project adversely depending on the timing of the occurrence of the changes.
- **Lack of Consultant's knowledge of available materials and equipment:** Knowledge of available materials and equipment is an important factor for developing a comprehensive design (Geok, 2002). In the construction industry where material standardization is not common, the Consultant's lack of knowledge of available materials and equipment can cause numerous major variation order during various project phases.
- **Differing site conditions:** It is common to encounter with site conditions different from anticipated ones indicated in the tender documents during construction phase. This can be an important cause of delays in large building projects (Assaf et al., 1995). This may affect the Contractor's cost estimates and schedule negatively.
- **Contractor's desired profitability:** This can be a potential cause of Variation order in construction projects. This is because variation order is considered a common source of additional works for the Contractor (O'Brien, 1998). The Contractor may eventually strive to convince the project Employer to allow certain variation order, leading to additional financial benefits for him.

- **Contractor's desire to replace low priced work items:** This is most often done when cost of work items usually material price is higher when compared with the unit price fixed in the contract document for the same. The Contractor, with the purpose of dealing with financial pain, requests substitution of the work items which cost him much when compared with his working price.
- **Inadequate working drawing details:** To convey a complete concept of a project design, the working drawings must be clear and concise (Geok, 2002). Insufficient working drawing details can result in misinterpretation of the actual requirement of the project (Arain et al., 2004). Thorough reviewing of design details would assist in minimizing variation order.
- **Replacement of materials or procedures:** This may cause major variation order during the construction phase. The substitution of procedures includes variations in application methods (Chappell and Willis, 1996). Therefore, an adjustment to the original contract value is required if there is a change in procedures.
- **Poor procurement process:** Procurement delays have various adverse effects on other processes in the construction cycle (Fisk, 1997). Occasionally, the procurement delay may cause an entire change or replacement for originally specified materials or equipment for the project (Arain et al., 2004). This may therefore cause a need for project activities to be reworked.
- **Impediment in prompt decision making process:** Prompt decision making is an important factor for project success (Sanvido et al., 1992; Gray and Hughes, 2001). A delay in decision making may obstruct the progress of subsequent construction activities and that may eventually delay the entire project progress.
- **Contractor's financial difficulties:** Construction is a labor intensive industry. Whether the Contractor has been paid or not, the wages of the worker must still be paid (Thomas and Napolitan, 1994). Contractor's financial difficulties may cause major variation orders during a project, affecting its quality and progress and in some cases even the safety of the site is affected if there is an argument.
- **Unforeseen problems:** Unforeseen conditions are usually faced by professionals in the construction industry (Clough and Sears, 1994; O'Brien, 1998). If these conditions are not solved as soon as possible, they may cause major Variation orders

in the construction projects. Eventually, this may affect the project negatively, leading to reworks and delays in the project completion.

- **Long lead procurement:** Procurement delays have various adverse effects on other processes in the construction cycle (Fisk, 1997). Occasionally, the procurement delay may cause an entire change or replacement for originally specified materials or equipment for the project. Delay in long lead procurement is a common cause of delays in building projects (Assaf et al., 1995).
- **Technology change:** This is a potential cause of variation order in a project. Project planning should be flexible for accommodating new beneficial variations (CII, 1994b). This is because the new technology can be beneficial in the project life cycle, for instance, reducing maintenance cost of the project. Or new methods of constructions that reduce construction cost.
- **Contractor's desired profitability:** This can be a potential cause of variation order in construction projects. This is because variation orders are considered a common source of additional works for the Contractor (O'Brien, 1998). The Contractor may eventually strive to convince the project Employer to allow certain variation orders, leading to additional financial benefits for him.
- **Inadequate project objectives:** These are one of the causes of variations in construction projects (Ibbs and Allen, 1995). Due to inadequate project objectives, the designers would not be able to develop a comprehensive design which leads to many of variation orders during the project construction phase.

2.3.2 Effect of variation orders

Numerous researchers studied the effects of variation orders. According to the research made by Arain and Low (2005), 16 potential effects of variation orders were identified and they are shown below in Table: 2.3 with a short brief on each of them.

Table 2.3: Effects of variation orders (Arain and Low, 2005)

No.	Effects of Variation Orders
1	Increase in project cost
2	Completion schedule delay
3	Progress is affected but without any delay
4	Increase in overhead expenses
5	Delay in payment
6	Quality degradation
7	Productivity degradation
8	Procurement delay
9	Rework and demolition
10	Logistics delays
11	Damage to firm's reputation
12	Poor safety conditions
13	Poor professional relations and dispute
14	Additional payments for contractor
15	Work on hold/Disruption/
16	Hiring new professional

1. Increase in project cost

Whenever variation orders are issued in the form of additions, substitution, modification or omission, there is a cost related to them. Except that of omission work, the other types of variation orders most of the time bring additional cost to the project. According to Arain and Pheng(2005a), increasing project cost is the most common effect of variation orders in construction projects.

Due to the nature of the variation orders, it may be necessary to deploy new equipment and new skilled labor which could be influenced by high market price. There may be a situation that the issued variation orders affect other work activities in a way of stoppage which in turn increase the overhead cost. Variation orders increase in the cost of a project performance due to time and material charge, overheads, rework and standby time, loss of productivity and change in cash flow due to inflation. All these tend to increase project cost. In its journal, CII (1990a) described increase in project cost as the most common effect of variation orders during construction phase of projects.

2. Completion schedule delay

When going into contract agreement, both the Client and Contractor agreed to complete the project with a pre-defined time frame. However, this is not the case due to several reasons. One of such reasons is that of issuance of variation orders which does have a potential to extend the completion scheduled date either by affecting portion of the project or by requiring the variation order's own time frame. Variation orders might affect the completion time of a project in the form of time spent during the preparation, negotiation and approval of the variation order, extra time needed for the additional works in the variation order, time spent in the loss of productivity and loss of time due to delayed material delivery.

According to Ibbs(1997), delay in completion schedule of projects as a result of variation orders is a frequent phenomenon. In his research on Ethiopian Roads Authority projects, Tadesse (2009) indicated that variation orders are primary cause of the projects' completion scheduled delay. Mohammed (2001) agrees that variation orders are one of the reasons for time overrun.

3. Increase in overhead expenses

Issuing variation orders need to follow some procedures and it requires to process from paper work up to implementation (O'Brien, 1998). All the processes need a cost that is direct and indirect. The indirect costs are expressed as a package to include profit and overhead costs. So, an increase in issuing variation orders increases the overhead expenses.

4. Additional payment for Contractors

Implementation of variation orders most of the time is followed by payment which is additional to previously agreed contract sum. According to Arain and Low (2005), one of the most common potential effects of variation orders is the result in the form of additional payment to Contractor. O'Brien (1998) supported this finding and gave the reason behind that variation orders are considered as a source of additional works.

5. Logistic delays

According to O'Brien (1998), variation orders issued after construction of projects are launched may require suspension as well as revision of procurement requests. The variation orders issued may not be the same type of the work items for which procurement may be in pipe line or their quantities may not be adequate. In such cases further procurement is necessary and this may delay the logistic. Fisk (2000) also confirmed this stating procurement delays may occur due to variation orders which require new materials and equipment. Arain & Pheng (2005a) also observed in their study that procurement delays were significant effects of variation orders in construction projects.

6. Rework and demolition

Though there could be other reasons, one of the causes for rework and demolition is issuance of variation orders. Variation orders issued after the commencement of projects in the construction phase or even after completion usually lead to rework and delay in project completion (Arain & Pheng, 2007). Rework and demolition depending on the time of variation orders issuance and the status of the projects' execution status are potential effects of variation orders.

7. Procurement delay

According to O'Brien (1998), variation order issued for the purpose of completing the project when it is under construction may require a revised procurement requests and supplies management. There may be a chance that the newly ordered variation order requires additional and sometimes even new resources for implementation. This resource requirement which was not in the original schedule needs time and may result a procurement made late. In their study, Arain and Low(2005a), pointed out that variation orders require new materials and specialized equipment which are frequently causes of procurement delays.

8. Delay in payment

When variation orders are ordered, there may be disruption of progress which could delay execution of work items as per the schedule which is also related to cash flow by which

payment can be requested. The delay of execution of work items does mean automatically delaying payment. According to Arain & Pheng (2005a), Al – Dubasi(2000), delay in payment as a result of variation orders is a frequently occurring phenomena.

9. Disputes between contracting parties and poor professional relations

Claims could be on the agenda during project implementation for different reasons of which one may be due to variation orders. Valuation of prices, schedule of the variation orders could be sources of the claims. Fisk (2000), identified disputes among the contracting parties can be resulted because of variation orders. Solving claims that arise due to variation orders amicably benefit the project in having a good working relationship among professionals. Frequent communication and good coordination among the professionals highly help in this process. Otherwise, the claim will be a dispute and will be resolved as per the dispute resolving mechanism of the project contract which may be costly, time taking and may be damaging professional relations.

10. Damage to firm's reputation

Solving claims that arise due to variation orders amicably as mentioned above is a preferred choice. If this is not the case and disputes are to occur frequently, the firms' reputation may be affected and may even lead to insolvency.

11. Quality degradation

Variations, if frequent may impact the quality of work adversely (Fisk, 200). Contractors with an ambition to maximize their profit may make substandard quality and cut quantities. According to CII (1995), this issue was made more specific and it was stated that the quality of work was usually poor because of frequent variation orders since Contractors tended to compensate for the losses they incurred during project implementation.

12. Productivity degradation

Variation orders have a potential to disrupt work activities and may also require demolition & rework. Such activities have negative impact on labor productivity. In their study, Thomas and Napolitan(1995) came to a conclusion that variation orders normally led to disruptions

which were responsible for productivity degradation. They also pointed out that the source of disruption was due to lack of materials which required their own time frame till they became part of the main work.

13. Poor safety condition

When variation orders are issued, they may require new working methodology, new materials and new equipment. These resources may require their own safety precaution requirements to be in place which was not there on the project previously. According to O'Brien (1998), variations may impact the safety conditions in construction projects. Arain and Pheng (2005a) also described that a change in construction methods, materials and equipment may require additional health and safety measures. So, variation orders unless addressed as mentioned above may lead to poor safety condition.

14. Progress is affected but without delay

Variation orders when issued during construction stage may affect progress of a project impacting specific work activities that are sequentially in line with the given variation order. However, there may be a case where these affected work activities could not be on the critical path of the project. In such cases, the variation order though affects the progress, it will not delay the project in the overall effect. According to Assaf et al.,(1995), variation orders during project execution may affect the project progress and quality. Arain and Pheng (2005a) elaborated this more and stated that only major variations during project implementation may not affect completion time.

15. Work is on hold/disruption

Variation order that is interdependent on other project activities, when issued can make the other activities to be on hold. According to Al – Dubaisi(2000), change in a certain work package can put the work on other activities on hold. Tadesse (2009), in his research made on Ethiopian Road Authority road projects pointed out that work on hold is the third most important effect of variation order. Work on hold may make some construction crew idle or shift to other scheduled activities. Quick decision-making procedures as regards to variation orders can help in reducing the undesired outcome of work disruption.

16. Hiring new professionals

Change orders may require complex technological inputs and professionals capable to handle the new technologies in need and do the work. Complex technologies required by projects need specialists to get the job done (Fisk 1997). According to Arain and Low(2005a), new professionals may be needed to be hired depending on the nature of the variation order. When there is a need to hire new professionals, it may take time to do so and hence affecting project progress.

2.3.3 Causes and effects of variation orders in Ethiopia and other countries

Variation orders have been identified globally as important reasons for poor performance of construction projects in most countries which have affected their national economic growth. The degree varies from country to country on how good the project management methods are implemented.

2.3.3.1 Causes and effects of variation orders in Malaysia

Norziah and Zabidi(2019) stated that the change of work was a common problem in construction of double – storey terrace housing projects in Malaysia. According to their research they found out that the major cause of variation orders is due to change of scope by Clients. Scope of work is basically related to definition of the work at the planning stage and lack of collaboration by the concerned bodies during design stage. However, the effect of the variation order by the scope change or other causes has not been mentioned in any form. According to Aftab et al., (2014) the five most significant causes of variation orders are unavailability of equipment, poor workmanship, design complexity, change of schedule and impediments to prompt decision making whereas logistic delays, delay in completion and increase project cost are significant effects of variations faced in construction projects handled by Malaysia Public Works Department.

2.3.3.2 Causes and effects of variation orders in Saudi Arabia

Abdulghfoor (2000) in his study of large construction projects in Saudi Arabia on change orders, he concluded that the Client is the main source of changes and the cost overrun due

to the changes is in a range of 6 to 10% of the original project amount. He also noted the schedule overrun is less than 10%. The reason he gave why the Client became the main source is that he was not involved in the design development together with the Client ability to understand designs was not good. Changing his mind on previous designs without appreciating the negative impacts of the changes was also a reason. He concluded that the causes of variation orders in ranking are change of plans by owner, substitution of materials and procedures, errors and omissions in design, owner's financial problems and change in design by consultant whereas the most important effects of variations in their order of ranking are increase in project cost, delay in completion schedule, additional revenue for Contractors, demolition and re-work and increase in Contractor's overheads.

2.3.3.3 Causes and effects of variation orders in Sudan

In a study in Sudan by S. Mahmoud & E. Elshaikh (2020), they indicated that variation order is categorized as one of the main challenges that all buildings' stakeholders face. In their study on ten building projects in Khartoum to determine how performance was impacted, they concluded that variation orders were a challenge. The time overrun due to variation orders showed an increase by 22 – 200% whereas the project cost increased by 2.67 – 42.86%.

They also stated the major factors causing variation orders in decreasing orders are Client's financial problems, change of plan by Client, change of scope by Client, Client's failure to hold on the project schedule and owner's failure to make or review documents at the right time whereas the impact of variation orders in decreasing order as increase the cost of projects, increase in duration of individual activities, delay in completion schedule, delay in payments and demolition and re-work.

2.3.3.4 Causes and effects of variation orders in Tanzania

Roziana Saki and Chunho Yeom (2022), in their study on the causes of variation orders on road construction projects in Tanzania, described financial problems, weather conditions, changes in design, poor scheduling, lack of coordination, delay in approval, unavailability of equipment and lack of communication as the most significant circumstances causing variation orders.

2.3.3.5 Causes and effects of variation orders in Kenya

In another study in Kenya, Oloo et. Al., (2015) on cause and effect of variations in civil engineering construction projects, observed that in Kenya variation orders in construction projects have been associated with cost and time overruns in the magnitude of 70 – 151% and 32 – 179% respectively. They indicated delay in acquisition of right of way, differing site conditions, change of scope, change of schedule by owners and lack of coordination between overseas and local designers as the most important causes of variations in their order of significance whereas cost overrun, contractual disputes & claims and time overrun as the most important effect of variation orders in their order of significance.

2.3.3.6 Causes and effects of variation orders in United Kingdom

According to Keanne et al., (2010), the five main causes of variation orders in United Kingdom are: errors and omission in design, little involvement in design from contractors, inadequate project objectives, poor design and conflicts between contract documents.

2.3.3.7 Causes and effects of variation orders in Ethiopia

Causes and effects of variation orders in Ethiopia are not widely researched as compared to those made worldwide. Those few researches conducted were done in partial fulfillment of Master's thesis and of which most are on road sector. On these researches, the researchers attempted to investigate into the relationship between the causes and effects of variations in construction projects. But how significant the causes and effects are different from one research to the other.

Tadesse Ayalew(2009) on his study on Ethiopian Roads projects, described variation as one of the major problems. He went on further and stated that out of a 35 potential causes of variations right of way, change of scope, lack of proper planning, lack of Contractors' proper evaluation of tender documents at tendering phase and Contractors' financial problem as major causes of variations in Ethiopian Federal road projects. As regards to who initiated the variations, he concluded that Contractors are the main responsible stakeholders. Finally, when he came to the effects of variations, he mentioned delay in completion,

increase in project cost, suspension of work, decrease in productivity and dispute between parties as the major effects.

Tewodros Zewdu (2015) on his study on 16 randomly selected national works contract of roads administered by Addis Ababa City Roads Authority, he confirmed the occurrence of variation orders and their numbers range from 1 to 7 per project. He also noted their effects in such a way that the average percentage increase of the original project cost as 24.11% whereas the time overrun as 126.5%. Regarding the causes of variations, he too analyzed 35 potential causes as Tadesse and came out, in their order of ranking as right of way problem, change in design, errors and omissions in design, lack of coordination between contracting parties, and change of scope as the major causes of variation orders. When it comes who the most responsible stakeholder for the origination of variations, Tewodros named the Consultant as the main responsible body. As to the effect of variation orders, Tewodros ranked cost overrun, time overrun and disputes between contracting parties as the main effects.

Andualem Endris (2016) in his study of the causes of variations on public buildings in Addis Ababa, in which five projects were selected and 38 potential causes of variations were analyzed, design changes were the most frequent causes of variation orders. He concluded that impediment in prompt decision making process, change in in design by the Consultant, inadequate working drawing details, change in specifications and poor procurement process were the most important causes of variation orders.

2.3.3.8 Comparison on the causes and effects of variation orders between Ethiopia and Other Countries`

Variation orders are project specific both in the factors causing them and the resulting consequences. To see this, the following tables are prepared showing samples from some corners of the world.

Table 2.4: Comparison of causes of variation orders in different countries

Rank	Malaysia (Aftab et al.,2014)	Saudi Arabia (Abdulghfoor 2000)	Sudan S. Mahmoud & E. Elshaikh 2019)	Tanzania (Roziana Saki & Chunho Yeom, 2022)	Kenya (Oloo et al.,2015)	United Kingdom (Keanne et al.,2010)	Ethiopia (Andualem Endris, 2016)
1	Unavailability of equipment	Change of plans by owner	owner's financial problems	Financial problems	Delay in acquisition of right of way	Errors and omission in design	Impediment in prompt decision making process
2	Poor workmanship	Substitution of materials and procedures	change of plan by owner	Weather condition	Different site conditions	Little involvement in design from contractors	Change in design by consultant
3	Design complexity	Errors and omissions in design	change of scope by owner	Changes in design,	Change of scope	Inadequate project objectives	Inadequate working drawing details
4	Change of schedule	Owner's financial problems	owner's failure to maintain hold on the project schedule	Poor scheduling	Change of schedule by owners	Poor design	Change in specification
5	Impediment to prompt decision making	Change in design by consultant	owner's failure to make or review documents at the right time	Lack of coordination between contracting parties	Lack of coordination between contracting parties	Conflicts between contract documents	Poor procurement process

Table 2.5: Comparison of effects of variation orders in different countries

Rank	Malaysia (Aftab et al.,2014)	Saudi Arabia (Abdulghfoor 2000)	Sudan S. Mahmoud & E. Elshaikh 2019)	Kenya (Oloo et al.,2015)	Ethiopia (Tadesse Ayalew, 2009)
1	Logistic delays	Increase in project cost,	Increase the cost of projects	Cost overrun	Delay in completion
2	Delay in completion	Delay in completion schedule,	Increase in duration of individual activities	Contractual disputes & claims	Increase in project cost
3	Increase project cost	additional revenue for contractors,	Delay in completion schedule	Time overrun	Suspension of work decrease
4		Demolition and re-work and increase in contractor's overheads.	Delay in payments		Decrease in productivity
5		Re-work and increase in contractor's overheads.	Demolition and re-work.		Dispute between the contracting parties

Generally, from research documents reviewed both abroad and in Ethiopia, there is no similarity on the causes and effects of variation orders though some countries share few events in common. Even the causes and effects of variations in Ethiopia differ from project to project. But all the researches stressed that variation orders are one critical aspect of construction projects that have to be addressed in a way that would minimize their adverse effects in the process of project delivery. The findings, especially in ranking, as seen from the reviews, differ from one research to another.

2.4 Controlling mechanisms to keep variation orders as minimum as possible

Construction projects pass through distinct phases in their life cycle: inception, planning, execution, performance (controlling & monitoring) and closeout. To deliver a project successfully, the way how the works in each stage are handled is very crucial. Good project management practice in these stages would enable all project executioners to perform as per the project objectives set.

One of the issues that is key to project delivery and yet can be influential to a level from low to high degree depending on the way how the project is handled in the above mentioned project life cycle stages is the management of variation order. For minimizing variation orders and their adverse effects after projects are launched, the tasks that are carried out during all the phases is very important and all the mechanism suggested for implementation on this part deals with how these tasks are executed. Arain and Low(2005a) suggested that variations can be reduced during design stage. In his study, Baharuddin(2005) also discussed this issue and concluded that variation orders can be minimized if all the parties involved in projects are aware that preliminary work before tendering must be carried out in detail. Rubben (2008) also noted in his research that one of the causes for variations that is design errors and omissions, though cannot be completely avoided, can be reduced to the maximum if designers assessed their workloads before going into new contracts.

Variation order controlling in construction requires an integrated solution. Critical review of contract documents, value engineering, owner's involvement during design stage, having

detailed designs, clear project brief, proper site investigation, established cost data base usage before issuing variation order, referring previously completed similar projects(if the project at hand is similar), proper communication during project execution with Clients, use of latest project scheduling technique can be stated as activities that can help in controlling mechanism to reduce variation orders. As regards to project delivery system, Design, Bid and Build(DBB) project delivery system allocates more risk in relation to design and contract document discrepancies which are potential source of variation orders. The Design and Build(DB) project delivery system helps a lot in minimizing variation orders as more risk is transferred to the Contractor who is not only the constructor but also the designer of the project. Using restricted tendering also help in avoiding those contractors who may tender if the tender is open competitive one and through which they may target getting the project by offering low price or not the appropriate price. Low pricing could give rise to Contractor to try to claim more for the low price offered during open competition bid.

Many researches were made to point out strategies that would enable project contracting parties to minimize variation orders as minimum as possible and reduce their negative effect when they occur. The following are list of controlling mechanisms suggested by different researchers (Bower, 2000; Baharuddin, 2005; Chan and Yeong, 1995; Arain, 2005; Ruben, 2008; Bin-Ali, 2008; Willis, 1980; Ming et al., 2004; Levy, 2006; Al-Hakim, 2005a; Sweeney, 1998; Formoso, 1999):

- Adequate planning is required by all involved parties before works start on site
- The consultant should produce a complete design and contract
- Drawings should be complete at tender stage
- Adequate time should be spent on pre-tender planning phase
- Clients should provide a clear brief of the scope of works
- All parties should forecast to overview unforeseen situations
- Closer consultant co-ordination is required at design stage
- Enhance communication and all parties should be proactive all times
- Works should be supervised with an experienced and dedicated supervisor
- Consultant should ensure that the design/specifications fall within the approved budget and the budget team should participate during the design phase

- Ensuring that the contract documents are unambiguous, explicit and read the same with each other
- Get accurate information and research with regard to procurement procedure, material and plant
- Carry out detail site investigation including detail soil investigations and consider it during tendering stage
- Have the underground cable route confirm by the local authorities
- Have the land application or land purchase completed before awarding contracts
- Once the tender is awarded, there should be no changes to the specifications
- Place experienced and knowledgeable executives in the engineering and design department
- Project risk factors are identified and the respective mitigation measure is set
- Final designs shall be presented to all concerned for comment before going to tendering

2.5 Variation orders, contractual provisions and contract administration

Variation order is a common phenomenon in the construction industry. It gives project clients and contractors flexibility to address unexpected events and those in need and yet not in the originally agreed contract documents. But the flexibility to be exercised on change orders could have adverse effects in terms of cost, time, quality and other effects. Disputes that arise in construction management regarding variation orders are most often occur in relation to valuation of cost and time to be set. Unless managed properly in such a way that their effects are entertained reasonably and the number of variations are kept as minimum as possible, they would adversely impact the project performance and would even endanger the overall achievement of the project's objectives. Both construction management and contract administration play roles in delivering projects according to design, with the estimated cost and quality standard set. Identifying variations, issuing instructions to proceed with the variation work order, analyzing variation claims and valuation of variation work orders are all works that are handled in contract administration.

2.5.1 Variation orders and related contractual provisions

During construction phase of a project, Client and Contractor may come to disagree over the precise composition and scope of work required by their contract. In addition to that making changes to the scope of the work may be necessary. Such events may affect the original cost of the project and a claim may arise on variation orders. When such a variation claim arise, the contracting parties look to their contract as regards to variations to determine who should bear the cost of the change, whether it is possible to vary the work or not. It can be said that almost all construction contracts have a change order clause that establishes procedures for revising and changing the contract's scope. This clause is an essential part of any construction contract and enables the contracting parties to agree in advance that a change order can be introduced due to factors influencing the construction work to issue such an act. The clause provides a basis for establishing who is responsible for what by detailing each contracting party's rights, obligations and remedies. According to Ssegawa et al. (2002) contractual clauses state how variation orders should be initiated.

Form of contracts used in construction projects state what the duties and responsibilities of the direct contracting parties are as regards to variation orders. FPPA (2011) Standard Bid Document on its Article 15 states that The Engineer does have power to give change orders that may include additions, omissions, substitutions, changes in quality, quantity, form, character, kind, position, dimension, level or line and changes in the specified sequence, method or timing of execution of the works. The FIDIC MDB (2010) general conditions of contract clause 13.1 stipulate that the Engineer may issue variations to the Contractor who shall execute the variations. Below are contractual clauses of variation orders as stated in the contract forms for selected ones.

A. General Conditions of Contract for Works (FPPA, 2011)

For public projects where the finance is to come from the Ethiopian government, most widely used standard bidding document for procurement of works is the one developed by FDRE Ministry of Finance, Public Procurement Agency FPPA 2011, unless the project delivery system forces not so. The clauses of the general condition of contract referred for variation order cited from Section -7 of the SBD are shown below.

Clause 15 – Modifications by Change Orders

- 15.1 The Engineer shall have power to order any modification to any part of the works necessary for the proper completion and /or functioning of the works. Such modifications may include additions, omissions, and substitutions, changes in quality, quantity, form, character, kind, position, dimension, level or line and changes in the specified sequence, method or timing of execution of the works. No order for a modification shall have the effect of invalidating the contract, but the financial effect, if any, of all such modifications shall be valued in accordance with GCC Clauses 15.5 and 15.7.

- 15.2 All change orders shall be issued in writing, it being understood that:
 - (a) if for any reason, the Engineer shall find it necessary to give an order orally, he shall as soon as possible thereafter confirm the order by a change order;
 - (b) if the Contractor shall confirm in writing an oral order given for the purpose of GCC Clause 15.2 (a) and the confirmation shall not be contradicted in writing forthwith by the Engineer, a change order shall be deemed to have been issued for the modification.

A change order for modification shall not be required for increase or decrease in the quantity of any work where such increase or decrease is the result of the quantity exceeding or being less than that stated in the bill of quantities or price schedule, as the result of valuation of works laid down in GCC Clause 63.

- 15.3 Except as provided by GCC Clause 15.2 prior to any change order for modification, the Engineer shall notify the Contractor of the nature and form of such modification. As soon as possible, after receiving such notice, the Contractor shall submit to the Engineer a proposal containing:
 - (a) a description of the tasks, if any, to be implemented or the measures to be taken and a program for execution; and
 - (b) any necessary modifications to the program of implementation of tasks or to any of the Contractor's obligations under the contract; and
 - (c) any adjustment to the contract price in accordance with the rules as set out in this Clause.

- 15.4 Following the receipt of the Contractor's submission referred to in GCC Clause 15.3, the Engineer shall, after due consultation with the Public body and, where appropriate, the Contractor, decide as soon as possible whether or not the modification shall be carried out. If the Engineer decides that the modification shall be carried out he shall issue the change order stating that the modification shall be carried out at the prices and under the conditions given in the Contractor's submission referred to in GCC Clause 15.3 or as modified by the Engineer in accordance with GCC Clause 15.5. Clause 40.3: For both admeasurements and lump sum contracts, if the contractor's quotation is unreasonable, the engineer may order the variation and make a change to the contract price, which shall be based on the engineer's own forecast of the effects of the variation on the contractor's costs.
- 15.5 The prices for all modifications ordered by the Engineer in accordance with GCC Clause 15.2 and 15.4 shall be ascertained by the Engineer in accordance with the following principles:
 - (a) Where work is of similar character and executed under similar conditions to work priced in the bill of quantities or price schedule it shall be valued at such rates and prices contained therein;
 - (b) Where work is not of a similar character or is not executed under similar conditions, the rates and prices in the contract to be agreed through negotiation between the Engineer and the Contractor shall conform to the prevailing market price;
 - (c) if the nature or amount of any modification relative to the nature or amount of the whole of the contract or to any part thereof shall be such that in the opinion of the Engineer any rate or price contained in the contract for any item of work is by reason of such modification rendered unreasonable, then the Engineer shall fix such rate or price as in the circumstances he shall think reasonable and proper;
 - (d) Where a modification is necessitated by default or breach of contract by the Contractor, any additional cost attributable to such modification shall be borne by the Contractor.

- 15.6 On receipt of the change order requesting the modification, the Contractor shall proceed to carry out the modification and be bound by these GCC in so doing as if such modification were stated in the contract. The works shall not be delayed pending the granting of any extension of time for completion or adjustment to the contract price. Where the order for a modification precedes the adjustment to the contract price, the Contractor shall keep records of the costs of undertaking the modification and of time expended thereon. Such records shall be open to inspection by the Engineer at all reasonable times.
- 15.7 Where on provisional acceptance an increase or reduction in the total value of the works resulting from a change order, or from some other circumstance which is not caused by the Contractor's default, exceeds 25% of the initial contract price (or as modified by addendum), the Engineer shall, after consultation with the Public Body and the Contractor determine any reduction from the contract price as a consequence of the application of GCC Clause 15.5. The sum so determined shall be based on the amount by which the increase or decrease in value of the works exceeds 25%. The sum shall be notified by the Engineer to the Public Body and the Contractor and the contract price adjusted accordingly.
- 15.8 The total value of the works resulting from a change order shall not exceed 30% of the total value of the initial contract price.
- 15.9 Any change to the terms of the Contract must be recorded in writing and executed by authorized signatory of the Contractor and the Engineer. Such record of the change in question must address all consequential amendments required to be made to the Contract as a result of such change.
- 15.10 Changes will take effect as from the date specified in the signed record of change and shall not have retrospective effect unless expressly provided for in such record.
- 15.11 Each record of change must be dated and sequentially numbered. Each of the Public Body and the Contractor will be entitled to an original executed counterpart of the record of variation.
- 15.12 Except as provided in any such record of variation, the Contract will continue in full force and effect.

B. General Conditions of Contract for Works (FIDIC MDB Harmonized Edition, 2010)

Sub Clause 13.1 - Right to Vary

Variations may be initiated by the Engineer at any time prior to issuing the Taking-Over Certificate for the Works, either by an instruction or by a request for the Contractor to submit a proposal. The Contractor shall execute and be bound by each Variation, unless the Contractor promptly gives notice to the Engineer stating (with supporting particulars) that

- (i) the Contractor cannot readily obtain the Goods required for the Variation, or
- (ii) such Variation triggers a substantial change in the sequence or progress of the Works.

Upon receiving this notice, the Engineer shall cancel, confirm or vary the instruction.

Each Variation may include:

- (a) Changes to the quantities of any item of work included in the Contract (however, such changes do not necessarily constitute a Variation),
- (b) Changes to the quality and other characteristics of any item of work,
- (c) Changes to the levels, positions and/or dimensions of any part of the Works,
- (d) Omission of any work unless it is to be carried out by others,
- (e) any additional work, Plant, Materials or services necessary for the Permanent Works, including any associated Tests on Completion, boreholes and other testing and exploratory work, or
- (f) Changes to the sequence or timing of the execution of the Works.

The Contractor shall not make any alteration and/or modification of the Permanent Works, unless and until the Engineer instructs or approves a Variation.

2.5.2 Variation orders and contract administration

When contracting parties go into a contract agreement for construction of a project, it means they are putting themselves into a legally binding part as per the terms and conditions of the contract in which duties & responsibilities and rights & obligations are set.

Arguing whether a work item is a variation order or not, issuing change order if it is a variation work, valuation the price of the issued change order and all other variation order related activities are handled in a contract administration process which is one part of a contract management process.

Contract Administration is a process that ensures the successful completion of a project under consideration with a substantial compliance of the terms and conditions of the contract. One of the activities handled through contract administration is managing changes one of which is the work related to issuing change orders. According to Ibbs et al., (2001), effective management of variation orders in turn requires a comprehensive understanding of the root causes and their potential consequential effects. In agreement with Ibbs et al.,(2001), Bruce (2006) also pointed out that, the ability to identify factors which cause variation or change is the first step in managing variation orders since it enables to manage them accordingly. Identification of causes of variation orders were discussed in previous sections.

When changes are encountered in construction projects, both the Client and Contractor have to take part in managing the change in a successful way so that the project benefits (Ibbs et al., 2001). As a part of minimizing variation orders and their adverse effects, Edward (2003) pointed out that problems related to variation orders should be studied collectively at the earliest stage of project implementation. This would enable resolving change management processes in time and effectively. Effective management of changes through contract administration processes for variation orders does mean implementing changes in a planned and systematic manner leading to effective execution of new works without affecting the ongoing project progress or with a controlled effect.

Many researchers who studied on variation orders proposed a change management system for variation orders which are more or less similar. Among these are Al-Dubaisi A.H.(2000) and Ibbs et al., (2001) proposed a project change management system. Most of them agree on steps of identifying variation orders followed by recognizing it. Evaluation of the variation order both cost wise and function wise is made followed by implementation.

The following variation order issuance management system can be used as an alternative where there is a clear understanding by all stakeholders as regards to the variation order under consideration. The flow chart enables those involved to control corruption related to variation orders which makes it unique.

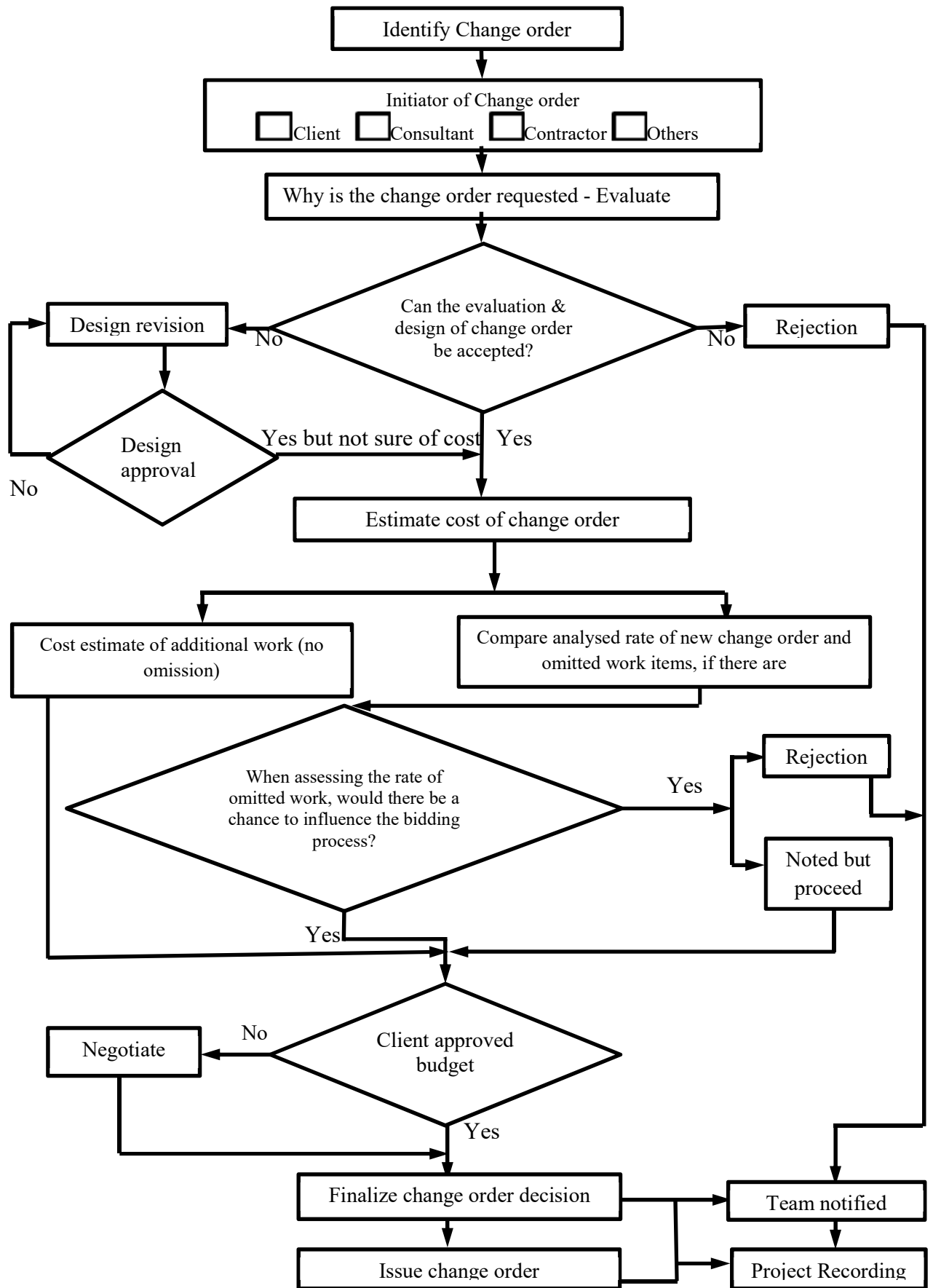


Figure 2.1: Variation issuance management flow chart (by own)

2.6 Variation orders, project delivery system and contract types

As mentioned in the previous sections of this study, the works handled before project execution is started may influence variation order occurrence both in type and magnitude. Clients after conducting preliminary studies, they select the type of project delivery system, contract types and procurement method in the planning phase for the intended project implementation. It is in these stages that obligations and rights are assigned to the contracting parties. Each type of contract and project delivery system affects the allocation of responsibilities and rights of the contracting parties. Their roles are also determined accordingly. The allocation of project risk differs from one project delivery system to the other. This is also the same for different contract types.

Because they have a direct effect on the occurrence and management of variation orders, discussing about project delivery systems and contract types is found out to be necessary and it is presented here below.

2.6.1 Variation orders and project delivery systems

According to Wubishet (2009), project delivery system is the way project owners together with project regulators & financiers determine the assignment of responsibilities to project stakeholders along the construction process. Odabasi (et al., 2003) also stressed the need to decide on project delivery system in such a way that every project Client who is responsible for implementation of the project must make an early decision regarding the method by which the project will be designed and constructed. Because of reasons related to finance, organizational objectives and time issues, a number of project delivery methods have come to exist in order to fit particular project and Client's needs of which three of them on the basis of familiarity and popularity are discussed here below.

1. Design Bid Build Delivery system (DBB)

This is the most practiced type of delivery system in Ethiopian construction industry. It is also very common to building projects in Addis Ababa. It is a fragmented type of delivery system. Project implementation is separated into a design stage and construction phase.

Consultants prepare the design with the necessary tender documents which will be used for tendering. The construction follows after the bid by the successful winner of the tender. The Consultant becomes legally liable towards the Client for its design services under the design services agreement. The Contractor then becomes liable for the works executed based on the design furnished by the engineer/architect during the construction process and/or thereafter, to the extent related to construction. In this type of delivery system, the Client is responsible for risks associated with the design and contract administration. Unless changes are made, the design of this type of delivery method lack to incorporate new construction technologies and constructability issues as the project progresses. That is, variation orders if they are to occur, most of them are more likely to be the responsibility of the Client and Consultant.

2. Design Build Delivery system (DB)

This is a delivery system in which the Client contracts with a single Contractor to perform both design & construction under a single design-build contract (Levy, 2006). It is less fragmented as compared to DBB. This delivery system has now been used to Ethiopian construction industry. There are mega projects of building type which are under construction with this type of delivery system. Client requirements with defined project concepts should be made available to the DB Contractor for project performance as may be desired by the Client. Project risks that may be resulted due to design are transferred to the DB Contractor minimizing that of the Client's risks. In this type of delivery, the Employer is almost certain the price he is to pay to the DB Contractor. As design risks are transferred to the Contractor, variation orders are reduced as compared to DBB.

3. Build Operate Transfer (BOT)

In this type of delivery system, a private company is contracted to finance, design, construct, operate the facility or construction product for a certain period of time and finally transfer it to the contracting party. In this type of project delivery, the project owner is not liable for what may come to the project except force majeure and agreed adjustments. Apart from securing finance from the Contractor for the project, this type of delivery system also makes project owners significantly not exposed to risks. Project definition and their packages clearly is the most important part before going into agreement for such type of delivery

system. As the risks are almost transferred to the project doers, variation orders in this type of delivery system are minimal.

2.6.2 Variation orders and contract types

During the construction phase of a project, there may be issues on which the Client and Contractor disagree. When such issues arise, the contracting parties will be governed by their contract agreement provisions. The contract is enforceable by law, it is a document where the terms and conditions are shown, duties & responsibilities, rights & obligations are assigned. It is a document in which risks are identified and allocated. Price issues, completion time, variation of works, dispute resolution mechanism are all handled as per the contract.

Issues on change orders, if they come to be a point of disagreement, it is no different and they are entertained as per the contract provisions by which the parties agreed to be administered with.

There are a number of contract types used in construction and depending on the project requirements, contracts can be identified as either fixed price or cost reimbursable (Ibbs et al., 2007). Below are selected types of contracts practiced in the construction industry in relation to where change order interpretation is required to be addressed.

1. Lump Sum Contract

In this type of contract, the Contractor is required to construct the project in accordance with plans and specification for a tender price that is determined and quoted as a total sum of money, fixed price, without individual rating. Hence, the Contractor is solely responsible for any cost exceeding the agreed amount.

2. Unit Rate or Bill of Quantities Contract

In this contract type, a detailed list of estimated work quantities of different types of work units are specified and tender price is determined and quoted from unit rates assigned to the detailed bill of quantities which include a short description of the work specification, unit of measurement, quantities and unit rate amount sum columns. In such kind of contract, the

Client has a better chance to administer changes. Unit price contract gives the Client the freedom to make changes in the volume of work.

3. Cost plus Fixed Fee Contract

When a project is a fast-track project and required to be completed urgently, and where it is difficult to estimate the project cost before, project costs will be recorded and fixed amount agreed by contracting parties will be added as payment to the Contractor. Such type of contract is called cost plus fixed fee contract.

The contractor in this type of contract is paid whatever cost associated with the project plus a lump sum fee for corporate overhead and profit. Such contracts are suitable for quality and time driven projects. There is no way that the Contractor can lose. The Client and Contractor can accommodate changes amicably.

4. Cost plus Percentage

This type of contract is similar to the Cost Plus Fixed Fee contract. The difference is in this type, the fixed fee is variable using a percentage of all the direct costs

2.7 Conceptual framework of the research

Conceptual framework is a summary of main points and principles drawn from field of study for which a particular phenomenon is under study accompanied by graphical depiction of major variables of the study. It plays a role in understanding the nature of the study by showing the relationship of the important elements of the study.

In this study, causes of variation orders as related to their initiators are considered as independent variables, whereas Increase in project cost, Completion schedule delay, Increase in overhead expenses, Additional payments for contractor, Logistics delays, Rework and demolition, Rework and demolition, Procurement delay, Delay in payment, Disputes among professionals, Damage to firm's reputation, Poor professional relations, Productivity degradation, Quality degradation, Progress is affected but without any delay and Additional fee for legal issues due to disputes are the dependent variables resulted due to impact of variation orders. Type of variation orders are taken as intervening variable

whereas project delivery, contract types and nature of the work are considered as moderating variables.

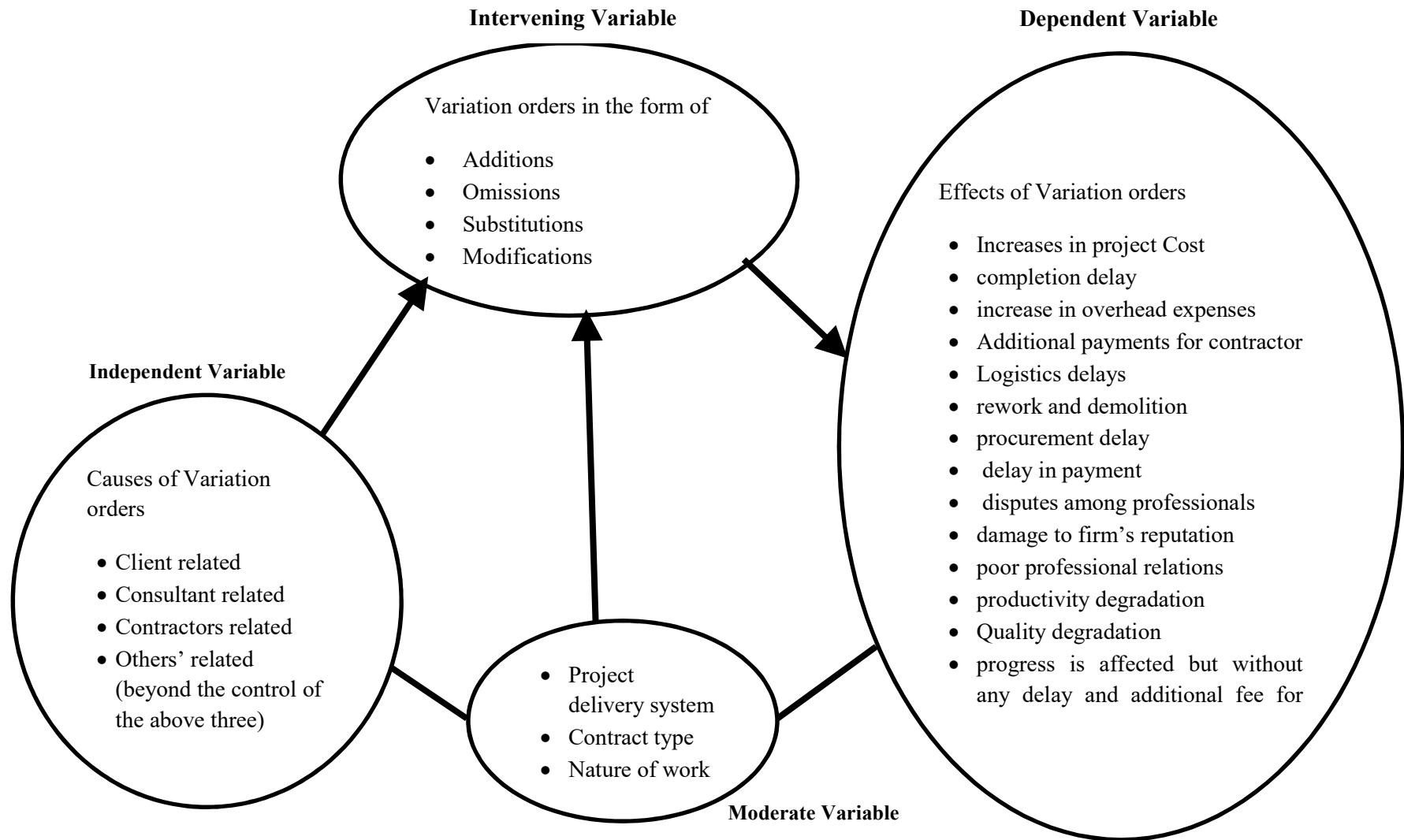


Figure 2.2 Conceptual Framework of the study (by own)

2.8 Research gap

The causes and effects of variation orders are widely researched worldwide for different types of projects. The studies made in Ethiopia on the subject are more of on the road sector. There are some made for building projects but not in numbers when compared to researches conducted on road projects.

Currently, there seems to give instruction for variation orders in the form of additions and omissions in consideration of previously accepted unit rate in an excuse to get the work done by a new rate as the old contractual rate (contract rate) is low as compared to the current (the specific time at which the work is to be executed) working price and the Contractor could not do the work. This can be interpreted at least into two ways: finding mechanism to expedite project completion and/or opening some unethical situation in which corruption would be on the table.

When the originators of variation orders are project Clients and Consultants, there are signs of making compromise to give variation orders for personal benefits. Discussions made during pilot test surveys with resident engineers and site supervisors of the projects on which the study was made confirmed corruption as a clear and present treat, now seen more and more affecting variation issuance. One cannot rule out this argument. It can be said that almost no studies are made in Ethiopia on this issue which has now become a grave concern in affecting the construction industry.

The study addressed this unethical and grave concern that brings damaging effect to the whole of the construction industry in the questionnaires and interviews.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area

Addis Ababa is the capital city of Ethiopia located at an altitude of 2,355meter above sea level at Latitude of $8^{\circ}0'48.9936''$ and Longitude of $38^{\circ}45'48.9996''$. It is a home of many International Organizations, the 3rd largest world diplomatic city next to New York and Brussels and recently it is growing as center of tourist attraction site. Along with the ever-increasing population of the city, there come numerous challenges that need to be met. Providing shelter, infrastructure, employment, water supply and other various social services have now become critical to sustain a metropolitan life.

The building projects studied for this research are those under construction for different purposes: Mixed Use Buildings (Shops, Offices, and Residential House Units), Institutes, Facilities for public use, etc. Below is the location map of the city with its eleven sub – cities mentioned by name and the projects are located in these sub – cities as shown in **Table 4.9** on page 76

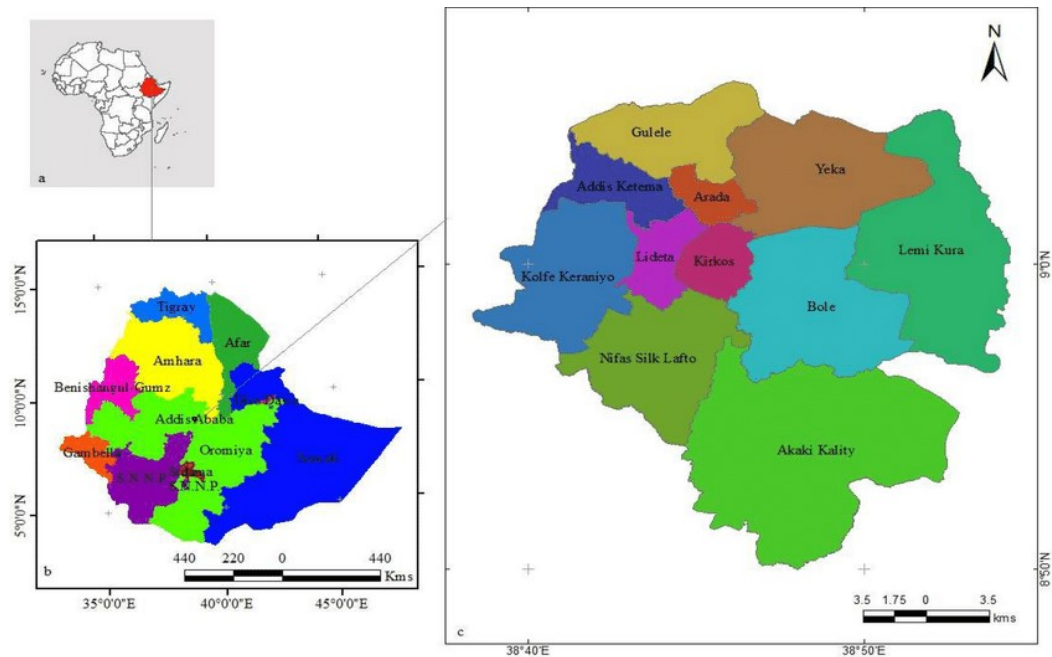


Figure 3.1: Location Map of the study area (Source: Ethio GIS (2022))

3.2. Research Design

Effects of variation orders most of the time have been adverse ones in construction projects influencing project delivery. To address this problem, this study was conducted with an objective of finding the causes and assessing the effects of variation orders together with developing strategic tools to reduce their impact. The study was conducted through a survey research based on a cause and effect relationship using both quantitative and qualitative researches based on the type of data collected. Using both types strengthen the research as they supplement each other.

Building projects considered for the research were those projects under construction in Addis Ababa and supervised by BUDSWS. From those projects, samples were selected and the variation orders issued on those sampled projects were assessed together with literature review and discussions with experienced professionals in the field to prepare a questionnaire for pilot test survey.

The approach followed for the study was that cause and effect of variation order sections of the questionnaire was prepared in a 5 – Point Likert Scale & with open ended questions whereas the government regulatory body's act to bring accountability for excess variation orders beyond the acceptable norm was requested in a YES/NO, multiple choice & open-ended questions. The questionnaire prepared for pilot test survey was distributed for those careful & purposefully selected respondents representing Clients, Consultants and Contractors. The final questionnaire was prepared incorporating the comments given from pilot test survey after checking its reliability and validity with an inclusion of some open-ended questions. The final questionnaire and interview made together with secondary data collected through desk study were used for the study.

3.3 Data Type

The research involved collecting data in a type of both quantitative and qualitative research. It is qualitative, because the study focused in obtaining the perceptions of building construction projects' stakeholders relative to the impact of variation orders. The study is also quantitative, because it focused on measurements (such as: high and low, less and low, slightly and extremely) of the variables that were identified from the literatures, assessed sampled desk study data and discussions with professionals which were obtained from pilot test survey to get answers for the formulated questions.

3.4 Source of data

Both primary and secondary data were used as a source of research data to determine the causes and effects of variation orders. Questionnaires and interviews were used as primary data source whereas data gathered from books, journals, desk study and other publications on the topic were used as a secondary data source.

3.4.1 Primary data source

The primary data were collected in the form of questionnaires and interviews from Clients, Contractors and Consultant representatives of the projects selected for the study. In addition to respondents working on the selected projects, questionnaires and interviews were distributed and made respectively to carefully selected respondents who were not directly involved on the selected projects for the study taking their wealth of experience & knowledge on the subject matter into account.

3.4.2 Secondary data source

Secondary data was collected from BUDSWS's Addis Ababa Project Coordination Office for desk study. These data include referred approved variation order documents, work progress reports, approved payment certificates and approved extension of time. The secondary data also includes data reviewed from various literatures, books and journal.

3.5 Sampling Design

3.5.1 Sampling Technique

By the time the research was conducted, there were 43 building projects in Addis Ababa supervised by BUDSWS that have been under construction phase. Of these projects, cost of approved variation orders for some of the projects has been more than 10% of their contract amount whereas the money allocated in the contract agreement of the projects for unexpected costs was 10% of the respective project amount. A 10% contingency is the norm the construction industry usually considers for unexpected costs and hence the projects with variation order more than 10% were selected for the study as they have been found appropriate for the research objectives. Thus, purposive method of sampling technique was used and the research was conducted on all of the projects which have had

approved variation orders cost with a cumulative of more than 10% of their original contract amount.

3.5.2 Sampling Population

The projects selected for the study were those 43 building projects in Addis Ababa (see Appendix 3) supervised by BUDSWS.

BUDSWS is an Ethiopian government owned company that renders engineering consultancy services to its Clients on a comprehensive range of study: Design, Construction Supervision and Contract Administration Services since 1977. The fields it has been involved are: design and supervision & contract administration of Buildings and Urban & Regional Planning. The specific works are design of Architectural, Structural, Electrical, Sanitary & Mechanical designs, Quantity Surveying, Bid Document Preparation and Supervision & contract administration of projects.

3.5.3 Sample size

The number of building projects selected for the study were based on purposive sampling, as mentioned on sampling technique were 16 and the targeted groups for the study were Contractors, Consultant Site Representatives & Contract Engineers and Client Representatives.

3.6 Method of data collection

To proceed with the findings of the study in line with the research objectives which demand identifying causes and assessing the impact of variation orders, data were collected using questionnaire, interview and from desk study of the 16 selected projects.

Questionnaires

The final questionnaire used for the study was developed after getting valuable information from the pilot test survey which gave the chance to add and remove some questions and even enabled to revise some questions in a way that would let respondents understand what that particular question did mean. A comprehensive questionnaire was prepared to collect the necessary information and was distributed to carefully selected respondents selected on purposive basis. The respondent groups were from Client, Consultant and Contractor representatives of the 16 projects on which the study was

conducted and to those purposefully selected respondents who can respond with knowledge on the research topic. The questionnaire consists of both open ended and closed ended questions. The respondents were asked to rate closed ended questions on a 5-point Likert Scale ordinal measure whereas they were requested to give their views and opinions on the open-ended question.

As it can be seen on Appendix 1, the questionnaire was designed to address four areas related to the research objectives:

Section A: The category of the organization in which the respondent serves, his/her role in the organization, the respondent's working experience and academic credentials.

Section B: To get responses from respondents on the causes of variation orders on building projects of which 32 causes were listed for rating together with open ended question.

Section C: To get responses from the respondents on the effects of variation orders on building projects of which 15 effects were listed for rating together with open ended question.

Section D: To get responses from the respondents on what the respective Government Regulatory Body has to do to control variation orders. Here Yes/No questions, proposed actions in the form of multiple choice and views for questions were indicated.

Interviews

Semi structured interview questions were prepared and asked during face to face meeting with carefully selected engineers who have engaged in the construction industry as a Contract Engineer and Contract Administration Team Leader to forward their opinions and views on the specific objectives of the study. Interview questions are attached on Appendix 2

Desk study

The projects selected for desk study were those ongoing construction projects supervised by BUDSWS under, The Addis Ababa One Project Coordination Office, one of the nine project coordination offices of BUDSWS. List of the projects and pertinent information is attached on Appendix 3.

Out of the 43 projects, 16 projects were selected for the desk study. The selection was based on the magnitude of the variation orders in terms of the cost of the variation works approved for that particular project. All the projects selected for desk study were those projects for which the cost of approved variation works were more than 10% of their respective project amount in the time of data collection.

Data collected from the selected projects were based on payment certificates, monthly reports and variation order approvals. The nature of the cases from the desk study differ from one project to the other depending on the problem, interest or need that let the variation orders given. The desk study conducted was used to supplement the findings obtained through questionnaire and interview.

3.7 Method of data analysis

The data collected was analyzed both for qualitative and quantitative analysis using appropriate methods mentioned below and Microsoft Excel Application and SPSS 26 soft wares.

3.7.1 Qualitative Analysis

Qualitative analysis was used to analyze data collected through open-ended questions from questionnaire. The views and opinions of the open-ended questions and interviews were organized in a logical order and grouped based on the central concept of the respondents and analyzed thematically.

3.7.2 Quantitative Analysis

Quantitative analysis was used to analyze data collected from questionnaires. Closed ended questions from questionnaires were analyzed statistically as per the rating given based on the 5- Point Likert Scale. Both inferential statistics and descriptive analysis were used using SPSS 26 software and Microsoft Excel Application

Descriptive Analysis

The data collected through questionnaires on a 5 – Point Likert Scale for closed ended questions were analyzed using descriptive analysis method. RII (Relative Importance Index) was used to determine the relative importance of the various causes and effects of variation orders based on responses from Clients, Consultants, and Contractors. The

analysis included ranking the factors in terms of degree of effecting, identifying which were the main source of variation orders.

$$RII = \frac{\sum W}{AN} \dots\dots\dots \text{Equation 3.1}$$

Where: W = the weight given to each factor by the respondents, it ranges from 1 to 5;

A = the highest weight = 5;

N = the total number of respondents

RII = Relative Importance Index

Inferential Analysis

The Spearman's rank of correlation was used to test the agreement, strength and direction of relation between different respondents' groups. The degree of agreement between the different respondent groups involved in the questionnaire was checked using this correlation coefficient.

The Spearman (rho) rank correlation coefficient for any two groups of ranking is given by the following formula:

$$\rho = 1 - \frac{6 \times (\sum d_i^2)}{N \times (N^2 - 1)} \dots\dots\dots \text{Equation 3.2}$$

Where: ρ: Spearman's rank correlation coefficient;

d_i: the difference in ranking between each pair of factors; and

N: number of factors (variables).

The value of the Spearman (rho) rank correlation coefficient varies between -1 and +1. A correlation coefficient of +1 implies perfect positive correlation, 0 implies no correlation and -1 implies perfect negative correlation. From the output of this formula, association of the variables was measured based on the ranks of the observation given on the data collection methods.

3.8 Method of data presentation

The analyzed data was presented using tables and charts. The presentations are believed to make those who read the research more comfortable and understand the analyzed data

much more quickly. Texts were also used to explain the findings shown on the above presentation methods.

3.9 Validity & Reliability Tests, Triangulation

One of the main factors that decides the strength and weakness of a research is the method by which the data are collected. There are requirements that researches should give attention that these data collection methods shall fulfill in order to produce a research finding that truly represent the problem that was the reason for the research to be conducted. These requirements are usually taken up by conducting validity and reliability tests.

Validity

Questions on the questionnaire whether they accurately measure what they were supposed to measure as expected, without misinterpretation and in a meaningful manner as planned with respect to the objective of the research were checked by validity test on the data collected by conducting pilot test survey. Content validity of the pilot test questionnaire, whether the questions were relevant to measure directly the important research objectives or not was checked by those carefully selected respondents who gave their comments by paraphrasing some questions, adding new questions and recommending to delete a few ones. Whereas the construct related validity test in which the questions were required to measure the construct or characteristic they claim to measure was checked statistically by Karl Pearson's Coefficient of Correlation. A maximum significant level of 0.05 with a 95% degree of confidence was selected for the analysis and validity of each question was checked by Pearson's method.

Reliability

The questionnaire that was prepared for the pilot survey was analyzed to check the consistency of the measurements listed on the questionnaire how dependable they were to use them further. For this study, respondents' replies on the Likert Scale were analyzed and the internal consistency of the measurements was checked using Cronbach alpha. The Cronbach alpha obtained from the analysis was 0.81 which can be interpreted as "Good". So, the questionnaire prepared for pilot test survey was used for data collection as the reliability test shows together with the validity test that the findings from the respondents can address the research problem.

Triangulation

Finally, to increase the validity of the research findings, triangulation of the closed ended data outputs, open ended questions analyzed ideas, interview and data from desk study (secondary data sources) was made. The combined outputs of the analyzed data through triangulation explained the findings of the research on Causes and Effects of Variation Orders on building projects on which the study was conducted.

3.10 Rule of Thumb – Level of Importance

Some organizations set their own level of importance when it comes to interpret RII values based on experience and case studies. In this research the following table proposed by Chen et al.,(2010) was used as rule of thumb to take RII values for further interpretation. In general, the High (H) level of importance is considered. But where the need arises to increase the number of factors for triangulation with that of interview and desk study results, the level of importance could be lowered from high to medium.

Table 3.1: Level of Importance from RII

No	Level	RII
1	High(H)	$0.8 < RII < 1.0$
2	High to Medium(H-M)	$0.6 < RII < 0.8$
3	Medium(M)	$0.4 < RII < 0.6$
4	Medium to Low(M-L)	$0.2 < RII < 0.4$
5	Low	$0.0 < RII < 0.2$

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Description of demographic profile and response rate of respondents

Respondents job background, their experience and response rate of questionnaires were analyzed and presented below.

4.1.1 Respondents' job background – position

Among the 28 respondents from the Consultant group, 13(46%) were Resident Engineers, 7(25%) were Contract Engineers, 4(14%) were Project Coordination Office Heads, 1(4%) was Contract Administration Team Leader and 3(11%) were site Supervisors. Among the 16 respondents from the Client group, 7(44%) were Project Managers, 2(13%) were Contract Engineers, 2(13%) were Supervisors, 3(18%) were Office Engineers, 1(6%) was Contract Administrator Director and 1(6%) was Senior Project Expert (Resident Engineer). As regards to the respondents from the Contractor group, out of the 24 respondents 7(29%) were Project Managers, 3(13%) were Contract Administration Department Heads, 4(17%) were Office Engineers, 2(8%) were Project Coordinators, 4(17%) were Site Engineers, 3(12%) were Project Planning & Monitoring Engineers and 1(4%) was Tender & Cost Expert. **Figure 4.1** below shows the group composition based on their position in their respective organizations.

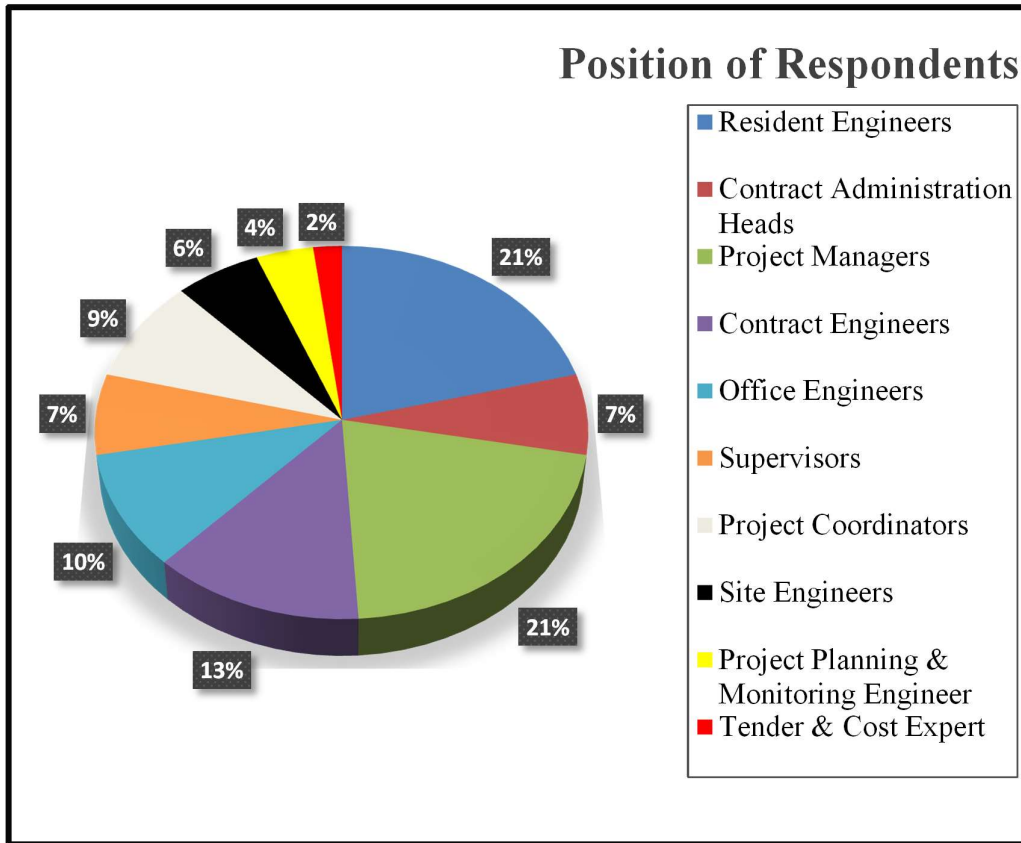


Figure 4.1 Positions of Respondents

4.1.2 Respondents' work experience

The respondents work experience in the construction industry, as categorized from the questionnaires show that they have different levels of involvement in the sector. Respondents with work experience of more than 10 years in the field are generally believed to respond with a very good knowledge of the subject matter. As tabulated in **Table 4.1**, the majority of the respondents have a work experience of more than ten years. Majority of respondents from the Client and Contractor groups have experience from 11 to 15 years whereas those of respondents from the Consultant group, the majority have experience over 15 years.

Table: 4.1 Respondents Work Experience in the Construction Industry

Experience in Years	Client		Consultant		Contractor		Total	
	Respondents	In %	Resp.	In %	Resp.	In %	Resp.	In %
Less than 5 years	0	0%	1	4%	1	4%	2	3%
5 to 10 years	0	0%	1	4%	1	4%	2	3%
11 to 15 years	13	79%	2	7%	16	67%	31	46%
Over 15 years	3	21%	24	85%	6	25%	33	48%

4.1.3 Rate of response

The respondents were grouped into three: from Clients, from Consultant and from Contractors. 75 questionnaires were distributed out of which 71 were returned. However, out of the 71 returned questionnaires 3 were found out to be not reliable for the data that can be used for the analysis and were rejected. 68 valid questionnaires (91% response rate) were used to analyze the data from questionnaires. The return of questionnaires from the three group respondents is tabulated in **Table 4.2** below.

Table: 4.2 Questionnaire response rate

Respondents' Group	Questionnaires distributed	Questionnaires returned	Response Rate (%)	Valid Questionnaires	Response Rate of Valid Questionnaires (%)
Consultant	30	29	97%	28	93%
Client	20	18	90%	16	80%
Contractor	25	24	96%	24	96%

4.2 Causes of variation order on building projects

4.2.1 Causes of variation order as per the data obtained from questionnaires

In this part of the study, closed ended questions of the questionnaires were analyzed using descriptive statistics using Relative Important Index (RII) and Spearman's Correlation. A 5 - Point Likert Scale was used to rate the questions in the questionnaires to which the respondents responded as per the instructions indicated on each section of the questionnaire.

The level of contribution of the factors that cause variation orders were ranked using RII method by using the 5 - Point Likert Scale being rated in the form of Least Contributing =1, Low Contributing=2, Medium Contributing=3, High Contributing=4 and Very High Contributing=5. Below are the results of the analyses.

A. Client group

Analysis of data from questionnaires responses from Client group on Causes of variation orders as obtained were shown below:

Table: 4.3 Factors that contributed to causes of variation orders from Client Respondents

Causes of variation orders	RII	Rank
Errors and omissions in design	0.76	1
Change of plans or scope (new additional work interest)	0.74	2
Change in specifications	0.73	3
Conflicts between contract documents	0.71	4
Design discrepancies	0.70	5
Inadequate working drawing details	0.69	6
Change in economic conditions	0.67	7
Change in design by the consultant	0.66	8
Contractor's desire to replace his low-priced item with a new price	0.65	9
Replacement of materials or procedures	0.64	10
Unforeseen problems	0.63	11
Poor procurement process	0.63	12
Differing site conditions	0.62	13
Contractor's financial difficulties	0.61	14
Impediment in prompt(quick) decision making process	0.61	15
Non-compliant design with owner's requirement	0.61	16
Consultant's lack of required data	0.60	17
Consultant's lack of judgment and experience	0.59	18
Lack of coordination	0.59	19
Inadequate project objectives	0.57	20
Long lead procurement	0.57	21
Lack of consultant's knowledge of available materials and equipment	0.56	22
Change of schedule	0.56	23
Contractor's desired profitability	0.54	24
Inadequate scope of work for contractor	0.54	25
Personal or group interests reflected through corruption for issuing variation orders	0.51	26
Honest wrong beliefs of consultant (lack of first-hand knowledge)	0.51	27
Non-compliant design with government regulations	0.51	28
Technology change	0.50	29

Unavailability of equipment	0.50	30
Client's financial problems	0.40	31
Client's unethical desire to replace low priced item of work with a new price	0.39	32

As shown in **Table 4.3** above, the most causing factor of variation orders was Errors and omissions in design whereas Change of plans or scope (including new additional works), Change in specification, Differing site condition, Design discrepancies causes ranked from second to fifth. Unavailability of equipment, Client's financial problem and Client's unethical desire to replace low priced item of work with a new price were the least three ranked factors that cause variation orders.

B. Consultant group

Analysis of data from questionnaires responses from Consultant group on Causes of variation orders as obtained were shown below:

Table: 4.4 Factors that contributed to causes of variation orders from Consultant Respondents.

Causes of variation orders	RII	Rank
Change of plans or scope (new additional work interest)	0.75	1
Conflicts between contract documents	0.72	2
Change in specifications	0.71	3
Change in economic conditions	0.70	4
Errors and omissions in design	0.67	5
Contractor's financial difficulties	0.66	6
Replacement of materials or procedures	0.65	7
Poor procurement process	0.64	8
Design discrepancies	0.63	9
Differing site conditions	0.62	10
Contractor's desire to replace his low-priced item with a new price	0.61	11
Change in design by the consultant	0.60	12
Impediment in prompt(quick) decision making process	0.60	13
Contractor's desired profitability	0.60	14
Long lead procurement	0.60	15
Change of schedule	0.60	16
Inadequate working drawing details	0.57	17
Inadequate project objectives	0.57	18

Unforeseen problems	0.57	19
Inadequate scope of work for contractor	0.57	20
Lack of coordination	0.54	21
Technology change	0.53	22
Non-compliant design with owner's requirement	0.53	23
Lack of consultant's knowledge of available materials and equipment	0.52	24
Personal or group interests reflected through corruption for issuing variation orders	0.52	25
Consultant's lack of required data	0.50	26
Client's unethical desire to replace low priced item of work with a new price	0.49	27
Consultant's lack of judgment and experience	0.49	28
Client's financial problems	0.49	29
Unavailability of equipment	0.47	30
Honest wrong beliefs of consultant (lack of first-hand knowledge)	0.46	31
Non-compliant design with government regulations	0.46	32

As shown in **Table 4.4** above, the most causing factor of variation orders was change of plans or scope (including new additional works) whereas conflicts between contract documents, change in specification, contractor's desire to replace his low priced items with a new item, errors and omissions in design were causes ranked from second to fifth. Unavailability of equipment, Honest wrong beliefs of Consultant (lack of first-hand knowledge) and Non-compliant design with government regulation were the least three ranked factors that cause variation orders.

C. Contractor group

Analysis of data from questionnaires responses from Contractor group on Causes of variation orders as obtained were shown below:

Table: 4.5 Factors that contributed to causes of variation orders from Contractor Respondents

Causes of variation orders	RII	Rank
Change of plans or scope (new additional work interest)	0.86	1
Change in economic conditions	0.80	2
Change in specifications	0.79	3
Conflicts between contract documents	0.78	4
Errors and omissions in design	0.76	5
Inadequate working drawing details	0.75	6

Design discrepancies	0.74	7
Change in design by the consultant	0.73	8
Differing site conditions	0.71	9
Poor procurement process	0.70	10
Unforeseen problems	0.69	11
Impediment in prompt(quick) decision making process	0.68	12
Replacement of materials or procedures	0.68	13
Contractor's desire to replace his low-priced item with a new price	0.66	14
Contractor's financial difficulties	0.65	15
Consultant's lack of required data	0.65	16
Client's financial problems	0.64	17
Inadequate scope of work for contractor	0.63	18
Lack of consultant's knowledge of available materials and equipment	0.63	19
Non-compliant design with owner's requirement	0.63	20
Lack of coordination	0.63	21
Unavailability of equipment	0.63	22
Technology change	0.61	23
Inadequate project objectives	0.60	24
Contractor's desired profitability	0.60	25
Long lead procurement	0.60	26
Honest wrong beliefs of consultant (lack of first-hand knowledge)	0.60	27
Consultant's lack of judgment and experience	0.59	28
Personal or group interests reflected through corruption for issuing variation orders	0.59	29
Change of schedule	0.56	30
Non-compliant design with government regulations	0.55	31
Client's unethical desire to replace low priced item of work with a new price	0.50	32

As shown in **Table 4.5** above, the most causing factor of variation orders was change of plans or scope (including new additional works) whereas change in economic condition, change in specification, change in design by the Consultant, inadequate working drawing details were causes ranked from second to fifth. Change of schedule, non – compliant design with government regulation and Client's unethical desire to replace low priced item of work with a new price were the least three ranked factors that cause variation orders.

D. Correlation of respondents – between their ranking on the causes of variation orders

The extent to which the rankings of the questions indicated on the questionnaires that were replied by the respondents were checked how their relationships looked like using Spearman's Coefficient. The coefficient for the given subtitle is a measure of strength and direction between two sets of ranks obtained from possible combination of respondent groups from the analysis on the causes of variation orders.

Table: 4.6 Summary of correlation coefficient test on the ranking of causes of variation orders

Respondents' Group	Spearman's Correlation Coefficient	Relationship of the respondents' ranking
Client Vs Consultant	0.80	Strong
Client Vs Contractor	0.86	Strong
Consultant Vs Contractor	0.97	Strong

From the above correlation table, it can be taken that there is a strong positive correlation between the respondents from each group in such a way that a higher variable increase in one group tends to be similar for the other groups. That means most of the respondents have the same perception about the causes of variation orders.

E. Results from respondents' groups

The results obtained from each respondent group on the causes of variation orders have been presented in Table 4.7 for a better picture.

Table: 4.7 Results of factors that contributed to causes of variation orders from all groups' respondents.

Causes of variation orders	Client		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
Change of plans or scope (new additional work interest)	0.74	2	0.75	1	0.86	1
Change in specifications	0.73	3	0.71	3	0.79	3
Errors and omissions in design	0.76	1	0.67	5	0.76	5
Conflicts between contract documents	0.71	4	0.72	2	0.78	4
Change in economic conditions	0.67	7	0.70	4	0.80	2
Design discrepancies	0.70	5	0.63	9	0.74	7
Differing site conditions	0.62	13	0.62	10	0.71	9
Contractor's desire to replace his low-priced	0.65	9	0.61	11	0.66	14

item with a new price						
Change in design by the consultant	0.66	8	0.60	12	0.73	8
Inadequate working drawing details	0.69	6	0.57	17	0.75	6
Replacement of materials or procedures	0.64	10	0.65	7	0.68	13
Poor procurement process	0.63	12	0.64	8	0.70	10
Impediment in prompt(quick) decision making process	0.61	15	0.60	13	0.68	12
Contractor's financial difficulties	0.61	14	0.66	6	0.65	15
Unforeseen problems	0.63	11	0.57	19	0.69	11
Long lead procurement	0.57	21	0.60	15	0.60	26
Contractor's desired profitability	0.54	24	0.60	14	0.60	25
Non-compliant design with owner's requirement	0.51	28	0.53	23	0.63	20
Inadequate project objectives	0.50	20	0.57	18	0.60	24
Inadequate scope of work for contractor	0.54	25	0.57	20	0.63	18
Lack of coordination	0.59	19	0.54	21	0.63	21
Consultant's lack of required data	0.60	17	0.50	26	0.65	16
Change of schedule	0.56	23	0.60	16	0.56	30
Lack of consultant's knowledge of available materials and equipment	0.56	22	0.52	24	0.63	19
Technology change	0.50	29	0.53	22	0.61	23
Consultant's lack of judgment and experience	0.59	18	0.49	28	0.59	28
Personal or group interests reflected through corruption for issuing variation orders	0.51	26	0.52	25	0.59	29
Unavailability of equipment	0.50	30	0.47	30	0.63	22
Honest wrong beliefs of consultant (lack of first-hand knowledge)	0.51	27	0.46	31	0.60	27
Client's financial problems	0.40	31	0.49	29	0.64	17
Non-compliant design with government regulations	0.51	28	0.46	32	0.55	31
Client's unethical desire to replace low priced item of work with a new price	0.39	32	0.49	27	0.50	32

The results shown in Table 4.7 above were referred in the discussion part of the study

4.2.2 Causes of variation order as per the data obtained from interview

Semi structured interview conducted with the selected interviewees were summarized in a way that can easily be categorized in line with the research objectives, in this case cause of variation orders are shown below.

Table 4.8: Results of interview on causes of variation orders

Questions	Interviewee A	Interviewee B	Interviewee C	Interviewee D
What are the main causes of variation orders on building projects?	<ul style="list-style-type: none"> ▪ Change of scope ▪ Conflict of documents (not read the same one another) ▪ Change of specification ▪ Design omission ▪ Incomplete design ▪ Design change ▪ Replacement of lower rated work items ▪ Material unavailability 	<ul style="list-style-type: none"> ▪ Design problem ▪ Change of Client interest ▪ Additional works ▪ Relocation of the site ▪ Replacement of materials ▪ BOQ which contradicts with drawing ▪ Material price rise of BOQ items 	<ul style="list-style-type: none"> ▪ Design omission and incomplete design. ▪ Additional interest by Client ▪ It is because of the up grading of the structural service. ▪ Material replacement ▪ Design review by the Client. ▪ Materials in the BOQ not available. ▪ Site relocation of site 	<ul style="list-style-type: none"> ▪ Lack of construction materials ▪ Change in design ▪ Conflicts b/n contract documents ▪ Owner's financial problem ▪ Government policy ▪ Change in specification by Client
To what extent does the Client's well-prepared project brief which clearly express what is required from the project during design phase help in reducing variation orders?	<ul style="list-style-type: none"> ▪ New interests during construction would be avoided if there is a good project brief ▪ Scope will be clear to Consultant/designer ▪ Enables to avoid some major causes of variations 	<ul style="list-style-type: none"> ▪ Clients well prepared brief about the project is very important to reduce unnecessary work items involvement that causes variation. ▪ Very important to consider all the project scope during design. ▪ It solves Consultants' lack of required data. 	<ul style="list-style-type: none"> ▪ This depends on the capacity of the Client's project office. Most of the Client's project office is not well structured in all discipline so that it is one of the sources of variation order ▪ The Client also didn't give enough time for the design. 	<ul style="list-style-type: none"> ▪ Not to change design drawings ▪ Reduce time overrun ▪ Reduce cost overrun

As per Table 4.8 shown above, factors that cause variation orders from interview results, referring common answers can be taken as change of scope and plan including additional works, conflict of contract documents, design omission and error, design change, change in specification, material unavailability, material replacement and relocation of the site. The result also stressed that if there is a well-prepared project brief by the Client, variation orders can be minimized significantly.

4.2.3 Causes of variation order as per the data obtained from desk study

Variation orders issued on the selected projects for desk study both in type of work and the respective monetary values together with pertinent information are shown below.

4.2.3.1 Status & type of variation orders

I. Project data

The project data of the 16 projects selected for the study are summarized in **Table 4.9** as follows:

Table 4.9: List of projects and their data -Selected for desk study.

Project Label	Project	Client	Contractor	Location (Sub - City in Addis Ababa)	Contract Agreement Signed Date	Original Contract Amount(in Birr)	Contract Time(in cal. days)	Commencement Date	% of Total Variation as of March 2023	% of Additional Time Due to Variations Orders	Work progress in % as of March 2023	Facility Constructed for
A	Geophysics Office Building B+G+6 and Site work	Addis Ababa University	FE Construction PLC	Kirkos	18-May-17	212,068,248.14	365	Sene 15, 2009 E.C	18.74	20.27	75.34	Office and geophysical survey equipment installation
B	G+6 Renovation Block C&D Office Building and Cafeteria	Ministry of Revenue	Ethiopian Construction Works Corporation	Yeka	26-Jun-21	200,547,391.41	300	17-Jul-21	17.75	21.67	41.00	Renovate existing building build new Cafeteria
C	Kality Bus Terminal Facility	Transport and Logistic Ministry	FE Construction PLC	Akaki Kality	13-Feb-19	208,325,573.38	540	10-Apr-19	14.94	18.89	63.66	To accommodate buses to Serve as point of Departure (station)
D	G+2 Specialized Laboratory Building	Ethiopian Water Technology Institute	Bereket Endashaw General Contractor	Akaki Kality	17-May-17	52,945,227.72	686	9-Jun-17	31.42	42.57	137.29	Specialized laboratory
E	Central Kitchen Electromechanical work	Federal Police Commission	Kibish Construction	Akaki Kality	8-Jan-19	48,401,102.25	600	21-Feb-19	11.28	11.33	90.31	Electromechanical units Installation for central kitchen
F	Office Building Maintenance	Afric Leather & Leather P.1	SINSIF Construction	Yeka	31-Dec-20	2,174,560.94	180	21-Feb-21	63.69	63.89	67.47	Maintain Africa Leather & Leather Products Institute Building
G	Ministry of Transport & Logistics Head Office	F.D.R.E Ministry of Transport & Logistics	Tamirat Temesgen Construction B.C	Kirkos	20-Jun-21	37,909,669.73	90	11-Jul-21	50.34	51.11	136.93	Renovate existing Head Office Building of the Ministry
H	Addis Ababa Police Commission Head Office Building Maintenance	City Gov't of Addis Ababa Design and Construction Works Bureau	Ethiopian Construction Works Corporation	Arada	26-Oct-20	86,462,009.28	390	24-Dec-20	43.28	43.08	67.47	Maintain Head Office of the Commission
I	G+3 Laboratory Complex Building @ Saris	Ethiopia Forestry Development	Mirab Construction	Akaki Kality	2-Feb-20	150,051,268.95	540	4-Mar-20	40.83	42.04	45.47	Laboratory for forestry research
J	New Addis Ababa Prison(Administration, Admission & Exceptional prison)	Federal Prison Administration	Ahmed Mohammed B.C	Akaki Kality	4-Mar-14	61,632,709.10	500	14-Apr-14	14.34	14.80	98.90	Administration Offices for the whole of the prison facility
K	Prisoners Family Hall & Garage	Federal Prison Administration	Amare Abayneh B.C	Akaki Kality	19-Feb-14	18,478,204.60	500	25-Apr-14	21.64	23.40	104.90	Families of prisoners and Prisoners meet in this building
L	New Addis Ababa (site Work, information desk, Watch tower, central kitchen and grain store) construction works	Federal Prison Administration	Radar Construction	Akaki Kality	19-Feb-14	244,784,468.00	270	Tikemt 29, 2012 E.C	41.16	43.33	92.31	Site works like information desk, incinerator, watch tower, central kitchen
M	Sectoral Head Office - 3B+20G+R	Addis Ababa City Administration Mega Project Construction office	Zhongyang Construction Group Company Limited	Yeka	20-Jan-20	1,575,236,702.75	720	13-Feb-20	10.21	10.69	55.18	Offices for the Transport Bureau
N	3B+G+M+8 & 9th to 13th Building of National Archives and Library Agency	National Archives and Library Agency	FE Construction PLC	Lideta	18-May-15	202,485,293.5 & 88,662,219.21	540	10-Jun-15	55.99	60.93	100.00	An all-out service for the National Library: Offices, Stores, Library, etc
O	B+G+4 Mixed Use Building	Secretariat of the House of People's Representatives of EFDRE	Safer Construction PC.	Kirkos	Nehassie 30, 2011 E.C	134,688,759.97	730	Tikemt 26, 2012 E.C	14.55	59.86	98.84	Offices, Meeting Rooms, Watch Tower, etc.
P	Property & supply, Workshop & Engineering Division	Federal Police Commission	FE Construction PLC	Nifas Silk Lafto	17-May-16	117,399,219.21	600	16-Jun-16	23.67	24.50	114.31	Offices, Workshop,, Stores, etc

II. List of variation orders with respect to the work items, amount of cost and why the variations were issued is shown in the following tables for each project.

Project A

Table 4.10: Factors that cause issuance of variation orders and related data for Project A

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Basement concrete retaining wall	4,841,097.11	2.28	8	Missed in BOQ	Consultant
2	Fire escape with steel structure (replacing concrete staircase)	1,850,877.85	0.87	3	Change of specification	Consultant
3	Fence work	5,342,736.65	2.52	9	Additional interest	Client
4	Subsurface drainage system	352,331.25	0.17	1	Design error	Consultant
5	Toilet partitions	329,685.03	0.16	1	Additional interest	Client
6	Quartz finishing	5,009,745.00	2.36	10	Conflict of documents (BOQ & drawing are different)	Consultant
7	Massive rock excavation	1,792,367.52	0.85	4	Lack of proper details in the geotechnical investigation report	Client
8	Assembly Hall stage and wall works	286,421.16	0.14	1	Change of specification	Client
9	Aluminium Curtain wall	4,757,425.80	2.24	8	Conflict of documents (BOQ & drawing are different)	Consultant
10	Data cable change	12,002,171.65	5.66	21	Change of	Client

	from Cat 6 to Cat 6a				specification	
11	CCTV cable change from Cat 6 to Cat 6a	380,293.02	0.18	1	Change of specification	Client
12	Armstrong ceiling replacing 19mm thickness with 13mm	-860,246.00	-0.41	0	Out of stock	Contractor
13	Septic tank and water treatment	3,664,236.95	1.73	7	Not in the design scope	Client
	Total	39,749,144.05	18.74	74		

Project B

Table 4.11: Factors that cause issuance of variation orders and related data for Project B

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Contextra wall painting finishing in place of quartz	2,327,984.19	1.16	4	Client interest	Client
2	Floor box for electrical power outlet devices	-490,521.54	-0.24	0	Change of specification	Consultant
3	Septic Tank	466,138.13	0.23	25	Additional interest	Client
4	Electric light fitting	-931,546.00	-0.46	0	Design error	Consultant
5	Aluminium wall panel replacing melamine board	0	0.00	0	Design error	Consultant
6	Cafeteria block	1,238,255.77	0.62	2	Additional interest	Client
7	Aluminium windows	569,876.42	0.28	1	Conflict of documents (BOQ & drawing are different)	Consultant
8	Aluminium curtain wall	32,268,512.40	16.09	33	Conflict of documents (BOQ & drawing are different)	Consultant
9	Emergency exit with RHS	142,665.55	0.07	0	Missed in the BOQ	Consultant
	Total	35,591,364.92	17.75	65		

Project C

Table 4.12: Factors that cause issuance of variation orders and related data for Project C

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Fence work	47,021,015.31	10.58	58	Additional interest	Client
2	Reinforcement bar	1,127,988.78	1.32	2	Design change	Consultant
3	Septic tank	4,006,079.63	0.99	30	Design change	Consultant
4	Ceramic floor finish	5,857,225.41	1.45	9	Out of stock	Contractor
5	Aluminium Curtain wall	2,454,353.00	0.60	3	Conflict of documents (BOQ & drawing are different)	Consultant
Total		60,466,662.13	14.94	102		

Project D

Table 4.13: Factors that cause issuance of variation orders and related data for Project D

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Concrete jacketing of foundation columns	2,846,021.63	5.38	27	Design error	Consultant
2	Aluminium windows and electrical work	5,803,874.97	10.96	55	Conflict of documents (BOQ & drawing are different)	Consultant
3	Addition and omission of different work items	-9,192,402.85	-17.36	0	Inaccurate BOQ preparation	Consultant
4	Aluminium work and floor finishing	4,729,316.12	8.93	45	Drawing discrepancies	Consultant
5	Aluminium windows & doors	-3,930,633.07	-7.42	0	Drawing discrepancies	Consultant
6	Asphalt work	7,149,088.85	13.50	68	Additional	Client

					interest-new scope	
7	Aluminium windows and doors	2,697,801.32	5.10	25	Conflict of documents (BOQ & drawing are different)	Consultant
8	Skylight	306,475.00	0.58	3	Change of specification	Contractor
9	Acid resistant pipe	824,906.16	1.56	10	Change of specification	Client
10	Louver doors	11,691.50	0.02	1	Missed in the BOQ	Consultant
11	Emergency eye wash & shower, Acid resistant pipe	1,155,805.20	2.18	14	New Interest	Client
12 13	Synthetic paint, Catch pit grill(in the form of supplementary agreement0	4,231,917.78	7.99	44	Missed in the BOQ	Consultant
	Total	16,633,862.61	31.42	292		

Project E

Table 4.14: Factors that cause issuance of variation orders and related data for Project E

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Unexpected ground water which led Kerosene Tanker to be on surface	4,117,243.00	8.51	51	Design change	Consultant
2	Steel structure to suspend kitchen hood	719,447.53	1.48	9	Design error	Consultant
3	Sanitary pipes installation	620,588.75	1.29	8	Client new interest	Client
	Total	5,457,279.28	11.28	68		

Project F

Table 4.15: Factors that cause issuance of variation orders and related data for Project F

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Various wall and floor finishing works	540,383.02	24.85	45	Conflict of documents (BOQ & drawing are different)	Consultant
2	Roofing, truss and different wall & floor finishing works	844,698.73	38.84	70	New interest	Client
	Total	1,385,081.75	63.69	115		

Project G

Table 4.16: Factors that cause issuance of variation orders and related data for Project G

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	One floor was added with all work types	7,978,659.12	21.05	19	Scope change	Client
2	One floor was added with all work types (in the form of supplementary agreement)	11,105,752.05	29.30	27	Scope change	Client
	Total	19,084,411.17	50.34	46		

Project H

Table 4.17: Factors that cause issuance of variation orders and related data for Project H

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Perforated pipe for subsurface drainage	4,628,114.62	5.35	20	Inadequate scope of work	Client (work description prepared by AACB)
2	Additional light fittings	112,088.75	0.13	1	New interest	Client
3	Mechanical units installation	15,799,955.80	18.28	71	Specification change	Consultant
4	Site work	12,921,174.14	14.94	58	New interest	Client
5	Electrical power outlets and cables	1,553,200.00	1.80	7	Additional work	Client
6	Electrical and wall & floor finishing works	1,217,673.00	1.41	6	Additional work	Client
7	Log box with all the electrical accessories	1,187,663.00	1.37	5	New interest	Client
	Total	37,419,869.31	43.28	168		

Project I

Table 4.18: Factors that cause issuance of variation orders and related data for Project I

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	EGA roofing, steel structure	1,064,940.25	0.71	4	Out of stock	Contractor
2	Metal work(shade changed to office)	1,242,039.79	0.83	4	Change of scope	Client
3	Sanitary pipes and wares installation	612,870.65	0.41	2	Change of specification	Consultant
4	Electrical cables, power outlets for machine installation	756,069.00	0.50	1	Lack of information about the machines during design	Consultant
5	Machine installation electrical works	6,685,215.65	4.46	17	New interest	Client
6	Machine installation electrical works	2,973,789.60	1.98	8	New interest	Client
7	Pavement work, wall & floor finishing, electrical fittings	3,081,524.24	2.05	30	Additional work	Client
8	Concrete shear wall, granite finishing change (in the form of supplementary agreement)	44,856,175.53	29.89	161	Conflict of documents (BOQ & drawing are different), Unavailability of granite from Benshangul Gumuz region due to security issues.	Client & Consultant
Total		61,272,624.71	40.83	227		

Project J

Table 4.19: Factors that cause issuance of variation orders and related data for Project J

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Chip wood, gutter & fascia board	101,042.45	0.16	1	Incomplete design	Consultant
2	Close wash trough	20,700.00	0.03	1	Incomplete design	Consultant
3	Gypsum	0.0	0.00	0	Incomplete design	Consultant
4	Electrical materials-fittings, power outlets	12,477.50	0.02	1	Incomplete design	Consultant
5	Aluminium & Wooden Door	1,302,038.63	2.11	11	Incomplete design	Consultant
6	Acoustic Ceiling	4,251,688.00	6.90	35	Change of specification	Client
7	Carpentry and Joinery	1,792,367.52	2.91	15	Incomplete design	Consultant
8	Roof Water Proofing, Aluminium & Metal Work	1,356,650.40	2.20	11	Incomplete design	Consultant
	Total	8,836,964.50	14.34	74		

Project K

Table 4.20: Factors that cause issuance of variation orders and related data for Project K

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Excavation & Earth Work	414,497.63	2.24	11	Design error	Consultant
2	Truss work – lattice purlin	316,461.60	1.71	9	Design error	Consultant
3	Half concrete pipe ditch	129,835.00	0,70	4	Design error	Consultant
4	Wall Cladding work – double brick wall	273,033.00	1.48	7	Design error	Consultant
5	Super laminated	1,986,117.00	10.75	54	Design error	Consultant
6	Extra over grill	295,512.01	1.60	8	New interest	Client
7	Roofing and painting	583,645.18	3.16	16	Design error	Consultant
	Total	3,999101.42	21.64	117		

Project L

Table 4.21: Factors that cause issuance of variation orders and related data for Project L

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Open Channel Type – III(400X850mm) & Type IV(400X160mm), Open Channel & Box Culvert in the compound	100,749,014.72	41.16	135	Flood Protection – Consultant's lack of data	Client
	Total	100, 749, 014.72	41.16	117		

Project M

Table 4.22: Factors that cause issuance of variation orders and related data for Project M

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Omission of excavation & earth work wall & floor finishing works, painting, sanitary pipes, septic tank of main building and Generator & Transformer house related works	-7,660,294.37	-0.49	0	Connection with adjacent building	Client
2	Excess quantities of reinforcement bars	168,496,803.51	10.70	77	Poor BOQ estimation	Consultant
3	Generator and Transformer house	71,012.50	0,005	0	Urgency of boundary works to the nearby construction work	Client
	Total	160,907,521.66	10.21	77		

Project N

Table 4.23: Factors that cause issuance of variation orders and related data for Project N

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Diameter 30mm reinforcement bar	18,880,132.59	9.32	50	Missed on the BOQ	Consultant
2	Water proofing work	3,179,307.62	1.57	9	Design omission	Consultant
3	Pump house and ground water reservoir works	-500,043.02	-0.25	0	Design error	Consultant
4	PVC ceiling,	579,653.13	0.29	2	Conflict of	Consultant

	aluminium window and aluminium partition wall				documents (BOQ & drawing are different)	
5	Aluminium work	-7,025,141.28	-3.47		Conflict of documents (BOQ & drawing are different)	Consultant
6	Floor and wall finishing	1,422,488.19	0.70	5	Missed item	Consultant
7	Floor and wall finishing	440,306.25	0.22	2	Missed item	Consultant
8	Steel structure for roof	711,862.84	0.35	2	Design omission	Consultant
9	Tempered spider glass -5134X625 cm for aluminium frames	3,982,474.01	1.97	11	Change of specification	Client
10	Mosaic tile wall finish	11,872,304.42	5.86	32	Change of specification	Client
11	Granite paint	3,536,173.74	1.75	10	New Interest	Client
12	Wooden doors	1,678,871.49	0.83	5	Conflict of documents (BOQ & drawing are different)	Consultant
13	Aluminum hand baluster and aluminium panel wall cladding	397,634.05	0.20	2	Design change	Consultant
14	Granite wall cladding (in the form of supplementary agreement	44,019,858.34	21.74	118	Change of specification	Client
15	Cafeteria building	30,189,427.36	14.91	81	New interest	client
	Total	113,365,309.73	55.99	329		

Project O

Table 4.24: Factors that cause issuance of variation orders and related data for Project O

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Shoring pile to protect the basement	8,588,110.55	6.38	47	Design omission	Consultant
2	Watch tower	1,654,917.96	1.22	9	design modification	Client
3	Electric board	735,628.55	0.54	4	Missed in BOQ	Consultant
4	Supplementary agreement, variation	1,557,429.59	1.16	20	New interest	Client
5	Material change- Tempered glass, Rough textured ceramic, SPC flooring and contextra paint	25,677,417.01	19.06	139	New interest	Client
6	Block 3 omission due to heritage case.	-46,135,527.85	-34.25		Lack of knowledge from client	Client
7	Material change- Granite tread and riser	3,177,358.23	2.36	17	Specification change	Client
8	Storm water Pipe and manhole b/se the basement bring water.	263,052.73	0.20	1	Unexpected substructure work	Consultant
9	Dismantle ceiling frame and mechanical pipe lines due to the client not need AC and extend the room height.	-4,524,505.38	-3.36	-	Scope change	Client
10	External toilet demolishing work for aesthetical value.	104,427.26	0.08	-	Scope change	Client
11	Due to omission of block 3 the block 2 basement become open and to close with a shear wall	947,427.50	0.70	1	New Interest	Client
12	Submersible pump	1,895,054.10	1.41	10	Unexpected	Consultant

	because the basement bring water.				substructure work	
13	Data active device.	10,975,168.75	8.15	34	Missed in the BOQ	Consultant
14	Toilet suspended aluminium ceiling	2,055,336.33	1.53	11	Missed in the BOQ	Consultant
15	Curtain wall	627,760.75	0.47	3	Design modification.	Client
16	Angle iron corner protection with aluminium L profile.	149,184.61	0.11	1	Missed in the BOQ	Consultant
17	Various work items as a Supplementary agreement	11,848,831.96	8.79	140	New interest	Client
	Total	19,597,072.65	14.55	437		

Project P

Table 4.25: Factors that cause issuance of variation orders and related data for Project P

Variation No.	Description of Variation Works	Amount (in Birr)	Percent of the variation (in %)	Time given (in cal. days)	Reason for the variation	Initiator of the variation
1	Water proof work	1,284,262.50	1.09	7	Design omission	Consultant
2	C-25 concrete for super structure, masonry retaining wall, aluminium window & door, plastering, granite tread and riser, plastic emulsion paint	474,851.10	0.4	3	Missed in BOQ	Consultant
3	Corrugated steel sheet & Accessories	130,886.24	0.11	1	Additional work	Client
4	Excavation, concrete work, cementitious water proofing work, ridge cover, aluminium window & doors, flor & wall finishing, quartz & plastic paint, sanitary fixtures & waste water drainage	19,905,519.60	16.96	102	Conflict of documents (BOQ & drawing are different)	Consultant

	system, UPS & distribution board					
5	Apply cementitious damp proofing material	514,556.00	0.44	3	Additional work	Client
6	Demolishing existing HCB wall, aluminium door & windows, plastering, porcelain floor tile, aluminium curtain wall	918,261.16	0.78	5	New interest	Client
7	Quartz paint to external plastered vertical surface	307,013.43	0.26	2	Specification change	Client
8	Water proofing for wet area	69,124.55	0.06	1	Missed in BOQ	Consultant
9	Demolishing existing concrete slab structure, of debris, RHS truss	58,898.76	0.05	1	New interest	Client
10	Light weight concrete, demolishing, fill, disposal, stone wall, plastering, pointing, plastic painting	1,610,524.77	1.37	8	Conflict of documents (BOQ & drawing are different)	Client
11	Bulk excavation, C-25 concrete for sub structure, pre painted ribbed steel sheet & accessories, RHS truss, metal fuel tank, down pipe, Main distribution board	1,967,962.73	1.68	10	New Interest	Client
12	RHS truss	276,067.40	0.24	2	Inadequate detail	Consultant
13	Aluminium window and door	162,163.37	0.14	1	Missed in the BOQ	Consultant
14	Supply & fix 750mm diameter RC Pipes & Waste water manholes	102,845.65	0.09	1	Design error	Consultant
	Total	27,782,937.26	23.67	147		

4.2.3.2 Types of causes of variation orders as per the data obtained from desk study

The result from the desk study showed twelve (12) causes of variation orders. The reasons for the causes were taken from the change order documents

Below are the twelve causes of variation orders as analyzed from the desk study data of the sixteen projects studied in descending order based on the additional cost incurred:

Table 4.26: Causes of variation orders as per the data obtained from desk study

No.	Causes of variation orders	Amount in 1,000(in Birr)	Percent from the total analyzed
1	Conflicting documents (drawing & BOQ do not read the same, missed in BOQ)	319,604	45.71%
2	Change of Plan or scope, new interest for additional works	193,441	27.67%
3	Change in specification	96,007	13.73%
4	Consultant's lack of required data	43,265	6.19%
5	Errors and omissions in design	24,641	3.52%
6	Change in design by the consultant	15,109	2.16%
7	Change in economic condition	6,062	0.87%
8	Inadequate project objectives	4,628	0.66%
9	Design discrepancies	799	0.11%
10	Lack of consultant's knowledge of available materials and equipment	756	0.11%
11	Inadequate working drawing	276	0.04%
12	Differing site condition	71	0.01%

Typical causes from the desk study – on work activity types

- **Conflicting Documents** – This generic form of variation order cause has been ranked 1st as per the data collected. Specifying some particular work activities may be necessary to provide a piece of information in this research. Accordingly, on Project M, due to poor estimation of reinforcement bar quantities in the BOQ, it was latter on required to give a variation order with ETB168, 496,803.51, which was 10.7% of the accepted contract amount price. On Project B, an amount of ETB32, 268,512.40 which was 16.09% of the accepted contract price was issued due to the Consultant's failure to make aluminium curtain wall size on the drawing and BOQ. On Project N, the Consultant failed to specify diameter 30mm reinforcement bar in the BOQ because of

which a variation order amounting ETB18,880,132.59, 9.32% of the accepted contract price was ordered.

- **Change of Plan or scope, new interest for additional works** – This cause of variation order has been ranked 2nd as per the data collected. Specifying some particular work activities may be necessary to provide a piece of information in this research. Accordingly, on Project C, due to the Client's new interest a for a fence to be provided, a variation order amounting ETB 47,021,015.31 which is 10.98% of the accepted contract price was ordered. On Project B, plan of the block was changed and one full floor was added on the existing one through a variation order amounting ETB 19,084,411.17. This was 50.34% of the accepted contract price. As per this variation order, all types of work activities that can make a floor functional were ordered.

- **Change in specification** – This variation order causing factor has been ranked 3rd as per the data collected. Specifying some particular work activities may be necessary to provide a piece of information in this research. Accordingly, on Project N, due to the Client's strong interest to have a granite external wall cladding instead of quartz paint a variation order amounting ETB 44,019,858.34 which was 21.74% of the accepted contract price was ordered. On Project H, it was required to make use of latest mechanical unit devices because of which the contracted specification was changed. This variation order cost ETB 15, 799,955.80 which was 18.28% of the accepted contract price was issued. Once again on Project N, the Client wanted also to change quartz finishing with mosaic finishing on some decorative part of external wall finishing, a variation amounting ETB 11,872,304.42 which was 5.86% of the accepted contract price was given.

The above variation orders can be analyzed from different aspects: cost aspect (direct), schedule impact (direct), productivity degradation and cost of delay.

The direct cost impact results in the form of material and labor of which the estimated costs were believed to cover. The schedule impact can be a controlling one on the completion of the project. On Project N, the procurement of granite material and accessories from abroad impacted the project completion in a way that it controlled the critical path of the project that required about four months. From the interview made, once it was known that there was a variation order to be given, the productivity of labor on those work activities related to that particular variation orders was low. This in turn

has a cost for delaying the work activities that were supposed to be executed had the variation order been not ordered.

4.3 Effects of variation order on building projects

4.3.1 Effects of variation order as per the data obtained from questionnaires

The level of impacts resulted due to variation orders were ranked using RII method by using a 5 - Point Likert Scale being rated in the form of No Impact =1, Low Impact=2, Medium Impact=3, High Impact=4 and Very High Impact=5. Below are the results of the analysis.

A. Client group

Analysis of data from questionnaires responses from Client groups on impact of variation orders as obtained were shown below:

Table: 4.27 Level of Impact of variation orders from Client Respondents

Impacts of variation orders	RII	Rank
Increase in project cost	0.93	1
Completion schedule delay	0.84	2
Additional payments for contractor	0.76	3
Logistics delays	0.73	4
Increase in overhead expenses	0.71	5
Procurement delay	0.70	6
Rework and demolition	0.67	7
Firm's reputation to be questioned	0.64	8
Delay in payment	0.63	9
Disputes among professionals	0.61	10
Productivity degradation	0.61	11
Poor professional relations	0.60	12
Additional fee for legal issues due to disputes	0.57	13
Quality degradation	0.53	14
Progress is affected but without any delay	0.47	15

As shown in **Table 4.27** above, increased in project cost, completion schedule delay, additional payment for Contractor, rework and demolition, increase in overhead expenses were the top five effects of variation orders whereas Additional fee for legal issues due to disputes, quality degradation and Progress is affected but without delay were the least three ranked impacts of variation orders.

B. Consultant group

Analysis of data from questionnaires responses from Consultant groups on impact of variation orders as obtained were shown below:

Table: 4.28 Level of Impact of variation orders from Consultant Respondents

Impacts of variation orders	RII	Rank
Increase in project cost	0.90	1
Completion schedule delay	0.84	2
Increase in overhead expenses	0.80	3
Additional payments for contractor	0.72	4
Logistics delays	0.69	5
Rework and demolition	0.67	6
Delay in payment	0.66	7
Procurement delay	0.63	8
Disputes among professionals	0.62	9
Firm's reputation to be questioned	0.61	10
Poor professional relations	0.57	11
Progress is affected but without any delay	0.55	12
Productivity degradation	0.54	13
Quality degradation	0.54	14
Additional fee for legal issues due to disputes	0.47	15

As shown in **Table 4.28** above, increased in project cost, completion schedule delay, increase in overhead expenses, additional payment for Contractor, logistics delay were the top five effects of variation orders whereas productivity degradation, quality degradation and additional fee for legal issues due to disputes were the least three ranked impacts of variation orders.

C. Contractor group

Analysis of data from questionnaires responses from Consultant groups on impact of variation orders as obtained were shown below:

Table: 4.29 Level of Impact of variation orders from Contractor Respondents

Impacts of variation orders	RII	Rank
Increase in project cost	0.91	1
Completion schedule delay	0.84	2
Increase in overhead expenses	0.81	3
Logistics delays	0.79	4

Additional payments for contractor	0.78	5
Rework and demolition	0.76	6
Disputes among professionals	0.74	7
Procurement delay	0.73	8
Delay in payment	0.71	9
Poor professional relations	0.68	10
Additional fee for legal issues due to disputes	0.65	11
Productivity degradation	0.64	12
Firm's reputation to be questioned	0.61	13
Progress is affected but without any delay	0.60	14
Quality degradation	0.56	15

As shown in **Table 4.29** above, increased in project cost, increase in overhead expenses, completion schedule delay, logistics delay, procurement delay were the top five effects of variation orders whereas firm's reputation to be questioned, progress is affected but without delay and quality degradation were the least three ranked impacts of variation orders.

D. Correlation of Respondents – between their ranking on the Impacts of variation orders

The extent to which the rankings of the questions indicated on the questionnaires that were replied by the respondents were checked what their relationships looked like using Spearman's Coefficient. The coefficient for the given subtitle is a measure of strength and direction between two sets of ranks obtained from possible combination of respondent groups from the analysis on the impacts of variation orders.

Table: 4.30 Summary of correlation coefficient test on the ranking of impacts of variation orders.

Respondents' Group	Spearman's Correlation Coefficient	Relationship of the respondents' ranking
Client Vs Consultant	0.92	Strong
Client Vs Contractor	0.91	Strong
Consultant Vs Contractor	1.00	Strong

From the above correlation table, it can be taken that there is a very strong positive correlation between the respondents from each group in such a way that a higher variable

increase in one group tends to be similar for the other groups. That means most of the respondents have the same perception about the impacts of variation orders.

E. Results from all respondents' groups

The results obtained from each respondent group on the impact of variation order are presented in Table 4.31 for a better picture.

Table: 4.31 Results of impacts of variation orders from all groups' respondents

Impacts of variation orders	Client		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
Increase in project cost	0.93	1	0.90	1	0.90	1
Completion schedule delay	0.84	2	0.84	2	0.84	2
Increase in overhead expenses	0.71	5	0.80	3	0.81	3
Additional payments for contractor	0.76	3	0.72	4	0.78	5
Logistics delays	0.73	4	0.69	5	0.79	4
Rework and demolition	0.67	7	0.67	6	0.76	6
Procurement delay	0.70	6	0.63	8	0.73	8
Delay in payment	0.63	9	0.66	7	0.71	9
Disputes among professionals	0.61	10	0.62	9	0.74	7
Firm's reputation to be questioned	0.64	8	0.61	10	0.61	13
Poor professional relations	0.60	12	0.57	11	0.68	10
Productivity degradation	0.61	11	0.57	13	0.64	12
Quality degradation	0.53	14	0.54	14	0.56	15
Progress is affected but without any delay	0.47	15	0.55	12	0.60	14
Additional fee for legal issues due to disputes	0.53	13	0.47	15	0.65	11

The results shown above in Table 4.32 were referred in the discussion section of the study

4.3.2 Effects of variation orders as per the data obtained from interview

Semi structured interview conducted with the selected interviewees were summarized in a way that can easily be categorized in line with the research objectives, in this case impacts of variation order are shown below.

Table 4.32: Results of interview on impacts of variation orders

Questions	Interviewee A	Interviewee B	Interviewee C	Interviewee D
From your experience, who is the most initiator (responsible party) for the cause of variation orders? Client? Consultant? Contractor? Other than the three?	<ul style="list-style-type: none"> ▪ Consultant 	<ul style="list-style-type: none"> ▪ Consultant 	<ul style="list-style-type: none"> ▪ Client 	<ul style="list-style-type: none"> ▪ Consultant
What are the main impacts (effects) of variation orders on building projects?	<ul style="list-style-type: none"> ▪ Increase in project cost ▪ Delay of project completion ▪ Additional payment to Contractor ▪ Increase overhead cost ▪ Delivery of resources will be affected ▪ Rework which results delay and wastage ▪ Work progress disruption 	<ul style="list-style-type: none"> ▪ Lower productivity against the planned. ▪ Increase project life time ▪ Increase project cost ▪ Impact on the quality of work ▪ Rework that leads to delay of the project and material wastage ▪ Logistic problem 	<ul style="list-style-type: none"> ▪ Delay of the project ▪ Increment of project cost ▪ Cause low productivity ▪ Quality compromise ▪ Material supply problem as planned ▪ Demolition and rework 	<ul style="list-style-type: none"> ▪ Increase in project cost ▪ Completion schedule delay ▪ Construction progress affected ▪ Rework and Demolition ▪ Increase in overhead expenses ▪ More payment to Contractor

As per **Table 4.32** shown above, impacts of variation orders from interview results, referring common answers can be taken as change of increase in project costs, delay of project completion, increase overhead expense, additional payment to Contractor, demolition & rework, resource supply problem, work progress suspension and low productivity,

The result also showed that the Consultant is the main initiator of the variation orders.

4.3.3 Effects of variation orders as per the data obtained from desk study

4.3.3.1 Effect types

From the desk study made, the impacts of variation orders were identified from three perspectives: cost, time and disputes & disagreement. The documents analyzed showed that due to variation orders issued, there was an increase in project cost for the projects by 10.21% to 63.69% of their respective original project amount. As regards to time, the completion of the projects was further extended by 11.33% to 63.89% of the projects' respective contract time. From the study, it was also identified that quite a significant number of days were elapsed from the moment on which it was agreed to give change orders to the time it was officially given to the Contractors. From the sixteen projects studied, on three of the projects, finally accepted documents showed that there was a dispute between the Contractors and the Consultant on the unit price fixed for variation works by the Consultant. Because of this valuation of prices for variation orders were revised again for the prices. This had an impact on the execution time of the variation works which in turn influenced the projects' completion time. When unit prices more than the omitted work item or unit prices for new additional works is fixed, it is automatic that variation orders bring additional payments. All the cumulative variations issued in the study bring additional payments to Contractors.

Table 4.33: Impacts of variation orders from the desk study

No.	Impacts of variation orders
1	Increase in project cost
2	Extending completion time of projects
3	Additional payment to Contractors
4	Dispute on unit price of variation works

4.3.3.2 Initiators of variation orders as per the data from desk study

One of the areas on which the desk study focused was the contracting party who initiated the change orders and how much does that specific variation order did cost. This was helpful in giving highlights on the strategies that was forwarded to minimize variation works. Below is the table showing results obtained from the desk study to identify who initiated the variation orders most.

Table 4.34: Variation work amounts & days with respect to who their initiator was - from the desk study

Project	Initiated by Client		Initiated by Consultant		Initiated by Contractor	
	Amount(birr)	Days	Amount(birr)	Days	Amount(birr)	Days
A	23,797,911.98	44	16,811,477.01	30	-860,246.00	0
B	4,032,378.09	31	31,558,986.87	34	0.00	0
C	47,021,015.31	58	7,588,421.41	35	5,857,225.41	9
D	9,129,800.21	92	7,197,587.40	197	306,475.00	3
E	620,588.75	8	4,836,690.53	60	0.00	0
F	844,698.73	70	540,383.02	45	0.00	0
G	19,084,411.17	43	0.00	0	0.00	0
H	21,619,913.51	97	15,799,955.80	71	0.00	0
I	13,982,569.28	220	46,225,115.18	164	1,064,940.25	4
J	4,251,688.00	35	4,585,276.50	40	0.00	0
K	295,512.01	16	3,703,589.41	101	0.00	0
L	100,749,014.72	135	0.00	0	0.00	0
M	-7,589,281.87	0	168,496,803.51	77	0.00	0
N	93,600,237.87	252	19,765,051.86	77	0.00	0
O	-5,064,462.97	329	24,661,535.62	107	0.00	0
P	3,897,578.32	22	23,885,358.94	125	0.00	0
Total	330,273,573.11	1,425	375,656,233.06	1,163	6,368,394.66	16

As shown above in the table, the Contractors were the least responsible in initiating variation orders whereas the Consultant and Client were the ones responsible for many of the variation orders in the order of being the first and second respectively. But the study showed that the margin between the Consultant and Client on the cost of variation based on who initiated them was minimal.

Table 4.35: Summary of variation orders amount with respect to who their initiator was - from the desk study

No.	Initiator of the variation order	Amount of variation order initiated (in Birr)	Percent from the total initiated
1	Consultant	375,656,233.06	52.74%
2	Client	330,273,573.11	46.37%
3	Contractor	6,368,394.66	0.89%

As it can be seen from the above tables, the Consultant, Client and Contractor were the initiator of the variation orders in their order of impact from top to bottom respectively.

4.4 Need for government regulatory body to bring accountability to Consulting Firms related to variation orders

In an attempt to include the very basic questions that have to be asked to the respondents in the questionnaire, one of the documents assessed was to look at some change orders issued to Contractors by the Consultant, BUDSWS on the projects selected for desk study. While doing so, it was noted that quite a significant number of variation orders were issued because of the Consultant's design errors, items missed in the BOQ, not accurately quantified estimates, incomplete designs and not entertaining the Client's requirements expected on the project. Later on, after analyzing the data from the desk study, it was proved right that the cost of variation orders given by the Consultant was more than that of the Client and Contractor. According to the study compared on the basis of the variation works cost, 52.74% of the variation orders were initiated by the Consultant whereas 46.37% & 0.89% were initiated by Clients & Contractors respectively.

The role of Consulting Firms in the construction industry is vital in producing designs that take quality requirements into consideration, giving current market price into account with the budget allocated, in contributing a lot in controlling unethical practices & corruption. When summed up, the Consultants' contribution for completion of projects in time and with budgeted cost is enormous. So, it is imperative that Consulting Firms are required to carry out their responsibilities with an expected level of professionalism diligently and with accountability.

Though variation orders are unavoidable, Consulting firms have to carry out their responsibilities in preparing designs and all other documents that later on form the contract document with the highest degree of professionalism and acceptable work ethics. The employees assigned by the firms to work on the design and contract documents of any given project have to have a very good wealth of experience and they should have the know-how on the subject matter. This would highly minimize variation orders and would help a lot in the effort to be made to complete projects within their contract time and budget. So, an emphasis was given to this key issue and respondents were asked during pilot test survey what they would propose about what government regulatory body should do in a way of directive or any other enforcement mechanism if a Consulting Firm failed to carry out its responsibilities to the extent of professionalism required. It was also noted to the respondents that because of this failure, issuing variation orders was found out to be necessary so that the project serves the purpose it is intended for and the variation order amount went beyond the acceptable limit.

To address this matter, inputs from the respondents and discussions with senior engineers on the field were used to develop questions which were distributed to respondents in the final questionnaire designed.

Findings of the questionnaires and interview on this issue were analyzed and presented below together with the questions asked. But it has to be emphasized that the practicality of the findings totally bases the interference of government regulatory body by issuing a directive or any other means that can be enforced between the contracting parties, the Client and the Consulting firm.

4.4.1 Regulatory body’s act to bring accountability as regards to variation orders as per the data obtained from questionnaires

- A. Penalizing Consultants for failing not to report and address variation issues as early as possible so that damages both in time and cost occurs

Table: 4.36 Penalty option considerations

Should the Consultant be penalized	In %
Yes	74%
No	12%
No comment	14%

- B. Type of penalty to address the damage resulted on the Client due to the Consultant's failure not to address variation issues as early as possible.

Table: 4.37 Penalty option due to not addressing variation issues as early as possible

Penalty option -for not addressing variation issues early	In %
Full reimbursement of the calculated damage cost the Client incurred	2%
10 -50% reimbursement of the calculated damage cost the Client incurred	8%
Giving a warning on the first instant and then reimbursing 10 -50% of the calculated damage cost the client incurred	70%
Ban license of the Consultant for a year	8%
Equivalent damage the Client incurred, give warning and finally disengage from the contract	12%

- C. Action(s) appropriate if the documents prepared by Consultants do not read the same (if there is a conflict) between specification and design as a result of which a change order that may have a potential to affect the project progress is resulted.

Table: 4.38 Penalty option due to conflict of documents

Penalty option -due to damage resulted because of conflict of documents	In %
Full reimbursement of the calculated damage cost the Client incurred	9%
10 -50% reimbursement of the calculated damage cost the Client incurred	15%
Giving a warning on the first instant and then reimbursing 10 -50% of the calculated damage cost the client incurred	57%
Ban license of the Consultant for a year	2%
Equivalent damage the Client incurred, give warning and finally disengage from the contract	17%

- D. What actions is appropriate if there is a design error because of the Consultant did not follow codes, standards and regulations and as to this effect a variation order is resulted?

Table: 4.39 Penalty option due to design errors

Penalty option -due to design errors	In %
10 -50% penalty of the design fee	16%
Giving a warning on the first instant and then penalize 10 -50% of the design fee	50%
Ban license of the Consultant for a year	24%
Giving warning repeatedly and then disengage	10%

- E. Action(s) appropriate if there is a design omission because of the Consultant's inexperience, negligence, etc and as to this effect a variation order is resulted.

Table: 4.40 Penalty option due to design omissions from contracted documents

Penalty option -due to design omissions from contracted documents	In %
10 -50% penalty of the design fee	31%
Giving a warning on the first instant and then penalize 10 -50% of the design fee	56%
Ban license of the Consultant for a year	9%
Giving warning repeatedly and then disengage	13%

4.4.2 Regulatory body's act to bring accountability as regards to variation orders as per the data obtained from interview

Semi structured interview conducted with the selected interviewees were summarized in a way that can easily be categorized in line with the research objectives, in this case as government body's responsibility as part strategic tools to minimize variation order for project from inception to closeout, are shown below.

Table 4.41: Results of bringing accountability for occurrence of variation order as per the data from interview

Questions	Interviewee A	Interviewee B	Interviewee C	Interviewee D
What directives should be set by government regulatory body on professional firms (Consultants) who are the source of variation orders due to their incompetence, negligence, etc.?	<ul style="list-style-type: none"> ▪ The government regulatory body should take the ever-increasing money spent for variation works seriously and shall make contracting stakeholders accountable 	<ul style="list-style-type: none"> ▪ The regulator body did not set rules based on this issue but it's very essential to control excess variation 	<ul style="list-style-type: none"> ▪ A directive set by the government to be a source of variation didn't for all stakeholders if they are involved 	<ul style="list-style-type: none"> ▪ A directive on Fraud, Corruption and Complaints Provisions related to variation order ▪ A directive to make all stakeholders responsible for excess variation orders
Do you believe that issuing variation orders could be a source of corruption? If so, what measures do you suggest to eradicate or minimize it?	<ul style="list-style-type: none"> ▪ Yes ▪ To have a preliminary study that can clearly define what the scope of the work is and stick to it ▪ Consulting firms shall do with the utmost degree of professionalism, if failed must be penalized ▪ To give training on corruption and ethics ▪ To take serious measures who are involved in corruption 	<ul style="list-style-type: none"> ▪ Yes ▪ To minimize this problem there should be detail check-up drawings before the agreement made b/n the contractor and the client. ▪ On preparation of BOQ it needs special attention to minimize variation. ▪ There should be close follow up of the project starting from preliminary design by the client and his representative. 	<ul style="list-style-type: none"> ▪ Yes ▪ An awareness should be created among to the professionals it has a great impact on the project as a result it will be a major cause for variations. 	<ul style="list-style-type: none"> ▪ Yes ▪ Expose corrupt activities and risks ▪ All stakeholders must be honest, transparent and accountable ▪ Penalize dishonest practices Ensure public interest

As per **Table 4.41** shown above, all the interviewees agreed that the regulatory body has to do something to minimize variation orders by making the responsible stakeholders accountable.

As regards to ethics in relation to issuing variation orders, all interviewees agreed that variation orders could be issued because of corruption. As regards to minimizing or eradicating it penalizing, awareness, training, well defined scope preparation, the highest form of professionalism while doing design & prepare BOQ, transparency, honesty, exposing corrupt practices can be considered.

4.5 Strategic tools to minimize variation orders on building projects

The strategic tools developed to minimize variation orders in building projects and reduce their adverse effects when they occur were made focusing on two ways:

- 1) Strategic tools for a proactive approach that is needed to be considered from initiation of a project up to contract negotiation
- 2) Strategic tools for projects that are already on construction stage.

The findings of the research for the other specific objectives were the basis of this development.

Accordingly, the strategies are summarized and shown in Table 4.42

Table 4.42: Strategic tools that can be taken to minimize variation orders

Construction Stage	Adverse effects of variation orders	Activities	Strategic Tools	Remarks
Pre – Construction Stage	<ul style="list-style-type: none"> ▪ Cost overruns ▪ Time overruns ▪ Health and safety ▪ Professional relations and, ▪ Others 	<p>Clients shall have to prepare a well detailed project brief in which the following activities are clearly specified:</p> <ul style="list-style-type: none"> ▪ Defining scope, objectives, timelines, deliverables ▪ Selection of suitable site ▪ Assigning roles and responsibilities to stakeholders ▪ Allocating budget after tentative cost estimate 	Having a Project Brief	If the Client does not have a team to carry the mentioned activities, it is advised to hire one.
		<p>To decide time for design involving the Consultant</p> <ul style="list-style-type: none"> ▪ Review and analyze Client’s requirements ▪ Complexity of the building ▪ Plan information – Plot Area ▪ Title deeds(cartá) ▪ Programs ▪ Terms of reference 	Design Period(time for design by Consultant)	Client’s project brief is also helpful in this regard.
		<p>Carrying out geotechnical soil investigation</p> <ul style="list-style-type: none"> ▪ Deciding types and number of tests ▪ Allocating the necessary resources (equipment, skill & unskilled labor) ▪ Deciding methods of soil exploration ▪ Conducting the test 	Report on geotechnical soil investigation	Test reports need to be included in the tender document so that they can be considered in pricing,

Construction Stage	Adverse effects of variation orders	Activities	Strategic Tools	Remarks
Pre – Construction Stage	<ul style="list-style-type: none"> ▪ Cost overruns ▪ Time overruns ▪ Health and safety ▪ Professional relations and, ▪ Others 	<p>Designing the project</p> <ul style="list-style-type: none"> ▪ Assigning experienced designers, quantity surveyors, contract engineers ▪ Topographic surveying, data analysis, contour drawing ▪ Using soil strata test reports ▪ Designing with professionalism ▪ Integration of design drawings ▪ Bid document preparation addressing all terms ▪ Checking drawings, specifications and quantity estimates whether they read with each other or not <p>Errors and omissions in design</p> <ul style="list-style-type: none"> ▪ Check the designed work against Client program on what is required ▪ Follow design codes, regulations, rules ▪ Careful reference of topographic survey data and geotechnical test results 	BIM(Building Information Technology)	<p>Having a complete design, close to error free contract documents</p> <p>Close follow up of by responsible body both from Client and Consultant</p>
		<p>Client’s involvement in the design stage</p> <ul style="list-style-type: none"> ▪ Scheduled meeting arrangement ▪ Evaluate design progress ▪ Ensure all Client requirements are included <p>Final design is presented to expertise, including to those outside Client’s group. preparation of the design in 3D, appreciated</p>	Communication mechanism/Electronic communication- paperless communication/	

Construction Stage	Adverse effects of variation orders	Activities	Strategic Tools	Remarks
Pre – Construction Stage	<ul style="list-style-type: none"> ▪ Cost overruns ▪ Time overruns ▪ Health and safety ▪ Professional relations and, ▪ Others 	<p>Professionals participating in the design & contract document preparation</p> <ul style="list-style-type: none"> ▪ Evaluating CV’s and experiences of the professions specific to the project at hand ▪ Assigning Designers, Quantity Surveyors, Contract Engineers and Cost Experts 	Team Set Up	
		<p>Compliance of contract documents with each other, budget, contract terms</p> <ul style="list-style-type: none"> ▪ Making sure the design prepared, bill of quantities and specification read each other ▪ Ensure the designed work, estimated quantities of the work, specification chosen fall within the budget allocated ▪ Care has to be taken to avoid contract terms and conditions that are unambiguous, that could lead to different interpretations. 	Set procedures to follow	Checklists for design, quantities, cost and budget confirmation helps a lot.
		<p>Checking the market availability that need to be considered during design</p> <ul style="list-style-type: none"> ▪ Materials ▪ Equipment, Plants ▪ Skilled labor 	Organized, evaluated list of materials, equipment and labor. Established cost data base	Include locally available items if it is in line with Client’s quality on the end products

Construction Stage	Adverse effects of variation orders	Activities	Strategic Tools	Remarks
Construction Stage	<ul style="list-style-type: none"> ▪ Cost overruns ▪ Time overruns ▪ Health and safety ▪ Professional relations and, ▪ Others 	Assigning supervision and contract administration team (Consultant) <ul style="list-style-type: none"> ▪ Experience and knowledgeable team ▪ Commitment and dedication 	Team Set Up & procedures to follow	
		Early notification of possible variation orders <ul style="list-style-type: none"> ▪ A comprehensive review of the contract documents at early stage ▪ Understand the contract terms and conditions ▪ Clear unambiguous contract terms and conditions early, if there are and make amendment if necessary ▪ Identify possible variations as early as possible ▪ Make sure the identified variation works scope are within the project objectives ▪ Discuss the identified possible variation orders with the respective stakeholders ▪ Quick decision making ▪ Issue the orders and integrate within the schedule of works, control development ▪ Maintain record of the variation order 		

		<p>Contractor's project team – Project Manager</p> <ul style="list-style-type: none"> ▪ Experienced, knowledgeable ▪ Include about their experience and capacity as a requirement in the contract condition ▪ Identify & communicate possible variations, unambiguous terms and conditions as early as possible 	<p>Team Set Up</p>	
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Construction Stage	Adverse effects of variation orders	Activities	Strategic Tools	Remarks
Construction Stage	<ul style="list-style-type: none"> ▪ Cost overruns ▪ Time overruns ▪ Health and safety ▪ Professional relations and, ▪ Others 	<p>Valuation of variation orders</p> <ul style="list-style-type: none"> ▪ Update cost data base ▪ Understand scope of the work ▪ Consider all the resources ▪ Pro-forma invoices, supporting documents ▪ Avoid disagreements ▪ Check cost breakdown fairly and impartially ▪ Fix applicable prices 	Organized, evaluated list of materials, equipment and labor. Established cost data base	Cost data base availability is instrumental and a team that works on this part helps a lot.
		<p>Variation order procedures - Produce agreed procedures and make it known and implemented</p> <p>Example can be:</p> <ul style="list-style-type: none"> ▪ Initiation of change orders ▪ Examine and evaluate change request ▪ Review & approve by Consultant ▪ Submit change order request to Client for approval ▪ Client's review and approval ▪ Prepare variation order for issuance ▪ Distribute and document variation order ▪ Prepare revised work schedule and budget ▪ Execution of works/Optional as execution can be before budget approval/ 	Clear variation order flow chart	

		<p>Corruption control</p> <ul style="list-style-type: none">▪ Prepare draft variation document with justification▪ Review draft document▪ Communicate reviewed document to all	<p>Approved document by all</p>	
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4.6 Discussion on the results of the study

Discussion on the findings of the study from the results obtained from the questionnaires, interviews and desk study are presented in this section. The discussion was made with respect to the specific objectives of the research which were causes of variation orders, assessing effects of variation orders, government regulatory body's act to bring accountability and strategic tools that can be used to minimize variation orders. The discussion for the first two specific objectives was made mainly on focusing on the top five rankings of the findings from both the questionnaire and desk study. That of interview data was difficult to rank rather it was made by taking common denominators. The government regulatory body's responsibilities in addressing accountability to issuance of variation orders with respect to Consulting firms' responsibilities was also discussed in bird's eye view to encourage further detailed studies from questionnaires and interviews.

4.6.1(a) Causes of variation orders on building projects

Results obtained from the questionnaire data on causes of variation orders for all respondents group is shown in **Table: 4.7**. The following discussion is based on this table. Results obtained from interviewee & desk study were also noted where necessary.

The first major cause of variation order from the questionnaire, change of plan or scope was ranked 1st by both Consultant and Contractor. This causing factor was most of the time resulted due to the problem of the Clients' lack of proper planning during early days of the project cycle. It may be due to this reason that the Client ranked this factor as 2nd major cause of variation order, to excuse itself. The Clients' limited or no involvement during design phase, as mentioned by site supervisors could also be another factor. The Clients' request for additional works and new interests also contributed a lot for this cause of variation order factor to be on the first list. Out of the four interviewees, three of them also mentioned scope or plan change as one of the variation order causing factors. This first major cause of variation order was also supported by the result obtained from the desk study which ranked variation orders due to plan or scope change second as shown in **Table: 4.26**. This finding is also in agreement with Arain and Pheng (2005) who identified change of plan or scope as one of the main causes of variation orders.

Change in specifications was unanimously ranked 3rd by all respondent groups. Most of the time, inadequate project objectives and the need to have latest technology & materials were the reasons for this factor as discussed on the projects on which the study was made. Out of the four interviewees, half of them also mentioned change in specification as one of the variation order causing factors. The result obtained from desk study also supported this result by stressing that the cost of variation works due to change of specification was the 3rd highest from the twelve assessed as shown in **Table: 4.26**. As per the study made by Arain & Pheng (2006) on building projects, change of specification was considered as one of the most significant causes of variation orders. According to O'Brien (1998), it was stated that variation changes because of change in specifications is a frequent occurrence in construction projects.

The third major contributing factor for the cause of variation orders was the errors and omissions in design. This factor was ranked 1st by Client whereas it was ranked 5th by both the Consultant and Contractor. There is a disagreement between the Client on one side and the Consultant & Contractor on the other side on the ranking of this factor. These are most of the time a result of lack of experience of the design Consultant and the time allocated for design. The Consultant's respondents ranking in a less position than the Client was not unexpected as the Consultants are accused for the errors and omissions in design, if they occur during construction phase. But it was noted that all the respondents from Client, Consultant and Contractor agreed that this is one of the top factors that contribute to the cause of variation orders. As per the data from interview, all interviewees also noted that errors and omissions as one of the variation order causing factors. The desk study result based on the additional cost incurred by variation works as shown in **Table: 4.26** also identified errors and omission in design as one of the top five causes of variation orders. The ranking of this factor also matches with the study made by Arain & Pheng (2006) on building projects, in which it was considered as one of the most significant causes of variation orders.

Conflicts between contract documents was ranked 2nd by the Consultant respondents whereas both the Client and Contractor respondents ranked it in 4th place. This could be due to problem of making all requirements of the projects as part of the contract document in a

way they do not read the same. Clear and sufficient details help to avoid this problem. There is a disagreement of the respondents on rating this variation order causing factor. The Consultant who most of the time is responsible for this cause, honestly ranked it taking the level of its contribution based on his daily activity. Out of the four interviewees, three of them also mentioned conflicts between contract documents as one of the variation order causing factors. As observed from the desk study, most of the variation orders due to conflicts between contract documents were resulted because the work items were shown in drawings and missed in the BOQ or due to problems resulted because of lack of drawing integration from each design disciplines. As per the desk study result, the result obtained based on the additional cost incurred by variation works as shown in **Table: 4.26** identified conflicts between contract documents as the 1st cause of variation orders. The Construction Industry Institute in its review, (CII, 1986a) mentioned that conflict between contract documents can be a cause of variation order due to misinterpretation of what a project actually requires.

Change in economic condition was rated as one of the main contributors of variation orders. The Contractor group respondents ranked this variation causing factor in 2nd place, the Consultant group respondents ranked it in 4th place and the Client group respondents ranked it in 7th place. All the respondent groups disagree on the ranking of this variation order causing factor. The Contractor group were the ones mostly affected with an immediate effect by change in economic conditions than the other two and it could probably be the reason why they rated it in a higher rank. This variation causing factor is an external factor related to the economic situation prevailing in the country during the time frame in which construction projects are underway. Variation orders occurring in a time where the influence of the economic condition on the construction industry is high or variations resulted due to change in economic conditions may affect projects negatively. Only one interviewee mentioned economic condition in the form of material price rise as a cause of variation orders. The desk study as shown in **Table: 4.26** also identified change in economic condition as the most important factor and placed it in 7th position. Identifying change in economic condition as one of the most contributing variation order causing factor is also supported by Fisk (1997), in which it is stated as one of the most important factors that influence construction projects.

Results of interview on factors that cause variation orders were: change of scope and plan including additional works, conflict of contract documents, design omission and error, design change, change in specification, material unavailability, material replacement and relocation of the site.

Results obtained from desk study based on the additional cost incurred on issued variation orders of the top five causes of variation orders in descending order were: conflict between contract documents, change in plan or scope, change in specification, consultant's lack of required data and errors and omissions.

4.6.1(b) Effects of variation orders in building projects

As per the results obtained from the desk study, increase in project cost and delay in project completion were the most common impacts of variation orders. Though the study was made on ongoing projects because of which a conclusive final statement could not be made, it was noted that project costs were increased by 10.21% to 63.69% of the projects' original contract amount for projects with a financial work progress at the time of the study being 55.18% & 67.47% respectively. As regards to time, there was an extended contract time by 11.33% to 63.89% of the projects original contract time with an execution of 90.31% & 67.47% respectively at the time of the study. The trend on issuance of variation orders is that the percentage increases significantly at early stages of the construction phase but can never be ruled out even at the final stages. As shown above on the impact of time, variation orders effects were project specific and were not uniform in the study. A project near completion may have less impact due to variation order than another one with a lower project status. Increased payments were also another impact of variation orders which was by default an automatic result for most of variation orders. From discussions made on the projects where the study was made with the Consultant and Contractor representatives, it was mentioned that claim and counter claim issues were there mainly between the Consultant and Contractor on disagreement on fixing of prices for variation works of which some were disputed. This affected the project in a form of lowering productivity & delaying procurement.

From the result obtained from questionnaire as indicated in **Table: 4.31**, increased in project cost, delay in completion schedule, increased in overhead expenses, additional payment for Contractors and logistic delays were the top five major impacts of variation orders from a total of fifteen (15) impacts requested for rating by respondents.

The first major impact of variation orders which was increased in project cost is the most common effect of variation orders. All the Client, Consultant and Contractor group respondents agreed on this impact and ranked it as the 1st major impact of variation orders. This result is in agreement with Alaryan et al.,(2014) study in which they came up with an outcome which confirmed that increase the cost of projects is one of the major effects of variation works in construction projects. According to Arain and Pheng(2005a), increase in project cost is a result of frequent variation order issuance. Variation orders in the form of additions or substitutions be it on the scope or design may ultimately increase in project cost. As per the results of interview, all the interviewees mentioned increase in project cost as one of the impacts of variation orders. The result from the questionnaire respondents was also in agreement with the desk study result as shown above in the discussion part of the desk study.

Delay in project completion schedule was ranked as the second major impact of variation orders by the Client, Consultant and Contractor respondent groups. According to Ibbs(1997), variation works affect project progress and lead to delay in achieving what has been planned for execution. Results from interview also showed that all the interviewees mentioned delay in project completion as one of the impacts of variation orders. The desk study result also showed a significant extension of project completion due to a time granted for variation works.

Increase in overhead expenses was another major impact of variation order. It was ranked 3rd by both Consultant and Contractor respondent groups whereas the Client respondents ranked it in 5th place. The Client respondents may not have the chance to see the effect as closely as the Consultant and Contractor respondent groups. Whenever a variation order is issued, it may require new professionals that can carry the work. Variation works that can even be executed by the available resources increase the overhead expenses for all that take part. The more variation orders are issued, the more the overhead expenses increment would be. Two

of the interviewees also mentioned increased overhead expense as one of the effects of variation orders.

The fourth significant impact of variation orders ranked in 3rd, 4th and 5th places by Client, Consultant and Contractor respondents respectively was the additional payment required for Contractors. Out of the four interviewees half of them also noted this impact. The results obtained from the desk study also supported this result as a significant amount of money was paid to the Contractors for the works executed as variation. According to the study made by O'Brian (1998), variation works are considered as a source of additional works for Contractors who in return get additional payment from the one agreed originally.

Logistic delays were ranked in 4th place by both the Client and Contractor group respondents whereas the Consultant respondents ranked it in 5th place. There is a small disagreement on the ranking between Client and Contractor respondents on one side and Consultant respondent on the other side. Variation works, if new when compared with work items specified in the contract, need additional and probably new resources that have to be procured and supplied. This could result in logistic delays. According to Hester et al., (1997), logistic delays are identified as one of the significant impacts of variation orders in construction projects. Three of the four interviewees also stated that logistic delay was one of the impacts of variation order.

Results of interview showed that increase in project costs, delay of project completion, increase overhead expense, additional payment to Contractor, demolition & rework, resource supply problem, work progress suspension and low productivity were the main impacts of variation orders.

The interview results also showed that the Consultant was the main initiator of the variation orders.

4.6.2 What government regulatory body needs to do to bring accountability as regards to variation works

As mentioned earlier in this paper, the reason for some kind of action from the respective government regulatory body that is involved in the construction industry was made part of

the study because during desk study, it was noted that it was the Consultant who initiated most of the variation orders. Surprisingly, most of the variations were either due to incomplete design, design errors, missed items from BOQ, inexperienced professionals design outputs, etc. As mentioned above on the discussion of impacts from desk study, there were variation orders as high as 63.69% of the respective project's contract amount. Representatives of the projects selected for the study were asked if there was any action taken from anyone of the stakeholders or any government body for such an excess variation order beyond what was stipulated in the contract agreement, 10%. The answer was none. As to this effect, the study was made to look what government bodies can do and have to do to bring accountability to Designers/Consultants so that this part would play its own role in minimizing variation orders.

Respondents were communicated with questions that would lead to further detailed research studies in the future. But for this study, the respondents' replies obtained are shown in **Tables: 4.36, 4.37, 4.38, 4.39, 4.40 and 4.41.**

Categorical, the discussions on this part were that majority of the respondents (74%) believe that there must be a penalty on the designer/Consultant for issuing variation orders resulted due to their negligence, error or inappropriate actions during pre-tender stage. Majority of the respondents (70%) also responded for the Consultant's failure not to entertain variation orders as early as possible so that the project progress would not be affected was to penalize the Consultant with 10 – 50 % of the calculated damage cost the Client incurred.

The respondents were also asked what penalty to be taken if there is a conflict between contract documents because of which variation orders were resulted. Majority of them (57%) responded that a warning shall be given on the first instant, and if it happens again, to reimburse 10 – 50% of the calculated damage cost the Client incurred. As regards to design errors because of which variation orders were resulted, majority of the respondents (50%) replied that a warning shall be given in the first instant and then penalize 10 – 50% of the design fee. A similar question was also asked, in this case if a design omission was encountered because of which variation orders were issued. Majority of the respondents (56%) responded similar to the penalty for design error.

4.6.3 Strategic tools to minimize variation orders in building projects

The strategic tools developed for the study as shown in **Table 4.42** were mainly based on the causes and effects of variation order results obtained from the study and it was strengthened further in discussion with professionals who have an in-depth knowledge on the subject matter. The way the developed strategies are presented is by mentioning widely known problems that may result due to issuance of variation orders which are generally labeled as “effects” and the respective activities that can be also termed as processes are described before indicating the output.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Desk study, Interview and questionnaire data collection methods which addressed the objectives of the research were used and results obtained were thoroughly discussed in the previous section. In this chapter the major findings of the study are summarized and conclusions are drawn in accordance with the objectives set.

5.1.1(a) Causes of variation orders on building projects in Addis Ababa

According to the results obtained from the desk study made on 16 projects, 12 causes of variation orders were identified of which conflicting documents (drawing & BOQ do not read the same, items shown on drawings but missed in BOQ), change of plan or scope including new interest for additional works, change in specification, consultant's lack of required data and errors and omissions in design were the top five causes of variation orders based on the sum of money the variation works cost. It was also noted that the Consultant was the main initiator of the variation orders with 52.74% from the total whereas the portion of the variation orders initiated by Client & Contractor were 46.37% & 0.89% respectively.

For the same objective, 32 causes of variation orders were listed in the questionnaire after conducting pilot test survey together with some open-ended questions to strengthen the outputs of the questionnaire. According to the results obtained from the questionnaire, change of plans or scope (new additional works interest also included), change in specifications, errors and omissions in design, conflicts between contract documents and change in economic conditions were the causes of variation orders based on their level of importance.

Interviews were also made with semi structured questions to know the views of carefully selected interviewees. Accordingly, change of scope and plan including additional works, conflict of contract documents, design omission and error, design change, change in specification, material unavailability, material replacement and relocation of the site were the commonly selected causes.

Results obtained from the desk study, interview and questionnaire were triangulated and a conclusion was drawn that **change of plans or scope, change in specifications, errors and omissions in design and conflicts between contract documents were the major findings** on causes of variation orders and the Consultant was the main initiator of the variation works.

5.1.1(b) Effects of variation orders in building projects in Addis Ababa

To answer what the impacts of variation orders were on the projects on which the study was made, 15 effects of variation orders were listed in the questionnaire after conducting pilot test survey together with some open-ended questions. According to the results from the questionnaire, increase in project cost, project completion delay, increase in overhead expenses, additional payments for contractor and logistics delays were the impacts of variation orders based on their level of importance.

On the same objective, the interview results were change of increase in project costs, delay of project completion, increase overhead expense, additional payment to Contractor, demolition & rework, resource supply problem, work progress suspension and low productivity were the commonly selected impacts.

Impacts of variation orders as per the results of the desk study showed that there was an increase in project cost by 10.21% to 63.69% of the respective project amount. The time given for the variation orders also ranges from 11.33% to 63.89% of the respective projects original contract time. That was to say the completion of the respective project was extended by the figure shown here. It was also noted that the above figures may increase as the projects were ongoing by the time the data were collected. All of the above variation orders issued required additional payment to Contractors. It was also stressed that during valuation of price fixing for variation work items, it was common to observe disputes and disagreements between Consultant and Contractors which sometimes affected the work progress of the project in general and that of the variation works in particular.

In consideration of the results obtained from the questionnaire, interview and desk study, a conclusion was drawn that **increase in project cost, project completion delay, increase in**

overhead expenses, additional payment for Contractor and effect on work progress were the major findings on effects of variation orders.

5.1.2 Regulatory body's act to bring accountability as regards to variation orders

As an enforceable tool in minimizing variation orders, respondents were also asked what government regulatory body needs to do to bring accountability on Consulting Firms. This was made so because, as shown in the desk study analysis, the Consultant was the main initiator of variation orders and most of the variation orders were resulted either due to design error, design omissions, inexperienced professionals or sometimes due to negligence. Bringing accountability to the designer/Consultant for failing to carry out his professional duty as required and because of which variations are resulted would help in minimizing variation orders. Though this part of the research is needed to be made in detail for future studies, the following conclusions were drawn from the study:

- There must be a penalty on the designer/Consultant for issuing variation orders resulted due to his negligence, error or inappropriate actions during pre-tender stage.
- To penalize the Consultant with 10 – 50 % of the calculated damage cost the Client incurred for the Consultant's failure not to entertain variation orders as early as possible.
- A warning shall be given on the first instant of variation order issuance due to conflict between contract documents, and if it happens again, to reimburse 10 – 50% of the calculated damage cost the Client incurred
- A warning shall be given in the first instant of variation order issuance due to design errors and then penalize 10 – 50% of the design fee.
- A warning shall be given in the first instant of variation order issuance due to design omission and then penalize 10 – 50% of the design fee

5.2 Recommendations

Based on the findings of the study, the following recommendations are suggested:

- Clients need to have an experienced team that shall do a comprehensive feasibility study and come up with a clear project brief in which the scope of the project, plans, objectives, budget, milestones and deliverables are clearly defined. This document represents the Clients' requirements and has to be communicated to the designer/Consultant.
- Geotechnical soil investigation has to be carried out as per the standard set depending on the type of building to be constructed. A well-prepared report of the test results has to be officially made available and important findings that may influence pricing during bidding have to be incorporated in the bidding document. All substructure hidden conditions, physical obstructions, soil profile, etc must be clearly mentioned and make sure bidders are aware of them.
- The Designer/Consulting firm has to assign experienced designers, quantity surveyors and contract engineers who shall do the design, quantity & specifications and bid document respectively to produce a complete design and contract document within a reasonable time. Designers need to make sure all required data for design are available and standards & codes are followed. The specification prepared has to be in compliance to the design. Using Building Information Modeling (BIM) highly facilitates different design discipline integrations and avoids conflicting documents. Engage Clients throughout the design stage which enables to correct gaps, if there are which are not as per the requirement of the Client. Finally, before going to tendering, the Consultant has to present the design to the Client and other concerned bodies for final say.
- The Contractor and Consultant have to assign well experienced, knowledgeable and dedicated project management and supervision & contract administration team who can identify variation works at early stage of the project commencement so that they can be managed without affecting project execution. The team can also help in bringing ambiguous contract conditions, if there are any and enable amendments to be made as early as possible.

- Designers/Consulting Firms are expected to carry out their responsibilities with an acceptable standard of professionalism taking their customers' satisfaction into account. Variation orders are one areas of dissatisfaction by project Clients when they are the result of the designers/consultants which Clients may suffer. As to this effect, it is recommended that the respective Government Regulatory Body from the construction sector has to bring accountability to the designers/Consultants in the form of penalty that may go to the level of banning for the variation orders resulted due to their errors, negligence or inexperience which amounts more than the norm widely accepted for unexpected costs.

Recommendations for future study

During the pilot test survey of this research, one of the comments given from the respondents was that corruption was one of the reasons why variation orders were given. As to this effect this comment was included in the questionnaire but did not come up as a major cause of variation orders. However, it was sensed that the danger is there.

As mentioned in the conclusion part of this research, it was made clear that bringing accountability to Consultants as regards to variation orders was brought to discussion because it was found out that in the desk study, the Consultant was the main originator of the variation orders. As per the discussion made on project sites on which the study was made with the Consultant and Contractor representatives, no action was taken neither by the Clients nor another regulatory body for all the variation orders mentioned in the desk study which did have not only adverse effects to the projects' performance but also the cost incurred went beyond the contingency amount.

So, the researcher of this study recommends further detailed future researches to be made in light of the piece of information provided in this study on the following areas:

- Variation order issuance and corruption
- Directive on accountability of Consultants due to variation orders beyond acceptable norm

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Appendices

Appendix – 1: Questionnaire

Subject: Request to respond to a study through a questionnaire survey that will be used further for academic and related purposes

Dear Madam/Sir;

I am carrying out a study on **“Responsibilities and Strategic Tools to Minimize Variation Works on Building Projects in Addis Ababa: the case of projects supervised by Building and Urban Design & Supervision Works Sector.”**

The purpose of the study is to identify the causes of variation orders which have been proven to negatively affect performance of construction projects, assess their impacts and ultimately develop strategies how they can be minimized.

I kindly appreciate your participation in this questionnaire survey. You are kindly asked to fill the attached questionnaire completely and responsibly. The responses provided will be confidential and will only be used for research purpose.

With all due respect, I will be grateful if you return the questionnaire within one week time as such type of research works do need care, scheduled time to analyze the responses and finally prepare the right up.

Thank you for your time and effort!

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SECTION B: CAUSES OF VARIATION ORDERS

Please indicate the level of contribution of the factors that lead to the causes of variation orders with the following questions on a scale 1 to 5.

Least Contributing Very High Contribution

1 2 3 4 5

Indicator: 1 = Least Contributing (LeC) 2 = Low Contributing (LoC)
 3 = Medium Contributing (MC) 4= High Contributing (HC)
 5 = Very High Contributing (VHC)

7. The following are causes of variation orders collected from literatures and experience. Based on your experience, indicate the extent of contribution each of the causes do have in leading to the issuance of variation orders on building projects in Addis Ababa. Please **click once** under the space of the indicator of your choice.

1 Least Contributing; 5 Very High Contributing

Causes of variation orders	1 LeC	2 LoW	3 MC	4 HC	5 VHC
1. Change of plans or scope(that also includes unlimited client interest for more work types execution)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Change of schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Client's financial problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Inadequate project objectives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Replacement of materials or procedures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Impediment in prompt(quick) decision making process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Change in specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Change in design by the consultant	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Errors and omissions in design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Conflicts between contract documents	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. Inadequate scope of work for contractor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Technology change	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Lack of coordination	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Inadequate working drawing details Project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Consultant's lack of judgment and experience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Lack of consultant's knowledge of available materials and equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Honest wrong beliefs of consultant (lack of first-hand knowledge)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Consultant's lack of required data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Design discrepancies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Non-compliant design with government regulations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Non-compliant design with owner's requirement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. Unavailability of equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Contractor's desired profitability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Contractor's financial difficulties	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Contractor's desire to replace his low-priced item with a new price	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Client's unethical desire to replace low priced item of work with a new price	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. Differing site conditions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. Poor procurement process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Long lead procurement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Change in economic conditions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. Unforeseen problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32. Personal or group interests reflected through corruption for issuing variation orders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- a) If you there are other causes of variation orders not mentioned above, please do specify and forward the degree to which these factors are contributing to cause of variation orders.

15. Additional fee for legal issues due to disputes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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- b) If there are other effects of variation orders not mentioned above, please do specify and forward the degree to which how these impacts affect projects during implementation.

SECTION D: GOVERNMENT REGULATORY BODY DIRECTIVE TO BRING ACCOUNTABILITY TO CONSULTANTS RELATED TO VARIATION ORDERS

1. The roles and responsibilities of direct contracting stakeholders in delivering constructions both in time and according to budget is crucial. Variation orders are one of the factors that influence these stakeholders not to do so. The factors could be related to one of them or compulsory due to reasons not attributed to them.

One area of controlling variation orders is to set directives by the respective government body so that each of them shall have to follow and be accountable when they failed to do so.

Based on your experience, please respond to the following questions in relation to **Consultants** and **click once** under the space of the indicator of your choice and **write** your opinion or view whenever necessary.

1. Do you agree on penalizing a Consultant for its failure to inform the client about a change order as early as possible before damages happen to the project in any form

Yes No No comment

1. If your answer to question No. 1 is “Yes”, what type of penalty should it be?

a) Full reimbursement of the additional cost the client incurred

b) 10 -50% reimbursement of the additional cost the client incurred

c) Giving a warning on the first instant and then reimbursing 10 -50% of the addition cost the client incurred

d) Ban license of the Consultant for a specified year

e) you have any other, specify_____

2. What actions should be taken on the Consultant if there is a conflict (not read the same) between specification and design as a result of which a change order is resulted?

a) Full reimbursement of the additional cost the client incurred

- b) 10 -50% reimbursement of the additional cost the client incurred
 - c) Giving a warning on the first instant and then reimbursing 10 -50% of the addition cost the client incurred
 - d) Ban license of the Consultant for a specified year
 - e) If you have any other, specify _____
-

3. What actions should be taken on the Consultant if there is a design error because of not following codes, standards and regulations as a result of which a change order is resulted?

- a) Deduct design fee of the Consultant by 10 -50 %
 - b) Giving a warning on the first instant and then reimbursing 10 -50% of the addition cost the client incurred
 - c) Ban license of the Consultant for a specified year
 - d) If you have any other, specify _____
-

4. What actions should be taken on the Consultant if there is an omission of design as a result of which a change order is resulted?

- a) Deduct design fee of the Consultant by 10 -50 %
 - b) Giving a warning on the first instant and then reimbursing 10 -50% of the addition cost the client incurred
 - c) Ban license of the Consultant for a specified year
 - d) If you have any other, specify _____
-

5. Any other directive you suggest that the government shall set in implicating the Consultant to minimize variation orders.

Thank You!

Appendix – 2: Interview Questions

1. What are the main causes of variation orders on building projects?
2. To what extent does the Client's well-prepared project brief which clearly express what is required from the project during design phase help in reducing variation orders?
3. From your experience, who is the most initiator (responsible party) for the cause of variation orders? Client? Consultant? Contractor? Other than the three? After naming who the most responsible party is, please mention the types of causes most frequently encountered.
4. What are the main impacts (effects) of variation orders on building projects?
5. What measures do you suggest to minimize variation orders during design stage?
6. What can be done to reduce the negative effect of variation orders on building projects once contract is signed and work started?
7. What directives should be set by government regulatory body on professional firms (Consultants) who are the source of variation orders due to their incompetence, negligence, etc?
8. Do you believe that issuing variation orders could be a source of corruption? If so, what measures do you suggest to eradicate or minimize I

Appendix – 3: List of Projects and Summary of Project Data

A. Project Name, Contracting Parties and Contract Amount

No. - Project	Project	Client	Contractor	Original Contract Amount)(in Birr)
1 - A	Geophysics Office Building B+G+6 and Site work	Addis Ababa University	FE Construction PLC	212,068,248.14
2 - B	G+6 Renovation Block C&D Office Building and Cafeteria	Ministry of Revenue	Ethiopian Construction Works Corporation	200,547,391.41
3 - C	Kality Bus Terminal Facility	Transport and Logistic Ministry	FE Construction PLC	208,325,573.38
4 - D	G+2 Specialized Laboratory Bulging	Ethiopian Water Technology Institute	Bereket Endashaw General Contractor	52,945,227.72
5 - E	Central Kitchen electromechanical work	Federal Police Commission	Kibish Construction	48,401,102.25
6 - F	Office Building Maintenance	Afric Leather & Leather P.I	SINSIF Construction	2,174,560.94
7 - G	Ministry of Transport & Logistics Head Office Renovation	F.D.R.E Ministry of Transport & Logistics	Tamirat Temesgen Construction B.C	37,909,669.73
8 - H	Addis Ababa Police Commission Head Office Building Maintenance	City Gov't of Addis Ababa Design and Construction Works Bureau	Ethiopian Construction Works Corporation	86,462,009.28
9 - I	G+3 Laboratory Complex Building @ Saris	Ethiopia Forestry Development	Mirab Construction	150,051,268.95
10- J	New Addis Ababa Prison (Administration, & Exceptional prison)	Federal Prison Commission	Ahmed Mohammed B.C	61,632,709.10
	Prisoners Family Hall & Garage	Federal Prison Commission	Amare Abayneh B.C	18,478,204.60

12 - L	New Addis Ababa (site work, information desk, watchtower, central kitchen and grain store) construction works	Federal Prison Commission	Radar Construction	244,784,468.00
13 - M	Sectoral Head Office - 3B+20G+R	Addis Ababa City Administration Mega Project Construction office	Zhongyang Construction Group Company Limited	1,575,236,702.75
14 - N	3B+G+M+8 & 9th to 13th Building of National Archives and Library Agency	National Archives and Library Agency	FE Construction PLC	202,485,293.5 & 88,662,219.21
15 - O	B+G+4 Mixed Use Building	Secretariat of the House of People's Representatives of EFDRE	Safer Construction PC.	134,688,759.97
16 - P	Property & supply, Workshop & Engineering Division	Federal Police Commission	FE Construction PLC	117,399,219.21
17	Addis Ababa Leadership Academy	Addis Ababa City Administration Mega Project Construction office	YOTEK Construction PLC	1,399,467,534.57
18	School of Journalism & Mass Communication Building	Addis Ababa University	SATCON Construction PLC	813,827,805.95
19	4B+G+M+25 ACSI Mixed use Building	Tseday Bank S/C (Former Amhara Credit and Saving Institution	China wu yi co LTd	2,097,503,533.65
20	Chain Link, Masonry, Ditch and Masonry Fence Works	Federal Prison Administration	Zelalem Ademasu BC	9,794,275.43
21	Hospital electromechanical work	Federal Prison Administration	Kibish Construction	68,582,228.00
22	Transport Management & Traffic Safety Training Institute Facility Building	Federal Transport and Logistic Minster	Beha Construction	346,551,462.16
23	Adwa Museum Zero Km	Addis Ababa City Administration Mega Project Construction office	China Jiangsu International	4,623,829,150.00
24	Electro mechanical work for 3B+G+13th Building of national archives and library agency	National Archives and Library Agency	Kibish Construction PLC	90,925,398.59

25	B+G+5 Ethiopian Forestry Development	Ethiopia Forestry Development	TNT Construction and Trading	467,034,186.40
26	Kolfe Keranyo General Hospital Building	City Government of Addis Ababa Construction Bureau	Ethiopian Construction Works Corporation	733,315,710.40
27	Design and Build of Nifas Silk Lafto General Hospital (B+G+2) Building, other Miscellaneous Building & Site Work	City Government of Addis Ababa Design and Construction Works Bureau	Ethiopian Construction Works Corporation	733,315,710.40
28	B+G+M Center of Excellency Building	Ethiopian Tourist Trading Enterprise	Cobalt Construction PLC	75,470,216.25
29	New Addis Ababa Prison Facilities (Hospital)	Federal Prison Commission	Radar Construction	228,719,293.00
30	Remaining Works for Dormitory, Concert hall, Office, Class Room and Site works of Yared music school	Addis Ababa University	LKM Construction PLC	29,011,464.00
31	Interior Works of Ministry's Office Project	Ministry of Irrigation and Lowland	Frankcon Building & Road Contractor	93,758,214.88
32	Construction Office Interior Renovation Building Works	Federal Democratic Republic of Ethiopia Policy Studies Institute	Tamirat Temesgen B.C	86,480,520.67
33	Waste Disposal (Containerized Treatment Plant)	Addis Ababa University	ELNAF Engineering & Trading PLC	33,850,000
34	Addis Ababa Small & Medium Scale Manufacturing Industry Cluster (Lot-01)	Addis Ababa City Administration Mega Project Construction office	MCG Construction (Grade 1 Contractor)	4,354,971,939.50
35	Addis Ababa Small & Medium Scale Manufacturing Industry Cluster (Lot-03)	Addis Ababa City Administration Mega Project Construction office	TNT Construction and Trading PLC(Grade 1 Contractor)	2,814,442,252.25
36	Construction work of security office and septic tank	New projects and their consultancy agreement was not signed -at the time of data collecting		
37	Guards' playing field and shade work			
38	Achieve Phase II			
39	Library Renovation			

40	Construction of Open Garbage Building	The Office Of The Prime Minister	TNT Construction and Trading PLC(Grade 1 Contractor)	2063358.38
41	Office Building Maintenance	New project and its consultancy agreement was not signed at the time of data collecting		
42	Design & Construction work of renovation of House of Federation Office Building	The House of Federation of the federal Democratic Republic of Ethiopia	Oromia Construction Corporation	420,000,000.00
43	Addis Ababa Leadership Academy Landscape Project	Addis Ababa Mega Project Construction office	Basalt Construction PLC	330,079,237.97

B. Project Name, Variation Amount, Contract Time & Time Related Data, Projects selected for desk study

No. - Project	Project	Variation Orders Issued		Contract Time				Work Progress in % as of March 2023(time of data collection)	Selection for desk study
		Variation Amount (in Birr)	% of Total Variation	Original Contract Time (in cal. days)	Time Due to Additional Works	Granted Extension of Time	% of Additional Time Due to Variation		
1 - A	Geophysics Office Building B+G+6 and Site work	39,749,144.35	18.74	365	74	849	20.27	75.34	Selected for desk study
2 - B	G+6 Renovation Block C&D Office Building and Cafeteria	35,591,364.82	17.75	300	65	170	21.67	41.00	Selected for desk study
3 - C	Kality Bus Terminal Facility	60,466,612.13	14.94	540	102	682	18.89	63.66	Selected for desk study
4 - D	G+2 Specialized Laboratory Building	16,633,862.61	31.42	686	292	890	42.57	137.29	Selected for desk study
5 - E	Central Kitchen electromechanical work	5,457,279.28	11.28	600	68	748	11.33	90.31	Selected for desk study
6 - F	Office Building Maintenance	1,385,081.75	63.69	180	115	215	63.89	67.47	Selected for desk study
7 - G	Ministry of Transport & Logistics Head Office Renovation	19,084,411.17	50.34	90	46	188	51.11	136.93	Selected for desk study
8 - H	Addis Ababa Police Commission Head Office Building Maintenance	37,419,869.31	43.28	390	168	287	43.08	67.47	Selected for desk study
9 - I	G+3 Laboratory Complex Building @ Saris	61,272,624.71	40.83	540	227	434	42.04	45.47	Selected for desk study

10- J	New Addis Ababa Prison (Administration, Admission & Exceptional prison)	8,836,964.50	14.34	500	74	2373	14.80	98.90	Selected for desk study
11 - K	Prisoners Family Hall & Garage	3,999,101.42	21.64	500	117	2350	23.40	104.90	Selected for desk study
12 - L	New Addis Ababa (site work, information desk, watchtower, central kitchen and grain store) construction works	100,749,014.72	41.16	270	117	0.00	43.33	92.31	Selected for desk study
13 - M	Sectoral Head Office - 3B+20G+R	160,907,521.66	10.21	720	77	178	10.69	55.18	Selected for desk study
14 - N	3B+G+M+8 9th to 13th Building of National Archives and Library Agency	113,365,309.73	55.99	540	329	1526	60.93	100.00	Selected for desk study
15 - O	B+G+4 Mixed Use Building	19,597,072.65	14.55	730	437	205	59.86	98.84	Selected for desk study
16 - P	Property & supply, Workshop & Engineering Division	27,782,937.26	23.67	600	147	1037	24.50	114.31	Selected for desk study
17	Addis Ababa Leadership Academy	46,333,457.89	3.31	1095	21	1221	1.92	50.58	
18	School of Journalism & Mass Communication Building	33,793,784.55	4.15	913	36	1281	3.94	43.58	
19	4B+G+M+25 ACSI Mixed use Building	0.00	0.00	1095	1026	108	93.70	32.84	
20	Chain Link, Masonry, Ditch and Masonry Fence Works	853,523.89	8.71	180	90	793	50.00	67.95	
21	Hospital electromechanical work	1,896,370.00	2.77	540		296	0.00	79.30	

22	Transport Management & Traffic Safety Training Institute Facility Building	- 12,475,987.14	-3.60	730	0.00	509	0.00	28.57	
23	Adwa Museum Zero Km	0.00	0.00	730	0	339	0.00	53.55	
24	Electro mechanical work for 3B+G+13th Building of national archives and library agency	0.00	0.00	270	0.00	400	0.00	91.13	
25	B+G+5 Ethiopian Forestry Development	0.00	0.00	540	0.00	90	0.00	25.84	
26	Kolfe Keranyo General Hospital Building	0.00	0.00	540	125		23.15	1.50	
27	Design and Build of Nifas Silk Lafto General Hospital (B+G+2) Building, other Miscellaneous Building & Site Work	0.00	0.00	540	0.00	138	0.00	21.91	
28	B+G+M Center Of Excellency Building	7,381,274.42	9.78	365	27	136	7.40	37.85	
29	New Addis Ababa Prison Facilities (Hospital)	0.00	0.00	270	0.00	0.00	0.00	78.71	
30	Remaining Works for Dormitory, Concert hall, Office, Class Room and Site works of Yared music school	0.00	0.00	120	0.00	0.00	0.00	70.18	
31	Interior Works of Ministry's Office Project	23,892,924.31	25.48	90	23	0.00	25.56	60.06	Client took over the work
32	Construction of Office Interior Renovation Building Works	3,203,326.79	3.70	90	4	247	4.44	87.67	
33	Waste Disposal	373,914.68	1.10	240	27	30	11.25	1.00	

	(Containerized Treatment Plant)								
34	Addis Ababa Small & Medium Scale manufacturing Industry Cluster (Lot-01)	0.00	0.00	730			0.00	3.95	
35	Addis Ababa Small & Medium Scale Manufacturing Industry Cluster (Lot-03)	0.00	0.00	730			0.00	9.77	
36	Construction work of security office and septic tank	New projects and their consultancy agreement were not signed -at the time of data collecting							
37	Guards' playing field and shade work								
38	Archive Phase II								
39	Library Renovation								
40	Construction of Open Garbage Building	0.00		30				87.49	
41	Office Building Maintenance								
42	Design & Construction work of renovation of House of Federation Office Building	0.00	0.00	210	0.00	0.00	0.00	8.25	
43	Addis Ababa Leadership Academy Landscape Project	0.00	0.00	240	0.00	0.00	0.00	4.70	